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Ontario Department of Agriculture

FRUIT BRANCH

Natural Swarming of Bees and How to Prevent It.

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THE PROBLEM.

There are three great problems in bee management in Ontario, viz., Brood Diseases, Wintering, and Swarming. While the first two are very real, the swarming problem comes home to every beekeeper whether he realizes it or not.

Fig. 1.—Queen, Drone and Worker of the Honey Bee. (*Gleanings in Bee Culture.*)

If his bees build up strong enough to gather a good crop of honey they are sure to develop the swarming impulse if left to themselves. If he cannot control this impulse to swarm, the beekeeper must either spend a great deal of time watching for and hiving swarms, or else lose enough swarms to take the profits off his bee business. If he has any other work the swarming is more than likely to take place at the most inopportune time, e.g., when he is busy in the hay field at the back of the farm, or when he is away from home. Now all this is very expensive and quite unnecessary.

Business Methods Needed.

There is nothing on the farm which requires so little care, in proportion to the returns, as bees. This is why they are sometimes kept at a loss: because the care they need is comparatively small and is often neglected. They require less attention than some other things; but what they do require they must have. The management of an apiary for honey must be approached in the same business-like manner as, for example, the management of a dairy herd for milk. There is no more "luck" or "chance" in the one than in the other. Scientific methods govern both. Failure in either is due to some definite cause which must be discovered and mastered before success can be attained.

Master of the Situation.

One first principle in handling any live stock is to be master of the situation. One cannot get full value from a horse until it is completely under control. It is the same with bees. To be a successful beekeeper one must be a bee-master; not in any cruel sense, any more than with a horse. To manage a horse, one must know a horse from A to Z. To manage bees one must study their habits and disposition, and learn as far as possible why and how they do things. This takes time, but it is well spent.

Equipment.

While it is possible to handle bees in a limited way without tools or protection, most successful apiarists find that three things are indispensable, first, a good *Smoker,* one which will hold ever in readiness a volume of smoke, not to be used cruelly, but to control the bees of a colony under all circumstances. The majority of the smokers now in use in small apiaries should have been in the museum years ago. Second, a good *Veil,* held out from the face by the rim of a hat, and drawn close around shoulders and chest so no bee can get near the face. The material must be black, light weight and strong, without dots or figures to interfere with the sight. Third, a *Hive Tool.* The commercial hive tools are good, or a screw driver and a wall scraper used by paperhangers will answer. Fourth, a queen excluder and at least two supers for each hive. A quantity of *wired frames* and full sheets of light brood *foundation* will also be needed.

System.

To manage bees successfully one must inspect them often, so as to always know their condition. This requires system. One day of the week should be set aside for the apiary, not necessarily the whole day if there are only a few hives. Weather or other conditions may cause the apiary work to be postponed till the next day; but next week the regular day should be resumed. System goes a long way towards success in anything. Of course, the bees should be visited and studied as much as possible, but one particular day of the week should be the day for regular apiary work.

Other live stock require attention two or three times a day throughout the year, and the results of neglect are immediately manifest. Bees do not need such frequent attention, nor does the casual observer notice the results of neglect; but they are just as real and are frequently quite serious.

The Spring Cleaning.

Let us suppose that Monday is Apiary day. On the first fine Monday in May, when a little honey is coming in and it is warm enough for bees to fly freely, the hives should be overhauled and their insides, as well as the frames of combs and queen excluders, scraped clean of superfluous wax. This can be done by

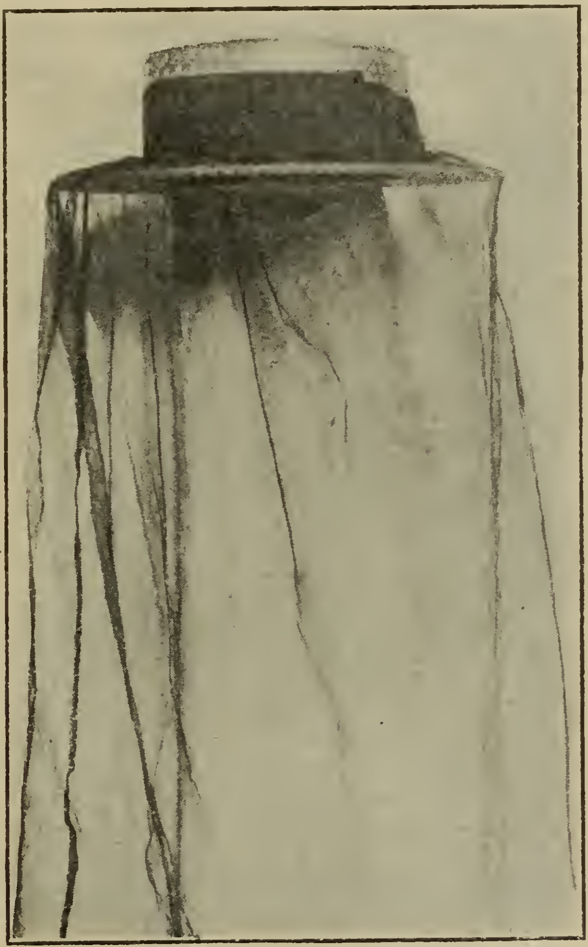

Fig. 2.—Bee veil on straw hat.

transferring the comb and bees of each hive in succession into a clean hive. In this operation care should be taken to expose brood as little as possible to hot sun, cold wind, or robbers, and to keep the combs in exactly the same order. It should also be remembered that the scrapings make beeswax, a valuable by-product of the apiary.

Clipping Queens.

Queens should have their wings clipped at this time. This is no factor in the prevention of swarming, but it usually prevents the escape of natural swarms that do occur. It is also the best way of marking queens for keeping a record of their age and efficiency.

Weekly Examination.

Every week after the beginning of fruit bloom, each colony is examined to note the progress of its development and give necessary treatment.

Before opening or even smoking any hive, study the actions of the bees at the entrance to see whether the colony seems strong or weak, whether they are working or loafing, whether robbers are about, etc. You will learn to judge internal conditions by outside appearances in a way which cannot be explained on paper. It is a thing to strive after to be able to tell without opening a hive what attention that colony needs.

To do this the weather and the progress of the honey flow must also be taken into account. For instance a colony will need different treatment at the beginning of the honey flow from what it would need for the same condition later on.

The clover honey flow usually begins in earnest about ten days after the first white clover blossom is noticed by the observant beekeeper. Up to that time

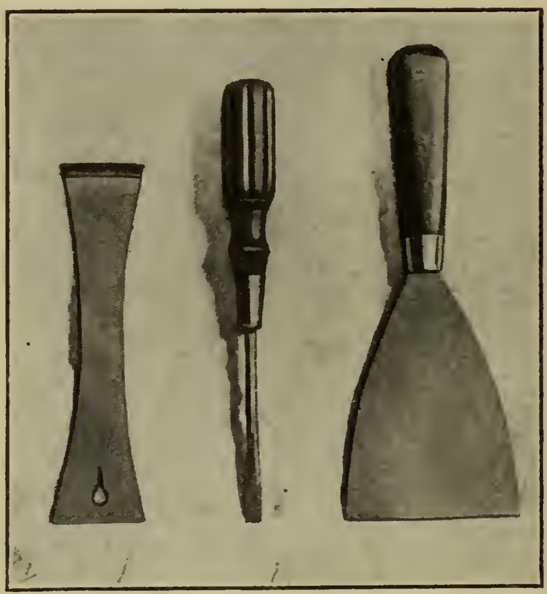

Fig. 3.—Hive Tool, Screw-driver and Wall Scraper—all handy apiary tools.

the effort is to get a large working force of bees in the hive by uncapping or feeding and turning all honey into brood. At the same time room and ventilation are given to prevent any chance of swarming impulse.

Turning Honey Into Workers.

At each visit some of the old honey is uncapped and placed next the brood. Regulate the uncapping so as to have all the old honey used in brood rearing by the opening of the clover bloom in June. Do not transfer combs from one hive to another unless necessary to feed a needy colony, and then not unless you are perfectly sure you have no foul brood.

If short of stores, colonies may be fed in spring as follows:—Make syrup of granulated sugar and water in equal proportions, fill the cells of empty combs with this and hang them in the brood chamber next the brood. This should be done towards evening to avoid robbing. There are a number of feeders on the market which would answer as well or better.

Giving Ventilation and Room.

As the strength of the colony increases, enlarge the entrance gradually, until about June 1st to 10th, according to the season, when all except weaklings should be given an entrance the full width of the hive and an inch and a quarter deep.

Every colony that is found to have its brood chamber crowded with bees before the clover flow should be given an extra set of worker combs, without an excluder, so the queen may have free range of this double brood chamber. It is very important to give the queen this extra room before any swarming impulse starts. At the commencement of the clover flow the queen must be again confined to one brood chamber by means of the queen excluder. Every colony should then have at least one super above an excluder, and when that is half filled with honey another placed between it and the brood chamber.

Dark Honey all Out.

When clover honey begins to come in freely every vestige of dark honey must be removed from the hives. This is one of the most important things in the production of white honey. Not one speck of dark honey must be left even in the brood chamber, as the bees are liable to transfer it to the super at any time and make room for the queen to lay.

Causes vs. Preparations.

There are two things one must learn in order to prevent natural swarming:—

1. The conditions which usually cause it. These must be learned so that when one sees them one will know that unless they are removed the bees are almost sure to get the swarming impulse if they have not got it already. When found they must be removed as far as practicable.

2. The preparations a colony generally makes before it swarms. When these are known in every stage, the apiarist must know, at whatever stage he finds them in the hive, what to do to stop them, and keep the colony from swarming.

There must be no confusion between preparations for swarming and causes of swarming. Preparations are not causes. To hinder preparations without removing causes is of little use. To remove causes after preparations are well under way is not nearly so satisfactory as to prevent the causes even before they occur. A division of the working force of the hive can be prevented by keeping all hands contented and at work; but a colony once determined to swarm will carry out its programme in spite of all but the most radical measures.

Causes of Swarming.

Some causes of swarming are the following:—

(*a*) It is the natural method of increasing the number of colonies.

(*b*) Some strains of bees are more inclined to swarm than others.

(*c*) Bees with an old or failing queen are more inclined to swarm.

(*d*) They often swarm when superseding an old queen.

(*e*) Brood nest crowded with brood, or "bound" with honey—needs laying space in middle for queen.

(*f*) Supers crowded with honey, and flow still on.

(*g*) Hive is poorly ventilated or has too much hot sun—or both.

(*h*) Weather conditions, such as excessive heat and humidity.

(*i*) A long continued, slow flow.

(*j*) The season—including (*h*) and (*i*) and other factors not determined—makes a difference in tendency to swarm.

The Colony Prepares to Swarm.

The preparations for swarming are as follows, and in the order named:—

(*a*) Queen-cell cups built along the lower edges of the combs, or in any other convenient place in the brood chamber.

(*b*) Eggs in some of the cell-cups.

(*c*) Larvæ in some of the cell-cups.

(*d*) Capped queen-cells.

The swarm comes almost immediately after that.

Queen-cells do not necessarily cause swarming. They are a part of the swarming operation when built for that purpose. Simply cutting them out after they are built does not remove the cause, and often does no more than delay the swarm for a few days. In the meantime it makes the bees discontented and may check honey gathering. The successful prevention of swarming, then, is not simply cutting out queen-cells, as many suppose. It is preventing or removing the conditions which cause them to be built.

Importance of Good Queens.

A colony with a young, vigorous queen is much less inclined to swarm than one having a queen that is beginning to fail.

The swarming instinct is stronger in some strains of bees than in others.

These two points have to be carefully observed in swarm prevention; the former by requeening where queens are failing, the latter by rearing queens from non-swarming stock. Some of our most successful beekeepers requeen each colony every year towards the end of the honey flow, others keep a supply of young queens on hand to replace those that are found to be failing from time to time. In either case, the careful beekeeper will rear his queens from good stock that does not show an inclination to swarm. One authority, after taking ordinary precautions to prevent swarming, kills every queen that takes out a swarm, and requeens from non-swarming stock.

The loss from poor queens also shows itself in winter and spring. From 10% to 20% of winter losses are caused by the death of queens which were failing and should have been replaced the fall previous. Another 10% of queens fail in spring and cause the loss of the colonies which would otherwise have wintered. Many which survive the spring spend the summer superseding and their colonies gather no crop.

How to Tell a Poor Queen.

A poor queen may be known by the following points: First—By the uneven appearance of the brood. The queen does not lay regularly in every cell, but skips back and forth, producing brood where capped cells are interspersed with empty cells and open brood. Second—More than one egg in the cell when the colony is strong. This condition in summer always indicates either a poor queen or laying workers. The latter will be known by the fact that there are usually quite a number of eggs in the cell, and these produce only drones. Sometimes in the spring a good queen will place two eggs in some of the cells, because the cluster of bees is so small that she cannot find protected cells enough to hold the eggs she is prepared to lay. Third—A poor queen will leave the worker brood and go down to the corners of the combs to lay in drone cells. A good, young queen will not lay drone eggs at all on the start. Fourth—Crippled queens are not usually good. Fifth—Old queens are usually shiny and slippery looking. They are often stiff in their movements and slow. Sixth—When bees are cross or do not work well, it is sometimes the fault of the queen. Seventh—Drones in worker cells are an indication of a poor queen. Eighth—A queen which goes through the queen excluder is always a nuisance, and, especially if she does this for the purpose of finding drone combs, she should be disposed of.

How to Tell a Good Queen.

A good queen, on the other hand, is known by possessing the opposite qualities to those given above, and some others. She will start laying in the middle of a

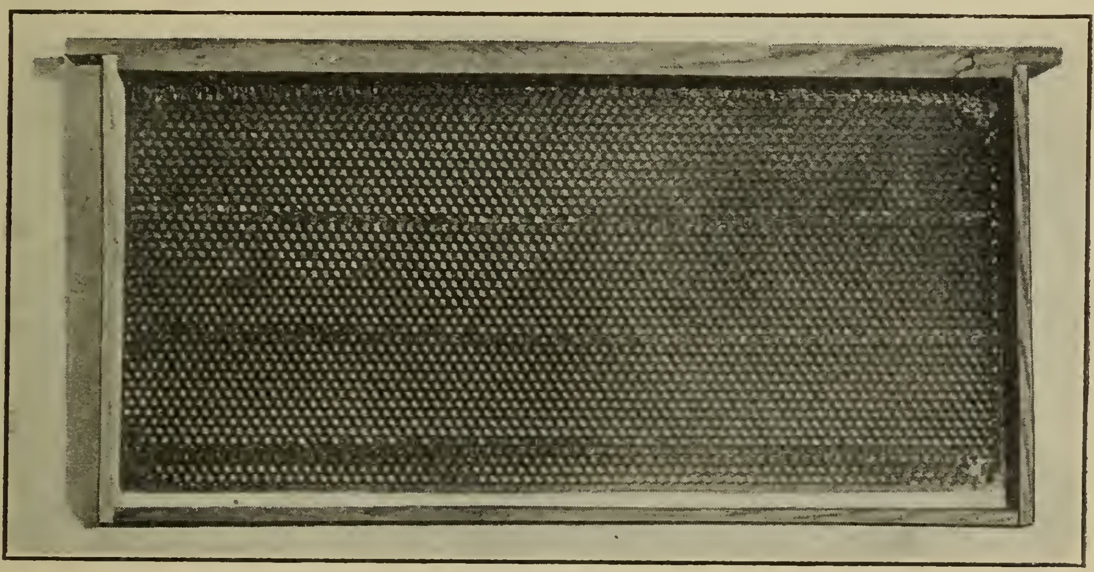

Fig. 4.—Frame of Wired Foundation.

comb and lay in every cell in a circle from day to day, so that, as the brood develops, each comb presents an even appearance. She will fill the combs right out to the end, down to the bottom, and up to the top; not leaving a rim of honey along below the top bar, if there is super room above for the honey to be stored. We do not expect the brood chamber to be used for the storage of honey; we expect the brood combs to be filled from end to end and top to bottom with brood. She will place her eggs evenly, all pointing in the same direction and only one in each cell. She will leave any bits of drone comb in the brood chamber until the season is advanced before she starts laying in them. She will have at least eight or ten combs of Langstroth size filled right up with worker brood in the height of the breeding season. She is well developed in appearance, graceful and strong in her movements; not excitable nor easily frightened, but on the other hand, neither awkward nor sluggish.

A good queen is known by the workers which hatch from her eggs. We shall look for a moment at the kind of workers we would expect from good queens. First—They will be industrious workers. There is a great deal of difference in the working of different colonies of equal strength, as we learn by keeping records of the amount of honey produced. Second—The workers are good nurses, that is, they feed the larvæ well. This difference can be noticed by examining the unsealed brood. If they are well fed there should be a little milky fluid around each one as it lies in the bottom of the cell. Well fed larvæ produce stronger workers and are better able to resist disease. This brings us to the third point, which is, resistance to robbers and disease. Some colonies will defend themselves against robbers and European Foul Brood much better than others. The fourth point is gentleness of the workers. You should always requeen a colony which is particularly vicious. There are gentle bees which work just as well as any savage ones and are much nicer to handle. Fifth—Some of our colonies swarm much less than others. There is no doubt that the swarming instinct can be bred out to a certain extent by selecting queens from non-swarming colonies. We know that queens reared under the impulse of swarming are always strong and vigorous and, as it is the easiest way, it is always a great temptation to simply use ripe queen cells found in colonies which have swarmed, for raising young queens. This selection of breeders that swarm is not wise.

Examining the Brood Chamber.

Certain points should be observed in every examination of the brood chamber. First, the health of the colony. Watch for symptoms of disease as described in Bulletin 213. Second, the queen condition of the colony. The presence or absence of eggs indicates whether a laying queen is present. The other symptoms previously described show whether she is doing well or is failing. If you have a record showing that she is old, and the appearance of brood, etc., indicates that she is failing, the sooner you replace her with a young queen the better. Third, see that general conditions as to amount of comb space for egg laying and honey storage are right, then watch for signs of the swarming impulse.

Not much attention will be paid to queen cell cups without eggs, except to look a little more carefully to the ventilation, room and general comfort of the hive, but where eggs or larvæ are found in cell-cups, some action must be taken.

Swarming, Supersedure or Requeening.

Not all queen cells are built for swarming, however, and when they are found, conditions must again be studied to know whether the intention is swarming, supersedure or replacing a lost queen. Queen cells for swarming are built with great care on lower edges of brood combs or in holes or hollows of the same. For supersedure, the same care in building is shown and it is often difficult to be sure whether supersedure or swarming is intended. The general index of queen condition, as previously described, is the best guide.

In a complete non-swarming system these cells cannot be left, because a young queen will often take out a small swarm. Where indications point strongly to supersedure, the old queen should be killed and all cells removed. The queenless colony can then be united with a nucleus having a laying queen as described below, or a queen may be introduced by one of the approved methods. This will give better results than to allow the colony to raise and mate its own queen. Good large capped cells from either swarming impulse or supersedure produce good queens, and can be given to newly-made nuclei.

Queens sometimes die suddenly from various causes. Then cells are built hastily on the sides of the combs wherever eggs or very young larvæ are found. These cells are always easily distinguished, and this sudden queenlessness is proven by the absence of eggs and young larvæ. All cells built under such conditions should be destroyed, as they are likely to produce poor queens. The colony is then hopelessly queenless. A good way to dispose of a queenless colony at any time is to unite it with one having a queen. This is done as follows:—

Requeening by Uniting.

Towards evening remove its cover and spread over the frames a sheet of newspaper having a small hole in the middle. Place over this a nucleus having a good young laying queen. The bees will gnaw away the paper and unite peaceably. There should always be a supply of nuclei in the apiary for this purpose, and for what increase is desired.

Fig. 5.—Two Colonies ready for uniting.

To Prevent Swarming.

The method of management to prevent natural swarming consists in judiciously from week to week studying the conditions of each hive, as a doctor studies each individual patient, and letting alone or giving treatment as each case requires. Experience enables one to do this rapidly and without the detailed examination which the novice must use. A knowledge of the habits of bees is necessary, and will be acquired by this work.

In the weekly examination when conditions which would cause swarming are discovered, they must be removed or counteracted in some other way. When preparations for swarming are found, the factors known to be opposed to swarming must be increased and the preparations removed if far advanced.

Essentials.

The essentials for swarm control are *room, ventilation* and *shade, given in time; also a good young queen of a non-swarming strain.* These all can be given in various ways.

Making Increase.

It is not at all necessary to allow natural swarming for the sake of increase. This can be made artificially by means of nuclei and the bees kept under control while doing it.

Making a Nucleus.

To make a nucleus proceed as follows:—When the main honey flow has well begun, place two or more combs of brood, mostly capped, and a comb having plenty of honey, in the super of a strong colony. At the next visit, a week later, bring queens that have been secured from a reliable queen breeder, or good ripe cells of your own rearing, and proceed as follows:—First examine the combs of brood and destroy any cells that may have been started because of the excluder separation from the brood chamber. Do this carefully so as not to drive the bees

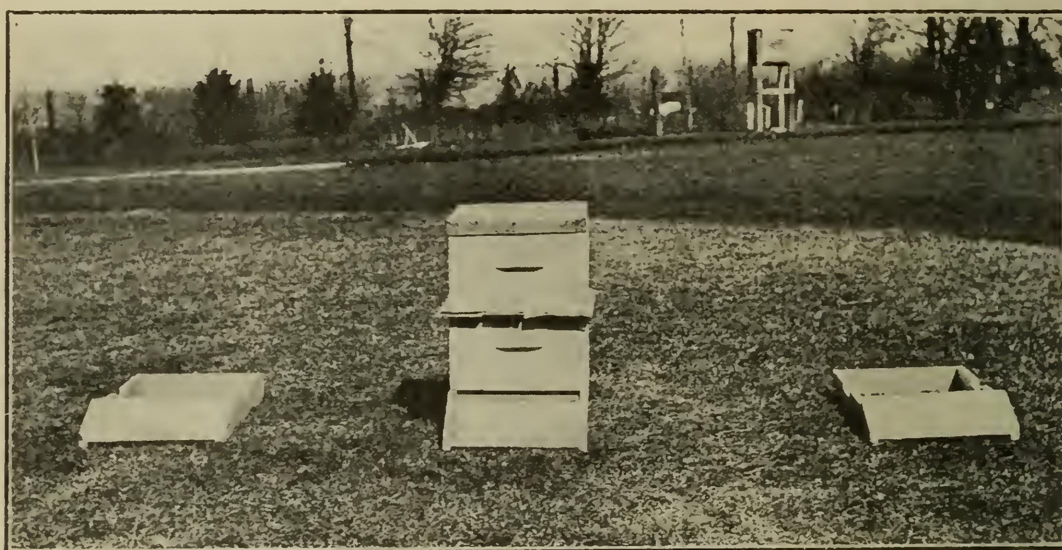

Fig. 6.—Two Colonies united by newspaper plan.

down out of the super. If the brood is from a good colony and good cells are built, it is as well to leave the best of these as to destroy them and introduce others.

You now have in this super a proper nucleus, with hatching brood and young bees which will not return to the parent hive, and which will easily accept a strange queen, and because of the week's separation from the queen, there is no open brood to perish from neglect. Now set the whole super gently off on a bottom board, contract the entrance to about two inches, introduce the queen or cell, and carry this new hive to its own stand wherever desired. Nuclei should be made as early as possible and not as a rule later than the middle of July. The safest way to introduce a new queen is to a nucleus, and the safest way to requeen a strong colony is to unite with a nucleus.

METHODS OF SWARM PREVENTION

Numerous methods of swarm prevention have been advocated in bee literature and at conventions. Several of these have been tested in the apiary of the O.A.C., and by co-operative experimenters of the Experimental Union. The three most successful methods will now be described.

No. 1. Swarm Prevention in Production of Extracted Honey.

As previously described, each strong colony has been given an extra set of worker combs without queen excluder in fruit bloom. Allowing the queen this extra laying space has put a strong check on the swarming impulse. When clover honey starts coming in June the queen is again confined to the old brood chamber with an excluder and the watch for swarming impulse begins in earnest.

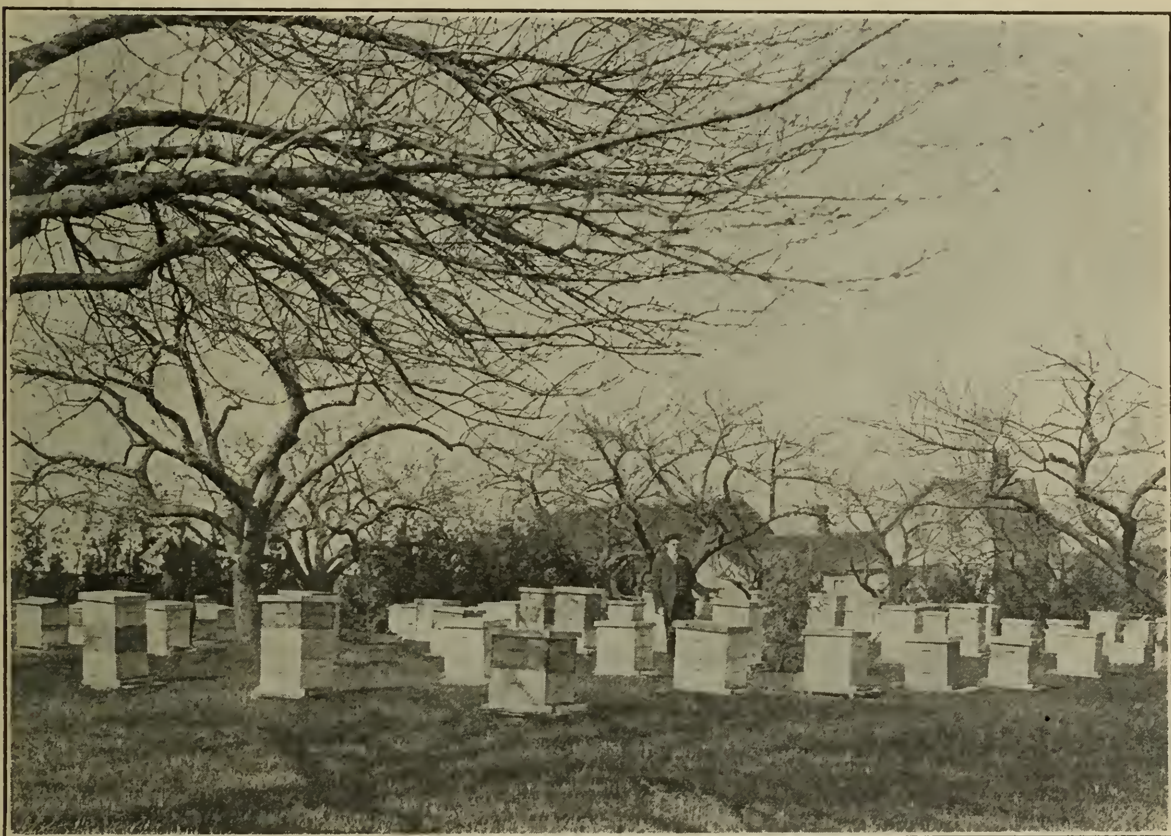

Fig. 7.—Apiary of Homer Burke, Highland Creek.

It will be seen that this apiary is well supered up for extracted honey production.

On the next visit a week later the brood above the excluder must be examined for queen cells, which may have been started because of the separation from the queen. If the colony is of a desirable strain these may be used with the brood and adhering bees in making nuclei for increase or queen rearing. In any case they must not be left in the colony for fear of their presence inducing swarming.

It is necessary for one who is beginning the study of swarm prevention to look at every brood comb of every hive once a week for the next few weeks until the swarming season is past. This seems like a lot of work; but it does not take nearly so much time as one would think. The stirring up the bees get makes them work all the better, and it is a great satisfaction after one day spent in the apiary to be able to go off about other work and know there will not be any swarming for a week at least. When one compares this with the worry of fussing with swarms and losing them before and after they are hived, the work of the weekly examination sinks into insignificance.

Giving the Queen Room.

When on the weekly examination we find cell-cups with eggs and indications do not point to supersedure or requeening it is time to start giving the queen room. Remove a comb from the outside of the brood chamber, and put an empty worker comb or frame of wired foundation in the centre of the brood nest. If the colony is quite strong, or if the queen cells contain larvæ, it may be given two or three such frames. All queen cells with eggs or larvæ must be destroyed. To miss destroying even one, may mean that it would be developed and a swarm issue. In every case alternate foundation or empty combs with brood.

In removing combs from the brood chamber follow this order, first empty combs and combs of honey till they are all out, then sealed brood. If the empties are clean and the honey white, place them in the extracting supers of the same hive (if they will fit), also the brood, unless it is needed for making increase or building up weak colonies. When open brood is placed in a super it should be examined next week and chance queen cells removed.

When queen cells for swarming are found far advanced the final remedy is to take away all the combs of brood but the one which has the least brood and give empty worker combs or frames of wired foundation.

In case cells seem to be built for requeening or supersedure, follow instructions given above.

See that the extracting supers do not get at all crowded with honey. It is most important to have lots of supers. It saves time during the busy season, and also gives a much better quality of honey to tier up supers and not extract until the close of the white honey season. On the other hand, it is necessary to remove all the white honey that is ripe just before the bees begin to gather dark honey. This in most sections is about the first of August.

If this method is followed carefully the colony will be held together throughout the season, giving best returns in honey and a good strong colony for winter. Desired increase may be obtained most economically by means of nuclei. For five years experimenters throughout Ontario have tested this method, along with others. It is still the most popular method where extracted honey is produced, and many flattering testimonials as to its value have been received.

No. 2. Swarm Prevention and Comb Honey Production.

For Comb Honey Production the work in the supers has to be so crowded to get well-filled sections that it is practically impossible to keep the bees from contracting the swarming impulse. In fact the best work in comb honey supers is usually done by first swarms newly hived on starters. They are full of energy due to the completely changed conditions, they have no brood to care for and having narrow foundation starters instead of full sheets or combs in the brood chamber they throw their working force strongly into the supers.

About the only way to avoid having natural swarms is to make artificial ones. Just as good results are obtained, and the expense is far less, when artificial swarms are made properly.

Artificial Shaken Swarms.

In the first place every effort is made to retard swarming by putting on extracting supers and gradually enlarging entrances during fruit bloom. When white honey begins coming in, the extracting supers are removed and comb honey supers put in their places, without queen excluders. Entrances are enlarged to the full width of the hive and an inch or more in depth.

When on the weekly examination we find queen cell-cups with eggs and the indications point to swarming impulse it is time to make an artificial swarm. This is done as follows:—

First, a hive filled with frames containing half-inch starters of foundation and one worker comb in the middle is set on its bottom board a few inches behind the hive to be treated. The operator, who sits at the left of the hive, removes two frames from the new hive and shoves over the remaining frames so as to have the empty space next him. He now lifts the comb nearest him from the brood chamber, shakes it almost free of bees, and places it in the new hive next the left

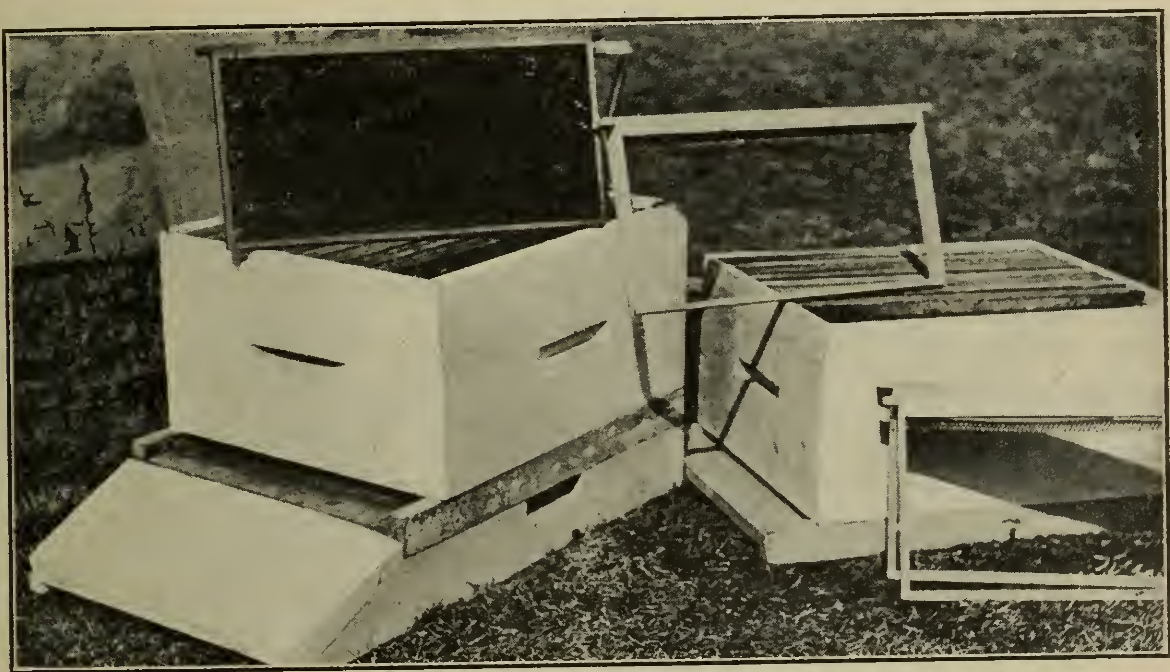

Fig. 8.—Showing method of making Artificial Shaken Swarm.

wall, the next comb has a double space for shaking off bees in the old hive. It takes its place beside the first comb and the return motion of the hands carries a frame with starter from the new hive to the old. Comb number three is shaken, carried to the new hive and frame number two is brought back. The fourth frame exchanges places with the third comb, and so on. If any good capped queen cells are found they may be saved and introduced to nuclei for queen rearing. In this case they must not be shaken, as a sudden jar is liable to injure or kill the embryo queens within. When the last comb has been shaken in its own hive and transferred to the new, and the old hive filled out with the starters, we put on the supers, close the hive, and the bees have been swarmed.

There is now a swarm hived on starters on the old stand, under conditions fairly natural, at the convenience of the beekeeper, without fuss, excitement or acrobatic feats. Leaving them in the old hive is merely a matter of convenience.

If there is no honey in the supers it is best to smoke and disturb the bees and give them time to fill themselves.

No. 3. Swarm Prevention by Manipulation of Hives.

When a colony is found to be ready for a super, that is when the brood chamber is full of bees, lift the hive and set it to one side, off its stand. Place an extra bottom board on the old stand and set on that a brood chamber of worker combs. If worker combs are not available use frames of wired foundation, or both together, but the more combs the better. Next remove the colony from its bottom board and set it on top of this, cover up warmly, contract the entrance if necessary, and leave until the next visit. We now have on the old stand a hive consisting of the following parts:—Bottom board, brood chamber of empty worker combs or frames of wired foundation (let us call this the new brood chamber), above that the old brood chamber and then the cover. As heat always rises, the brood is now in the warmest part of the hive for the changeable weather of spring. Any dark spring honey brought in will also be stored in the old brood chamber at the top. Whenever this becomes crowded with brood or honey, the queen goes down into the new brood chamber to lay. If she does not need the extra room it does no harm.

Once a hive is fixed in this way, there is not much more to do to it until the clover season opens, unless it is short of stores and has to be fed. When honey begins coming in freely from clover, which will generallly be from the 10th to the 20th of June, lift the old brood chamber off and set it down on a hive stand. Then examine the new brood chamber to see if the queen has gone down to lay yet. If there are no eggs, take out one comb and exchange for it a comb of open brood from the old brood chamber. There must be some open brood in the new brood chamber to which the queen is now to be confined. Next put a queen excluder on the new brood chamber, on that a super of extracting combs, and an empty super on top of all. Now proceed to shake the bees from the combs of the old brood chamber in front of the hive, taking care that there is a good runway up to the entrance, so the queen will not get lost on the ground. As the brood combs are freed of bees, place them in their regular order in the empty super on top. The object of this shaking is to make sure that the queen is located in the new brood chamber underneath the excluder. When all the combs are in place, cover the hive. The latter now consists of bottom board, new brood chamber containing the queen, queen excluder, super of extracting combs, old brood chamber and cover.

Most of the young bees immediately go upstairs to feed the brood, but some will stay with the queen, because she has some young brood with her. If she were left without brood she would be practically deserted. As it is, however, she will have enough attendants to make her satisfied to go on laying, and with the great number of empty cells available for brood there will be no more thought of swarming. Honey storing will continue in the old brood chamber, but as it has been on top all the time there will not be much room, especially if the queen has done her duty. Storing will now start in the extracting super. The young bees, finding that the queen does not come to lay eggs in the old brood chamber, will start queen cells there. If, however, by any chance the queen should be left in the old brood chamber, cells would be started down below. These would have to be removed and the queen put down on the next visit.

Now the swarming impulse has been disposed of for the whole season, especially if the queen is young and vigorous and ordinary precautions are taken to provide storage room and ventilation.

Disposing of Old Brood Chambers.

There is still the old brood chamber to be disposed of. If left where it is the cells vacated by hatching brood would be filled with clover honey, which, when extracted, would mix with the fall and spring honey, producing an inferior grade. In fact this is one of the most valuable features of this method of management, namely, the fact that the removal of the old brood chamber takes all dark honey from the hive at the beginning of clover.

Use Brood for Nuclei.

If you have been successful in getting the queen into the new brood chamber below the excluder, you will find next apiary day that the brood in the old brood chamber is nearly all capped, and has a number of nice queen cells. It is now in prime condition to lift off for a nucleus, according to directions given above. In doing this no precautions should be taken to prevent bees returning to the colony from the nucleus. The brood in the latter, being capped, requires very few bees to care for it, and the colony needs workers for the harvest.

To Requeen the Apiary.

This nucleus should be left beside or just behind the colony for one week, or until young queens are nearly ready to hatch, then removed to another part of the apiary to cheat it of its flying bees and knock out any idea of sending out what might be called an "after-swarm." It will be better to give it a super of extracting combs, if possible. If the queen is not one from which you care to breed, you might destroy all the cells and put in a cell from a good queen.

After the young queen starts to lay she can be introduced to any full colony, according to the directions given under "Requeening." This is a very good way to see that each colony has a young queen for going into winter quarters. If one is buying or rearing queens from selected stock, they can be introduced to these nuclei at the time of setting off. In that case the queen cells would have to be destroyed.

B234

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Ontario Department of Agriculture

CO-OPERATION AND MARKETS BRANCH

Organization of Co-Operative Marketing Associations

F. C. Hart, B.S.A.

INTRODUCTION.

During the last few years considerable interest has been aroused in the subject of Co-operative Marketing. The discussions, however, have centred mainly about the benefits of co-operation. Little has been said of the equally important methods by which co-operation is to be carried into effect.

So far in Ontario co-operation has not made as rapid progress as some would desire. The failures have been explained by one cause or another, the most frequent, perhaps being the general lack of knowledge of the co-operative idea, sometimes spoken of as the "disloyalty of the members." A primary cause of many failures, and one which is not fully appreciated when co-operation is under discussion, is the lack of a proper basis of organization, and the lack of proper business safeguards in the detail methods of doing business and of accounting.

This bulletin is designed to fill the evident need of such detailed information as to *organization*. It will be general in character, and will be followed by others dealing with organization for specific purposes, and giving details of business methods and accounting for these special organizations.

To many already engaged in successful co-operative enterprises, the observations and directions here outlined may seem elementary, yet it is desired to make the directions simple and easily understood, so that communities just starting a co-operative association may have a clear understanding as to the necessary steps.

An Organization for Business.

Co-operative marketing is organized selling, in place of individual selling. The members are left free to specialize in production, their natural field of endeavor, and unite to hire proficient ability in marketing. A prime necessity, therefore, is that the basis of organization should be such as to adequately carry on the work for which it is intended, should be capable of allowing natural growth of the business, and for this purpose, strict attention should be paid to modern business principles and methods.

Farmers' Clubs and other Educational Organizations have attempted co-operative marketing. While the amount of business is small this can be carried on with fair success. The basis of organization of a Farmers' Club is, however, usually such that growth of business brings numerous difficulties, and a time arrives when a reorganization is essential. The difficulties of reorganizing are as great as, or greater than the original organizing, and it would seem preferable to start on a right basis rather than later go through this tearing down and building up process.

The Club, however, is a valuable organization for the study of co-operation, perhaps for experimental shipments and for the more important work of acquiring the "get together" habit, and so in a position to successfully carry on co-operation; but for actual operations a separate business organization should be constructed.

The First Step.

While it is necessary to start with the prospects of having at least enough business to carry the overhead charges, a too ambitious beginning should not be attempted. In entering the new field there will be much to learn, unforeseen difficulties will arise, and mistakes, as in any business, will inevitably occur. It is the part of wisdom to overcome these difficulties in a small way and grow with success.

Start with the marketing of one commodity or one class of commodities. It is difficult to find a manager who can successfully market all farm produce, though he may know markets and marketing conditions for a few; there are no legal standards or grades of most farm produce, and the Association must establish its own standards and make these known on the market; a basis of paying members for produce on this quality basis should be worked out; these and many other considerations point to the wisdom of a modest and reasonable start.

A discussion of the proposed undertaking should take place at a Club meeting, or a special meeting called for the purpose. It is well to have some one at the meeting who is familiar with the trade in the article to be marketed. If possible, also a representative from another successful marketing association should be present. Opportunity should be given for free discussion. To be permanently successful, a co-operative organization must be more efficient than the present method, consequently there should be practically unanimity of opinion that such an organization would better the conditions of marketing the product under discussion.

Before the meeting closes, a small committee should be named of men who have the confidence of their neighbors and who are interested in the product to be marketed. This committee should gather all available information, and should draw up a definite set of by-laws, rules and regulations, all of which should be presented at a later meeting. If, at this second meeting it is decided to organize on practically the same basis as submitted by the committee a provisional Board of Directors should be named to complete the organization.

Write to the Co-operation and Markets Branch, Department of Agriculture, Parliament Buildings, Toronto, for assistance and advice in organizing, and submit a copy of the by-laws for suggestions. Get in personal touch with your District Representative of the Department of Agriculture and discuss the situation with him. Obtain from the Provincial Secretary, Parliament Buildings, Toronto, a copy of The Ontario Companies Act, (fifty cents).

Incorporation.

The Association may be either incorporated or unincorporated. An unincorporated organization partakes of the nature of a partnership and each member is personally liable for the acts and liabilities of the association. An incorporated Association has a more definite legal standing, with the resulting advantages, and each member's liability is limited to the amount due on his subscription for shares of the capital stock, or to the amount he is called on to pay according to the by-laws.

If it is desired to be incorporated, write to the Provincial Secretary, Parliament Buildings, Toronto, for application blanks for incorporation. As the forms vary, state whether the proposed organization is for a share company or a non-share corporation. It is not always necessary, but it is sometimes advisable to obtain legal assistance in putting through an incorporation.

Share Company.

A share company raises capital by selling shares. The application for incorporation must be signed by not less than five persons of the age of twenty-one years. The application must be accompanied by a memorandum of agreement and stock book (blanks of which accompany the application blanks) signed and sealed by the applicants. A copy of the proposed by-laws of the company should be sent to the Provincial Secretary with the signed application.

Before a company can offer shares for sale to the public, a prospectus signed by the Directors or Provisional Directors must be filed with the Provincial Secretary. The following is a suggested form of prospectus. A copy of the prospectus must be delivered to each subscriber at or before the time of his subscription:

PROSPECTUS

THE......................................CO-OPERATIVE ASSOCIATION, LIMITED

Incorporated the..... .... day of................ 19...... Under The Ontario Companies Act

AUTHORIZED CAPITAL - - $....................

Divided into

..........................Shares of.......................Dollars each

Provisional Directors :

....

....

....

....

....

Head Office :

.................................., Ontario.

Prospectus.

(The first paragraph of the Prospectus should give an outline of the objects of the business, the outlook for success, and what is to be attempted at the start. Any information of a general character as related to the trade of the article to be marketed as it affects local conditions might be stated, but nothing exaggerated or any statement that cannot be substantiated should be inserted. Statements as to the subjects mentioned in the following paragraphs are necessary, not of course as they are written, but to agree with the by-laws.)

The original incorporators are (names, occupations, addresses), each of whom has subscribed for one (or as the case may be) share.

A shareholder holding one share is qualified to be a Director. Directors will receive no salary as such, but will be paid bona fide expenses of attending Directors' meetings.

The proposed Directors are (names, occupations, addresses).

The minimum subscription on which the Directors may proceed to allotment is (   ) shares, and the amount payable on application is (   ) per cent. of the subscription, balance payable on the call of the Directors, but no call is to exceed (   ) per cent. of the subscribed stock, and there must be an interval of at least (   ) days between calls. No shares, debentures, or debenture stock have been issued or agreed to be issued except for cash. Nothing has been paid and nothing is payable by the Company as commission for subscribing or agreeing to subscribe or procuring subscriptions for shares of the company or for underwriting.

(Note.—This is an important clause. There must be some stated number of shares, other than the shares subscribed for in the application for incorporation, sold before allotment. If this amount is not sold in ninety days, the money collected must be returned to the subscribers; thus, the subscribers have the assurance that the undertaking will not proceed unless the stated number of shares is sold. The money collected on sale of shares cannot be used before allotment, but must be placed in trust at a chartered bank. At least five per cent. of the value of the share must be paid at the time of subscription.)

From the proceeds of the stock now issued, the company proposes to purchase
and proposes
to pay $ in cash for same.

The estimated amount of preliminary expenses is $. Nothing is to be paid to any promoter outside the estimated preliminary expenses.

The Auditor (if any) of the company is   (name and address).

None of the Directors has any interest in the promotion of the Company not disclosed in this prospectus, nor has he any interest in any property to be acquired by the Company directly or indirectly as a partner in a firm or otherwise.

A copy of this Prospectus has been filed with the Provincial Secretary.

Dated this   day of   A.D. 19   .

(Note.—The date of the prospectus is not the date of the day of signing it, but the date of its issuance to the public, and as a prospectus should not be issued until after the copy is filed in the office of the Provincial Secretary. The date of the prospectus should be the date of filing or some subsequent date.)

Allotment of Shares.

After the necessary number of shares are subscribed for and the required amount of cash paid thereon, the directors shall meet and allot the shares to the subscribers, and make return of such allotment to the Provincial Secretary within two months. When subsequent allotments are made, a return thereof must also be made to the Provincial Secretary within two months.

Form of Return for Allotment..............................Limited.

RETURN OF ALLOTMENTS OF SHARES PAYABLE IN CASH.

No. of Shares.	Nominal Amount.	Name.	Address.	Description.	Amount Paid.	Date of Allotment.
1	$100	E. P. Jones	Port Hope	Farmer	$5 00	January 9, 1915

The above Company hereby certifies that the above return is a correct state ment of the facts purported to be stated therein.

WITNESS the Seal of the said Company by the hand of its Secretary this day of 19 .

(Seal) ....

Secretary.

Certificate to Commence Business.

If incorporated with share capital and issuing and selling shares to the public, the company must obtain a certificate entitling it to commence business. This certificate is applied for to the Provincial Secretary when the minimum upon which the directors may proceed to allotment has been subscribed and allotted. Evidence of this subscription and allotment is given to the Provincial Secretary by filing a statutory declaration on the prescribed form, obtained from the Provincial Secretary.

Statutory Meeting.

Of a share company. Every company issuing or selling shares to the public shall within a period of not less than one month nor more than three months from the date at which the company is entitled to commence business, hold a general meeting of its shareholders. At this meeting the directors shall report as to:—

(*a*) the total number of shares allotted, distinguishing shares allotted as fully paid or partly paid up otherwise than in cash, and stating in case of shares partly paid up the extent to which they are so paid up, and in either case the consideration for which they have been allotted;

(*b*) the total amount of cash received by the Company in respect of such shares so distinguished;

(*c*) An abstract of the receipts and payments of the Company on capital account to the date of the report, and an account or estimate of the preliminary expenses of the Company;

(*d*) The names, addresses, and descriptions of the directors, auditors, if any, manager, if any, and secretary of the Company; and

(*e*) The particulars of any contract, the modification of which is to be submitted to the meeting for its approval, together with particulars of the modification or proposed modification.

The directors shall cause a copy of the report, certified as correct by the auditors, if any, to be filed with the Provincial Secretary. A copy of the report, signed by at least two Directors, must be sent to each shareholder at least ten days before the meeting.

Non-Share Corporations.

Non-share corporations or associations are those without capital or have acquired capital by means other than selling shares. Associations working under the promissory note basis come under this head. A non-share corporation does not have to issue a prospectus.

The signed application blank for incorporation must be accompanied by a Memorandum of Agreement, in triplicate, of which the following is a sample:

MEMORANDUM OF AGREEMENT of the
made and entered into this day of
19 .

(1) We, the undersigned, do hereby severally covenant and agree each with the other to become incorporated under the provisions of The Ontario Companies Act as a corporation without share capital for the purposes and objects following:

(2) The subscribers to the memorandum of agreement of the corporation shall be the first members and the corporation shall consist of the subscribers and of those who shall, hereafter, be duly elected as members of the corporation in accordance with the by-laws and regulations from time to time in force.

(3) The interest of a member in the corporation shall not be transferable, and shall lapse and cease to exist when such member shall cease to be a member of the corporation, by death, by resignation, or otherwise, in accordance with the by-laws and regulations from time to time in force.

(4) The first directors of the corporation shall be as set out in the Petition herein and shall constitute the Committee of Management of the Corporation.

(5) By-laws and regulations for the management and control of the corporation and governing the election of the Committee of Management from time to time and the conditions of membership of the Corporation shall be established, subject to amendment as therein provided, at a general meeting to be held not more than six months after incorporation at such time and place as the directors may determine, and such by-laws, regulations and amendments shall replace those set out in Form 4 in the schedule to The Ontario Companies Act, save that in any matters covered by such Form 4 and not provided for in the Corporation's by-laws, regulations or amendments,

the provisions of said Form 4 shall apply and be in force, but all such matters, which after the passing of the Corporation's first by-laws and regulations may be left to be governed by such Form 4, may be varied and amended by any by-laws, constitution or regulations.

IN TESTIMONY WHEREOF we have hereunto set our hands and affixed our seals.
WITNESS:

(Signed and Sealed.)

(Form 4 of The Companies Act covers the provisions usually contained in the by-laws, explained later in this bulletin.)

First General Meeting.

Of a Non-share Corporation. Every such corporation shall, within a period of time mentioned in the Memorandum of Agreement from the date of incorporation, hold a meeting of the members, at which the provisional directors shall report:

(*a*) The names and addresses of the members;
(*b*) The amount of capital subscribed and amount paid thereon;
(*c*) All contracts entered into by or on behalf of the company;
(*d*) The amount of preliminary expenses; and
(*e*) A financial statement of the affairs of the company signed by the auditors, if any.

At this meeting, or at a previous meeting, permanent Directors, Officers, etc., should be appointed, and the by-laws approved.

Fees.

1. Fees must accompany all applications and all documents to be filed with the Provincial Secretary. Where the fee does not accompany a document to be filed, such document will be returned to the sender forthwith.
2. No cheque will be accepted unless it is marked.
3. Cash not registered is at the risk of the sender.
4. Post Office Orders, postal notes, cheques, and drafts should be payable to the order of the Provincial Treasurer.

The following schedule of fees, as amended by an Order-in-Council dated December 2nd, 1909, shall be payable for the various services rendered by the Department under the provisions of The Ontario Companies Act.

Incorporation With Share Capital.

When the proposed capital of an applicant company is $40,000 or less, the fee shall be $100.

When the proposed capital is more than $40,000, but does not exceed $100,000 the fee shall be $100 and $1.00 for every $1,000 or fractional part thereof in excess of $40,000.

When the proposed capital is more than $100,000, but does not exceed $1,000,000, the fee shall be $160 and $2.50 for every $10,000 or fractional part thereof in excess of $100,000.

When the proposed capital is more than $1,000,000, the fee shall be $385 for the first $1,000,000 and $2.50 for every $10,000, or fractional part thereof in excess of $1,000,000.

Rural telephone companies, and other rural companies coming within the provisions of Part XII of The Ontario Companies Act, where the proposed capital does not exceed $25,000, $25.00.

Where the proposed capital is more than $25,000 the fee shall be on the same scale as that applying to ordinary share capital companies.

Rural cemetery companies, rural cheese and butter companies, and other rural companies of a similar nature, where the proposed capital does not exceed $10,000, $10.00.

Where the capital of a company of the classes in the two next preceding paragraphs referred to exceeds $10,000, the fee to be levied on the excess shall be at the rate of $1.00 per thousand, but in no case shall such fee exceed the sum of $25.00. To take advantage of this special tariff it must be demonstrated to the satisfaction of the Department that the purposes for which the company is being incorporated bring it within the classes referred to.

Supplementary Letters Patent.

Where the capital of a company is increased, the fee shall be according to the foregoing list, but on the increase only. No fee previously paid is taken into account.

Where the capital is not increased the fee shall be $100.00.

Where the fee paid for incorporation is $25.00*, or less, the fee for Supplementary Letters Patent shall be* $5.00.

Incorporation Without Share Capital.

Charitable Corporations	$5 00
Corporations without Share Capital	10 00
Supplementary Letters Patent	5 00

Filing.

Filing the annual statement of a share company having capital under $50,000, $2.00.

Filing the annual statement of a share company having a capital of $50,000 and less than $100,000, $3.00.

Filing the annual statement of a company without share capital, $1.00.

Filing prospectus, $2.00.

Filing report for statutory meeting, $2.00.

Certificate.

Where fee for incorporation is over $10.00, $25.00.

Where fee for incorporation is $10.00 or less, $5.00.

Books, Etc.

Every Company or Association must keep:

(*a*) A copy of the Letters Patent or any Supplementary Letters Patent and of the by-laws duly authenticated.

(*b*) A Stock Book, with the names alphabetically arranged and addresses and callings of all persons who are or have been shareholders or members and (in the case of share companies) the number of shares held by each shareholder, the amounts paid and remaining unpaid on such shares, and the date and other particulars of all transfers of shares in their order.

(*c*) A Minute Book, containing minutes of all proceedings and votes of the company and of the Board of Directors, verified by the signature of the President or other presiding officer.

(*d*) A proper set of books of account.

Annual Return.

An annual return must be sent to the Provincial Secretary on blanks supplied by that Department. Notice of any change of Directors (in a share company) must also be filed with the Provincial Secretary.

By-Laws.

The following set of by-laws is given as suggestive. Changes may with advantage be made to suit local conditions, but such changes should not be such as to affect the co-operative nature of the undertaking. Only the necessary articles for determining the general organization should be incorporated in the by-laws. The details of management, etc., should be placed in the rules and regulations. No rules and regulations are suggested here, as they will naturally vary with the articles marketed.

If the organization is incorporated, it is unnecessary to insert by-laws regarding the "Name" and "Objects," as they are embodied in the Letters Patent; they are inserted here for the use of unincorporated Associations.

Explanatory notes accompany the By-laws.

By-Laws of the   Co-operative Association, Limited.

Whereas the   Association, Limited, deem it expedient that certain by-laws for regulating the affairs of the company should be made,

Therefore, be it enacted and it is hereby enacted.

Name.

(1) This Association shall be known as the   Co-operative Association, Limited.

Note.—The name should be as simple as possible and not too closely resembling that of any known business being carried on. If the name of any business either incorporated or unincorporated is used, consent to use such name, properly signed, must be sent to the Provincial Secretary with application for incorporation.

The word "Company" means a company having capital divided into shares. A "Corporation" includes a company whether with or without share capital. The word "Co-operative" should be used only if the following provisions are contained in the by-laws.

1st. One man, one vote.

2nd. No voting by proxy.

3rd. Payment of dividend on capital not exceeding the usual rate of interest.

4th. Profits divided among members upon the basis of business done by the member through the Association. (See note, By-law 15.)

Objects.

(2) The objects of the Association are to produce, grade, buy, and sell the (milk, live stock, fruit, etc.), and (fruit, etc.), products of the members, and to buy, sell and deal in other and products, and to buy, sell and deal in supplies, feeds, packages, machinery, and to erect, buy, sell, own and control buildings and other materials as needed in the business, and to do all things incidental or conducive to the attainment of the aforesaid objects or any of them.

Note.—The objects should be stated in as few words as possible, but should adequately cover the business to be attempted. Sometimes these objects and powers are very wide and designed to allow the organization to carry on many kinds of farmers' business, though but a small portion may be attempted at first. Usually, however, it is better policy to build an organization to market but one class of farm produce, such as live stock, vegetables or fruit. In this way the members of the community interested in the different products are grouped. It is desirable that an Association master the details of marketing one commodity rather than a multiplicity of products, especially while the Association is young.

Members.

(3) Any (fruit grower) or (poultry keeper) or (honey producer) or (dairyman), etc., in District shall be eligible to membership in the Association.

Application for membership must be made to the Secretary of the Association in writing. The Board of Directors shall have the right to refuse any such application by a majority vote for any reason which to them shall seem sufficient.

The signing of an application for membership, unless the application be refused, shall be construed to be an agreement to conform to all the by-laws, rules, regulations and requirements of the Association which may from time to time be adopted by the Association.

The annual membership fee shall be .

Members may withdraw from the Association only during the month (or months) of in any year by giving notice in writing to the Secretary and by the payment of all moneys due to the Association at date of resignation.

OR

Any producer in District shall be eligible to become a member by a two-thirds vote in the affirmative of the members present at a meeting at which application is considered.

Any member may withdraw from the Association during the month (or months) of in any year by giving notice in writing to the Secretary, and by the payment of all moneys due the Association at date of resignation.

OR

Any person in a Co-operative Association or Co-operative Company engaged in business in the Province of Ontario or any Association of such individuals in good standing shall be eligible to membership in the Association.

Application must be made to the Secretary in writing on the prescribed form. The Board of Directors shall have the right to refuse any such application by a majority vote for any reason which to them shall seem sufficient.

The signing of an application for membership, unless the application be refused, shall be an agreement on the part of the said person, Association, or Company, to conform to all the by-laws, rules, regulations, etc., of the Association which may from time to time be adopted by the Association.

The annual membership fee shall be .

NOTE.—The choice of members is important. Too many Associations formed at a public meeting contain undesirable members who are a detriment rather than a help. It is often better to organize at a small meeting of invited persons. Some Associations have the application for membership come before a general meeting. This is feasible where the membership is small, otherwise the Board of Directors should decide.

Members should be allowed to withdraw only during the non-shipping season. The main consideration in this connection is that the Association should know approximately the amount of produce upon which it can depend.

An annual membership fee is desirable, though not always practised where capital is available. Where collected it might be placed in the reserve fund.

FORM OF APPLICATION FOR MEMBERSHIP.

Place Date

I, the undersigned, hereby apply for membership in the Co-operative Association, Limited, and agree, if accepted, to abide by all the by-laws, rules, and regulations of the said Association which may from time to time be in force.

This application shall be null and void unless within months from date (number) accepted applications are received by the Association

....

Witness. Signed.

MEMBERSHIP CERTIFICATE	
No............	Date....................
The..............................Co-operative Association, Ltd.	
........................Ontario.	
Expires................19 .	Not Transferable.
Mr..................................	
....	
....	....
Treasurer.	President.

Expulsion of Members.

(4) Any member may be expelled if found guilty of conduct detrimental to the Association, provided that he shall have received in writing one month previously the particulars of the charge against him and that two-thirds of the members present at a special or general meeting vote for his expulsion.

Directors.

(5) At the annual meeting of the Association a Board of Directors shall be elected of whom shall form a quorum at any Board meeting. Any member in good standing shall be eligible to be elected a Director.

If from any cause a vacancy occurs in any office of the Association it shall be filled for the unexpired term by the Board of Directors. Directors shall be elected for a term of one year but are eligible to be re-elected to office.

Questions arising at any meeting of Directors shall be decided by a majority of votes. In case of an equality of votes, in addition to his original vote, the Chairman shall have a casting vote.

Directors, as such, shall not receive any stated salary for their services, but shall be paid bona fide expenses for attending Directors' meetings.

Note.—No matter how small the organization the election of Directors should be by ballot. Open voting when once established is sometimes a difficult habit to break and should never be countenanced under any circumstances. It is essential to have the best men available and open voting at times is influenced by other considerations.

Duties of Directors.

(6) The President and Vice-President shall be chosen by the Directors from among themselves at the first Board meeting after the annual meeting. The Directors shall have general charge of the affairs of the Association and shall meet at the call of the President (at least twelve times during the year) or (once in every month) or (as the business of the Association shall require).

The Board of Directors (may or shall) appoint a committee from among themselves called the Executive Committee, consisting of President, Vice-President and   Directors. The Board of Directors may delegate any of their powers to the Executive Committee.

The Board of Directors shall fix the salaries or wages to be paid the manager and employees of the Association; also the Board of Directors shall appoint and arrange the duties of and may remove all employees of the Association.

Note.—In some Associations the officers are elected at the annual meeting. In other cases the Directors only are elected and they choose the officers from among themselves. The Secretary may or may not be a member of the Board of Directors. The Board of Directors should actually direct, that is, they should hold meetings and examine the work of the manager frequently enough to be acquainted with the business at all times. If too much is left to the manager the Association finally becomes a one-man concern. The Board of Directors should be large enough to adequately cover the District, but the smaller the number the better. Five, seven or nine Directors are usually enough to carry on the work. In some cases Directors are given the power to appoint not only an Executive Committee but other Committees for directing special departments.

Manager.

(7) The Board of Directors may (shall) employ a business manager who shall not be a member of the Board of Directors. The manager, subject to the control of the Directors, shall have charge of the business of the Association in detail. He shall have the custody of all the plant, goods, wares, merchandise and buildings of the Association and be responsible therefor. He shall keep a full set of commercial books which shall be open to inspection at all times to Directors or any officers of the Association. He shall take stock of all assets of the Association in conjunction with the Secretary and shall exhibit a complete inventory to the Directors at least once every year and oftener if required by the Directors to do so. He shall hand over to the Treasurer of the Association all moneys received by him on behalf of the Association. He shall permit free access to all books, stock, stocksheets, and all the assets of the Association to any Auditor appointed by the members or by the Board of Directors.

Note.—In all cases the manager should not be a member of the Board of Directors for the reason that he should not have a vote on his own actions. As a matter of fact his office is designed to take the place of one or more middlemen, and he should be but an agent of the farmers' organization and under its control. It is more important that the manager have business capacity rather than a knowledge of production. He should know something of the markets and marketing conditions of the commodity he is selling. It is equally important that the manager should know how to keep proper accounts, and exceptional care should be taken to see that his books are in proper shape at all times. In some cases the offices of Secretary and Treasurer may be filled by the one person. The Manager or Secretary from the start should be compensated for the time he puts on the work. This is best accomplished by paying him on a commission basis. Later on when all his time is engaged by the Association he can be paid part salary and part commission. Where the turnover justifies it, Associations find good results by paying their manager and other employees a straight salary as in other commercial concerns.

Duties of the President.

(8) The President shall, if present, preside at all meetings of the Association. He shall call meetings of the Board of Directors and shareholders, when necessary, and shall advise with and render such assistance to the manager as may be in his power. He shall do all things necessary to the proper conduct of his office.

In his absence the Vice-President shall have and exercise all the rights and powers of the President.

Note.—It is important to have in the office of President a trustworthy person who is willing to sacrifice some time and convenience for the good of the community; some one who will feel it his duty to keep in close personal touch with the activities of the Association and with the manager at all times.

Duties of the Secretary and Treasurer.

(9) The Secretary and Treasurer shall hold office until such time as he, or they, may resign or be discharged by the Board of Directors. The Secretary shall keep a record of the proceedings at all meetings of the Association and of the Board of Directors and Committees. He shall have the custody of all books, papers, records, etc., belonging to the Association, which he shall deliver when authorized to do so by a resolution of the Board to such person or persons as are named in the resolution.

The Treasurer shall have and keep custody of all moneys and securities of the Association. He shall deposit all such moneys immediately upon receipt thereof to the credit of the Association in the bank of   at   or such other chartered bank as the Directors may from time to time designate. He shall upon the direction of the Board of Directors (or Executive Committee) pay all accounts of the Association by check, countersigned by the President or Vice-President. No check shall be signed by both Treasurer and President or Vice-President in blank.

All officers or employees of the Association having charge of money or property belonging to the Association shall, before entering into the employment, provide such security as the Directors deem adequate and in such form as they may approve.

Note.—All accounts except petty cash accounts should be paid by cheque so that there may be no doubt at any time as to accounts. If the Treasurer or President signs cheques in blank, contrary to the provision of the by-laws, he becomes personally responsible therefor.

Bonds issued by a surety company are preferable to personal bonds. The names of reliable companies may be obtained from any good business man or insurance agent. Bonds of this nature cost about five dollars per thousand and this cost should be paid by the Association in order that the bonds may not lapse. Bonding the manager or other officers handling funds should be put into practice when the organization starts business; this will obviate the difficulty of asking for them at some inopportune time.

Meetings.

(10) The annual meeting shall be held at at such time during the month of as the Directors may decide to receive the reports of Directors for the past year, to elect Directors and Auditors for the ensuing year and for all other general purposes relating to the management of the affairs of the Association.

A general meeting of the members may be called at any time by the Directors whenever they deem the same necessary or advisable for any purpose.

The President shall call a special meeting of the members whenever required to do so in writing by not less than of the members.

Notice of the time and place of holding an annual, special or other meeting of the members shall be given by written notice to each member at his last known address at least days previous to the time of holding such meeting.

Special general meetings shall not transact any business other than that appearing in the written requisition and notice calling the meeting.

At the annual, general or special meetings of the Association one-fifth of the members shall be a quorum.

Note.—The annual meeting should be held at the place where the head office of the Association is situated. Special general meetings should not transact any business other than that appearing in the written requisition in order to avoid snap verdicts on important methods or policies of the Association.

Voting.

(11) At all meetings of the Association each member shall have one vote only, which shall be deposited by him, or her, in person. Should the decision of the Chairman on any question voted upon be challenged by five members present the meeting may decide the question by ballot.

Or

At general meetings of the Association each shareholder shall have one vote only, irrespective of the number of shares he holds. Votes must be deposited by him, or her, in person.

Note.—One of the fundamental differences between the industrial, mercantile or commercial (regular Joint Stock) Company and a Co-operative Company is that the former is for the purpose of making profits on investment and the latter is for the purpose of bettering the conditions of trade. One man, one vote, insures the democratic nature of the Association and prevents the business being run in the interest of a few, rather than in the interest of all the members. Where the interests of the few and the many conflict, the majority of members, not the majority of money invested, should rule.

Seal.

(12) The Association shall have a corporate seal of such design as the Board of Directors may determine, which seal shall, whenever used, be authenticated by the signature of the President and Secretary or the Vice-President and Secretary.

Note.—A seal of some description is necessary, even if it is only a rubber stamp. A regular stamping seal may be obtained at small cost.

Capital.

(13) The capital of the Association shall be divided into shares of $ each, carrying not more than per cent. interest. Calls upon the subscribed stock shall be made from time to time as the Board of Directors may determine but no call shall exceed (25 per cent.) of the subscribed stock, and there shall be an interval of at least (30) days between calls.

The Board of Directors shall have power to summarily forfeit shares and money paid thereon upon which any calls shall have remained unpaid for six months after it shall be due and payable and such forfeited stock shall thereupon become the property of the Association and may be disposed of in such manner as the Association in general meeting see fit.

Receipts for payment of calls shall be issued from time to time as such payments are made but stock certificates shall only be issued when shares are fully paid up. Both receipt and certificate shall be authenticated by the signatures of the President and Secretary and sealed with the Association's seal.

Shareholders may with the consent of the Board of Directors, but not otherwise, transfer their unpaid shares, and such transfer shall be recorded in a book provided for the purpose and signed by shareholder and transferee and duly witnessed, but no person shall be allowed to hold or own unpaid stock in the Association without the consent of the Board of Directors.

Or

Each member at the time of uniting with the Association shall give a promissory note, payable on demand, to the Association for the sum of $, and an additional for each and every owned by the member at the time of uniting with the Association, but in no case shall the promissory note be for a less sum than $.

At the time of uniting with the Association and at the end of each three years after the incorporation of the Association and not less than ten days prior to the date of next annual meeting, each member shall file with the Secretary a true statement of the number of owned by the members at the time.

Within two weeks after the annual meeting at the end of each third year the Directors shall require each member to give a promissory note, payable on demand, to the Association for the sum of $ and an additional for each and every owned by the member at the time, but in no case shall the promissory note be for a less sum than $. In consideration for the same the Secretary shall deliver over to the member the note previously given by the member duly cancelled and sealed with the seal of the Association.

The notes of the members shall be the property of the Association and may be used by the Directors as collateral security with which to secure needed capital for the transaction of the business of the Association.

Whenever the notes of any of the members are deposited as security for a debt, all the members shall individually share the liability in proportion to the value of the note given to the Association by each member.

Or

Each member at the time of uniting with the Association shall give to the Association a promissory note, payable on demand, to the Association for the sum of $, and said notes shall be the property of the Association and may be used by the Board of Directors as collateral security with which to acquire needed cash for the transaction of the business of the Association.

Any member may, with the consent of the Board of Directors, but not otherwise, give all or part of the amount of his note in cash; but in no case shall the total amount of note and cash be a less sum than $

At the end of each third-year period, after incorporation each member shall give to the Association a promissory note in amount equal to his previous capital note. In consideration for the same the Association shall deliver to the member the note previously given by the member duly cancelled and sealed with the seal of the Association.

Whenever the notes of any of the members are deposited as security for a debt, all the members shall individually share the liability in proportion to the value of the note given to the Association by each member.

Interest at a rate not exceeding per cent. shall be paid on all cash capital deposited by the members with the Association.

Note.—It is unwise to engage in any business without sufficient money to successfully carry it on. Every consideration demands that the Association be properly financed. Two outstanding reasons demand capital:

First, the member's capital to a certain extent insures his loyalty. Actions of a member detrimental to the business jeopardizes his capital and the member is made to realize that the success of the whole concern is of more importance than occasional losses of individual members.

Second, the Association should be in a position to pay at least part cash to the members when goods are delivered. The middlemen, whose place was taken by the Association, provided themselves with capital for this purpose. In any event the goods must pay for the capitalization while on the road to market. Where the members have to wait an indefinite period for complete returns of sales, sometimes delayed through unavoidable causes, their private business is seriously interfered with, and dissatisfaction results. With capital this difficulty is overcome.

In some Associations capital supplied by each member is varied in accordance with the amount of business the member is likely to do with the Association. As for example, varying with the size of orchard or number of trees in a Fruit Association. In most Associations, however, it is impossible to previously determine the members' business even approximately, and all members are required to supply capital in equal proportions. Capital may be raised in two ways. First, by using the cash of the members, and second, by using their credit. The most common method is that of selling shares. Where this method is used, at least five per cent. of the face value of the share must be paid in cash at the time the share is bought. Future calls for payment on shares may be made from time to time, or the profits that should naturally go to the members are sometimes applied toward paying for their shares. The shares do not become the absolute property of the members until fully paid up. Where cash is taken in payment for shares, the interest (or cash dividend) should not exceed the usual rate of interest. The unpaid portion of the shares may be used as collateral for raising capital. Where an Association has its capital tied up in buildings or other permanent outfit the share method is perhaps preferable.

Non-share corporations obtain capital by using the joint and several notes of the members, or their individual notes. These are personal notes payable on demand to the Association and constitute the credit of the members used for acquiring capital. As long as the Association is solvent the notes are not cashed. Where, however, the business has been unsuccessful the liabilities of the Association must be met by these capital notes. In the event of the liabilities having to be met by the notes of any of the members which have been placed as security, all the members must share the liabilities irrespective of which individual notes have been so placed.

By this method also interest is paid on capital only when it is in actual use.

A form of note is suggested:

THE CO-OPERATIVE ASSOCIATION, LIMITED.

Capital Note.

$100.00 Ontario, Canada.

Jan. 4th, 1915.

On demand I promise to pay The Co-operative Association, Ltd., the sum of One Hundred Dollars, to be used in accordance with the by-laws of the said Association.

Signed ....

....

Reserve Fund.

(14) Before any distribution of any surplus funds to be distributed to the shareholders (members) shall be made, there shall be set aside out of such funds of the Association such sum, or sums, not less than ten per cent. in any one year as the Directors may from time to time think proper as a reserve fund, for meeting contingencies, for maintaining or repairing any property of the Association, or for any other such purpose as the Directors shall think conducive to the interests of the Association, but at no time shall the total amount of reserve fund exceed the amount of capital at the disposal of the Association.

Note.—Every sound business sets aside a portion of its surplus funds for meeting unexpected difficulties and for repairing its property. Without such a reserve fund a small financial difficulty will often wreck an Association. Usually the reserve fund is limited by the by-laws so that an excessive amount of the profits cannot be kept from the members. Sometimes a Members' Reserve Account is kept so that upon withdrawal, his share of the reserve fund, less a certain percentage for depreciation, may be returned to him. The Association, however, should not bind itself to return such reserve, if doing so would financially injure the Association. Most of the Associations make no provisions whatever for returning any portion of the reserve fund to the members, and this latter is the safer plan.

Distribution.

(15) All surplus moneys in possession of the Association to be divided amongst its members shall be proportioned to each member on the basis of the value of the business done by the member with the Association.

Note.—After all legitimate expenses of carrying on the business have been paid, including interest on capital (which should be limited by the by-laws), the net surplus funds are distributed to the members who created such surplus and in the same proportion in which they contributed towards it. Where but one commodity is marketed, this is accomplished by dividing the surplus in proportion to the amount of business done by each member. Where a number of commodities is marketed, however, the profits in one line may be greater than the profits in another. The profits also vary at different seasons of the year. In such cases the returns are pooled for each commodity or, for certain times, that is, for each shipment, for each day, each week, or each season. In other cases, as for example, in cattle, each member's shipment is sold separately and returns made accordingly. Distribution of surplus depends on the nature of the business, but in all cases the surplus should be returned on a just basis.

Liquidated Damages.

(16) All farm produce handled by the Association and grown for sale through the Association by the members, and which is acceptable to the manager, shall be delivered to the Association as directed by the Board of Directors, and without the written consent of the manager members shall not sell through the Association produce produced by non-members.

Because of the difficulty of determining losses occasioned by members not adhering to the above rule, such losses shall be estimated by the Board of Directors, and shall be payable to the Association by offending members as liquidated damages.

Note.—This clause is sometimes inserted in the by-laws, sometimes in the regulations, and sometimes as a special agreement, preferably the last. It is important, however, that the Association should have some guarantee that it will have the necessary amount of goods to carry on the business and that it should know approximately the amount it will have for sale. Haphazard methods in the long run are seldom profitable. The loss entailed by the defection of members should be borne by the offending members and not by the loyal ones. If it is his intention to go into the business of marketing the member should be willing to say so and back it up with his guarantee. If he does not intend to stay with the Association it would be better to know it before he becomes a member rather than after.

As it is difficult to determine the exact amount of loss incurred by members not adhering to the rules and by-laws, the regulations should provide a specific agreement as to what those losses shall be, as for example, so much per barrel of apples, dozens of eggs, etc.

Form of Agreement Re Liquidated Damages.

The Co-operative Association, Limited.
Place Date

I, the undersigned, as a member of the Co-operative Association, Limited, hereby agree to deliver to the said Association all the and products grown (produced) by me for sale, and acceptable to the Association; and I further agree to pay to the said Association as liquidated damages (and not as a penalty) cents for each of not so delivered without the written consent of the Manager (or Secretary).

Witness .... Signed ....

Auditors.

(17) The accounts of the Association shall be audited by an auditor or auditors who shall be appointed at the annual meeting in each year. No employee or Director of the Association shall act as its auditor.

Vacancies in the position of auditor may be filled by the Board of Directors.

The auditor shall present a statement of accounts in such form and for such purpose as the Board of Directors may decide. He shall also prepare the annual returns of the Association and shall duly fulfil all the obligations pertaining to the office.

Note: A proper audit of the accounts of the Association is extremely important and this importance is not sufficiently recognized by Co-operative Associations generally. Large business concerns carry on a continual audit at all times. It is recognized that too large a proportion of the failures of co-operative associations has been due to the fact that proper accounting has not been practised. When an Association starts, Directors should cause an audit to be made each month for the first few months. Usually one or two of the members are appointed as auditors and too often these members have no knowledge of how to properly audit books and slip-shod methods of managers are allowed to pass. It is money well invested to acquire the services of an expert accountant to make an audit at least once every year. The annual audit should reveal the entire financial standing of the Association and should be clear enough to give every member a complete idea of the business transacted. Where a number of Co-operative Associations are carrying on business in the same district they might club together to hire the services of an expert accountant and the payment of the services divided in proportion to the time spent with each Association.

Changing By-laws.

(18) These by-laws may be amended at any regular or special meeting by a two-thirds vote of the members present, in the affirmative.

Notice of such amendments must be given each member by letter at least days previous to the meeting.

Note.—The by-laws should contain no more than enough to determine the general basis of organization. The details of running the business should be embodied in the rules and regulations which may be changed from time to time as occasion demands.

SUMMARY OF PROCEEDING.

1. Discuss the question with your District Representative of the Department of Agriculture, and with your neighbors personally, or in Club or other meetings.

2. Write to the Co-operation and Markets Branch, Department of Agriculture, Parliament Buildings, Toronto, and explain the situation as fully as possible.

3. Hold a small meeting of interested persons, or of a committee appointed at a Club or other meeting.

4. Have this committee gather all available information relating to the trade in the article to be marketed. Acquire local facts and figures to determine the advisability of such an organization. Get from the Co-operation and Markets Branch a list of other organizations in the Province in the proposed trade, and write them for information.

5. Have the committee frame and complete a basis of organization.

For Corporations Without Share Capital.

6. Write to the Provincial Secretary asking for forms for incorporation without share capital.

7. Return the forms properly filled out and with the necessary fees.

8. At the same time return three copies of a Memorandum of Agreement, each signed and sealed by the applicants.

9. As soon as the requirements of the Provincial Secretary's Department have been complied with, and notice to that effect has been received, the business may be started; but before starting the directors should adopt by-laws, rules and regulations, and obtain the minimum number of members mentioned in the application for membership.

10. Within the time specified in the Memorandum of Agreement hold a meeting of the members, make a full report of all transactions, have by-laws, rules and regulations approved by the members, and appoint permanent officers.

11. In January each year make the necessary annual return to the Provincial Secretary.

For Companies With Share Capital.

6. Write to the Provincial Secretary asking for forms for incorporation of a share company.

7. Return the forms properly filled out and with fees, and state, if so, that the proposed company is a rural co-operative company.

8. File a Prospectus with the Provincial Secretary with fee.

9. On notice from the Provincial Secretary that prospectus has been filed, issue the prospectus and sell (within 90 days) at least the minimum number of shares.

10. Allot the shares to the subscribers.

11. Make the necessary declaration to the Provincial Secretary on the form supplied and obtain certificate to commence business.

12. Appoint permanent officers, etc., and adopt by-laws, rules, and regulations.

13. From one to three months after receiving certificate hold the statutory meeting. File report of this meeting with the Provincial Secretary.

14. In January each year make the necessary annual return to the Provincial Secretary.

15. Notify the Provincial Secretary of any changes in the Directorate.

For All Companies.,

16. Keep records of the minutes of all preliminary and other meetings.

17. Have a seal made. Bond the Manager and Treasurer, and see that other details recommended receive attention.

BULLETIN 235] [FEBRUARY, 1916

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Sweet Clover

(*Melilotus.*)

H. L. FULMER.

FOREWORD

On account of the recent interest arising in relation to sweet clover as a farm crop, it has been thought desirable to make a study of the plant, its distribution, adaptation, manurial and feeding value, and management. The following article gives a consideration of this study. Samples were taken for ascertaining its feeding value, manurial value, digestibility, proper stages of cutting for hay, total yield of nutrients, etc., and the results of these tests are herein given. This publication is not for the purpose of urging the adoption of this plant as a crop, but simply has for its object the summing up of the estimate in which it is held at the present time, and the presentation of a short description of its nature, distribution, habits, and management in so far as these are known at this date.

Fig. 1. A meadow of Sweet Clover on June 5th. The growth is about two feet high and at about the proper stage for cutting for hay, the flower buds just beginning to appear. Note the alfalfa-like appearance, from which plant it is not easy to distinguish Sweet Clover up to this stage.

PROGRESS IN THE SCIENCE AND PRACTICE OF AGRICULTURE.

It is a matter of common knowledge that in the history of all lines of human thought and effort changes in attitude and direction have always occurred from time to time. These changes have in most cases been quite gradual, for man is, fortunately, endowed with the characteristic of conservatism; still, in many cases, these changes have taken place rapidly. We need not, for instance, go far into the realm of science to find examples of the working of this law in scientific thought and effort, for the history of Science is rich in instances of this kind. At one time, for example, it was held by men of Science, that gold could be made artificially; that water could be changed into earth or air by the application of heat or the extraction of moisture, respectively; that a vessel full of earth could hold as much water as it could when no earth was in it; and many other, to us, equally absurd things. We now hold different beliefs in relation to the foregoing. A few years ago, also, such a cause of ill-health as bacteria, was a thing unheard of, but now it is universally accepted that some of the worst forms of human ills are the result of the inroads of these microscopic organisms. And so we might mention scores of like cases; but we need not quote history nor confine ourselves to any one phase of human interest. Socially, morally, scientifically, industrially, we have changed, and are changing, in our own day and generation—and almost imperceptibly, in some cases, noticeably in others. And in the science and practice of agriculture we have no exception to the general rule.

Change in most cases denotes progress, and in agriculture we are changing and, on the whole, progressing. Through investigation, instruction, precept and example, we are learning how better to grapple with the various problems found in the different fields of agriculture. Soils and crops and their management, the nature and use of fertilizers, the breeding and rearing of animals, the construction of farm buildings, the utilization of farm power, the transportation and marketing of our products, are all now more fully and intelligently understood than ever before, and we believe the end of our progress in matters agricultural is not yet in sight.

One field of agriculture, in which considerable progress has been made and is being made, is that of crops. By a system of breeding, selection and exploration, better kinds and sorts of the different crops have been reared, isolated or discovered by the scientist and experimenter, varieties which are hardy and best yielders, resistant to disease and pest, and which not only enrich or improve the soil on which they are grown, but often at the same time, furnish a maximum of wholesome and nutritious food for man and beast. These improved varieties are available to the farmer of the present day, and as work along these lines is still being carried on, other and better varieties will no doubt appear in the future, to take the place of those now being cultivated, or those which are just being introduced.

AN OLD PLANT IN A NEW GUISE?

A plant which is beginning to attract considerable attention at the present time in this province is the one commonly known as Sweet Clover. This plant is well known and by many is deemed a bad and noxious weed where it grows—and it grows almost universally—but there is now evidence which seems to indicate that it will eventually be turned to a very desirable and useful purpose on the farms of Ontario.

Sweet Clover is known under several names, such as Bokhara clover, melilot or melilotus, bee clover, honey clover, mountain clover, giant clover, wild alfalfa, etc., and consists of several species. These species differ botanically and in their geographical distribution.

Species:

(*a*) *White Sweet Clover* (Melilotus alba) usually called *Sweet Clover* because it is the commonly occurring and most widely distributed species, is a biennial, producing its seed the second season. It is an erect branching plant having much the appearance of alfalfa in its early stages of growth, and from which it is difficult to distinguish, until the bloom is produced or by its somewhat bitter taste and strong, vanilla-like odour when cut and curing. It grows 2 to 2½ feet high the first season and stores up reserve food for its second season's growth, but produces no bloom or seed. The second season, it produces its bloom, matures its seed and then dies. The second season's growth is more open and stemmy, more sparsely supplied with leaves, and attains often to a height of 8 to 10 feet. At this stage it is very bushy, woody and unsightly. The flowers are white and produced in long racemes, those at the base opening first, often weeks before those at the tip, and maturing their seed long before, so that the phenomenon of having ripe seed and bloom on the same plant, at one and the same time, such as in the common Shepherd's purse, is present. The stems get very fibrous or woody after blooming begins, and more so as the season advances. This is the plant which is found growing so commonly along roadsides, railway tracks, in vacant lots, by the sides of ditches and in cuts, and other waste places.

(*b*) *Yellow Sweet Clover* (Melilotus officinalis) is a biennial, with the same habit of growth as the white sweet clover except that it is not quite so stemmy nor does it grow quite so large. These two species are hard to distinguish from each other except when in bloom, when it is rendered easy, the officinalis producing a yellow-coloured flower instead of one of a white colour. This species is not so widely distributed in Ontario as the former, and blooms one or two weeks earlier in the season.

(*c*) *Melilotus Indica,* a small yellow-flowered annual, with erect growth and early flowering habit. It lasts only one season, producing its growth and seed all in one year. It is not widely distributed. It is reported in California and in some of the Southwest States where it has found favour as a cover crop for orchards.

(*d*) *Melilotus Azureus,* a purple-flowered annual found in the Southern States and in Switzerland.

(*e*) *Melilotus parviflora,* a yellow-flowered kind found in South Africa, South America and Australia.

History.

Sweet Clover is a native of Central Asia. It is known to have been growing in the region of the Mediterranean Sea for the past 20 centuries or more and has, therefore, long been known. Its introduction into America perhaps occurred in the early part of the eighteenth century, when it was brought in probably by settlers from Europe, either intentionally or accidentally, or perhaps conveyed in shipments of merchandise from countries where it occurred, for it is reported as having been in some cases first noticed in the vicinity of seaports.

Distribution.

Although at one time, according to its origin, Sweet Clover was confined to the central part of Asia, it is now to be found in all parts of the world. It, therefore, seems to be a very adaptable plant. In fact, it does accustom itself to nearly every kind of environment, for it is to be found growing luxuriantly under all conditions of climate, from the extremely hot to the very cold, and on all types and nearly all kinds of soil. All the states of the American Union report it as occurring within their boundaries, particularly the two species—alba and officinalis; and from correspondence and observation we find these same two species growing in nearly all of the settled parts of Canada, the alba being particularly widely disseminated and commonly occurring. About the only places where this plant does not seem to take root and thrive well, are those which possess an extremely cold climate, practically beyond the limit of vegetation, or those where the soil is sour or acid in nature, or, on the other hand, is excessively charged with alkali.

Fig. 2. On the roadside—a favorite habitat of Sweet Clover.

Is It a Weed?

Various authorities have defined a weed as "a plant out of place," "a plant that is not wanted," or as "any plant growing in cultivated ground to the injury of the crop or the desired vegetation, or to the disfigurement of the place." Accepting these definitions, it can easily be seen that Sweet Clover is, or might be, a weed. A corn plant growing in the alfalfa field or on the lawn would be a weed and just as truly would alfalfa be a weed if found growing among the wheat or if it found its way into the perennial border. There is no doubt that the general impression throughout the Province of Ontario is that Sweet Clover is a weed, and, what is more, is in most minds, nothing but a weed. This opinion has gained acceptance primarily, I think, from the prevalence of the plant in waste and vacant places, along roadsides and railway tracks, in cuts, on ditch banks and in other noticeable places, places where it is particularly neglected in most cases, and allowed to grow to that tall and unsightly state which it attains in its second or seed-producing year. Its first year's growth, and the same luxuriant alfalfa-like growth produced in the first part of the second year, is very rarely noted, if at all. This, coupled with the general observation that where other foliage is abundant, Sweet Clover is not relished by our domestic animals, has stamped this plant as a weed, and from this has sprung up a general and more or less deep-rooted prejudice, which has blinded the general farming community to the probably natural function which this plant is performing in these waste and neglected spots, or to the possibility of it becoming an acceptable and valuable farm crop, finding a place in the regular farm rotation. That it is a weed, as it now largely occurs, is without question, just as much so as wild mustard, sow-thistle or any of the other numerous plants of this same category. But it is not a noxious weed, nor can it be classed as such, for it is seldom, if ever, seen encroaching into regularly cultivated areas, except where some seed may have found its way into the regular seed sown, as sometimes has happened in the case of clover or alfalfa, from the seed of which the seed of Sweet Clover is not easily distinguished, and in which the latter has been known to have been occasionally present as an adulterant. Moreover, it is not a persistent plant, being a biennial, and can for this reason be easily destroyed by merely preventing it from producing seed. Neither is it a plant which can stand severe competition from other classes of plants, and thus it is that it is usually found growing in the wild state in waste places only, places where most other plants refuse to grow until after the Sweet Clover has paved the way for them by improving the fertility of that soil.

Agricultural Value.

As to the agricultural value of Sweet Clover, there is abundant evidence in its favour from nearly every quarter of the globe. In Ontario it has been known for the past twenty-three years as perhaps possessing some value as a farm crop; and indeed in the years 1891-1896 experiments were conducted with this plant, but these had to do largely with it in regard to comparative yield of green fodder, and no attempts were made to find its value as a green manure, as a pasture crop, or for other agricultural purposes. It was discarded as "a very coarse plant and the hay not relished by animals." However, as a result of more recent observation, mainly by practical farmers, it appears to have decided agricultural value, and along several lines, for Ontario farms; and from accounts from foreign countries, this value is beyond experimental stages in many places, and in these countries Sweet Clover occupies a prominent place among the general crops of the farm. (For evidence to this effect, see Appendix.)

As a Hay and Pasture Crop.—For the production of hay, and for utilization as a pasturage, Sweet Clover does not at the present time occupy the position that some of the grasses and common legumes do, although it is in many cases successfully used for both purposes. On further acquaintance it may become, however, just as favourably looked upon and as widely used as any of those plants now in common use for these purposes. As we shall presently see, it certainly, at least compares very favourably in composition with the *other* legumes now so extensively used.

For hay-making the Yellow Sweet Clover (melilotus officinalis) is prized more highly than the White variety (melilotus alba). The Yellow is superior to the White in this respect, because of its finer stems and greater production of leafage, making thereby a more succulent and less fibrous or woody feed than the latter—which is, of course, of decided advantage in that it will be more thoroughly relished, more completely consumed and more highly digested. It must not be overlooked, however, that the White variety is the more vigorous grower, the greater yielder, and the more widely adaptable. These factors tend to give it a decided advantage over the Yellow sort.

All domestic animals—horses, cattle, sheep and swine—thrive well on Sweet Clover after they have once acquired a taste for it. This plant contains a bitter principle, coumarin, most abundant in the blossom, which seems to be distasteful to most animals at first, but which they come to relish after a time. The agreeable odour of Sweet Clover, especially noticeable when cut and curing, and something akin to the smell of vanilla, is due to the presence of this substance. Some strains of Sweet Clover contain less of coumarin than others, and if it is found necessary it will be quite possible, no doubt, by selection and breeding, to produce a strain of this plant which will contain not enough of this substance to give it that objectionable taste or smell which makes animals at first refuse to eat it.

There is some conflict of evidence, however, in regard to the usefulness of Sweet Clover as a pasture crop. Some people claim that they cannot induce their animals to eat it, even by starvation; but there are abundant cases reported from all over the world where this plant is being used extensively as a forage crop. And there are not wanting farmers in our own Province who are using this plant with decided success for this purpose. (See Appendix). All animals do not take to it at once (although some individuals do), but with some coaxing they soon will. It is well to remind the reader in this connection that such valuable feeds as alfalfa and ensilage are not relished at first by most animals, but that after a time, they are eaten with much relish.

As a hog and sheep pasture, Sweet Clover has been used with decided success in some of the Western States, notably Iowa and Wyoming, and as a pasture for cattle in Ontario. Mr. P. L. Case, of Aurora, York County, uses it for milch cows, and finds it to be excellent forage for this purpose, giving abundance of feed and a splendid milk flow. And the milk, in his experience, is not tainted. Here, however, experiences differ, as some report finding a bad taint given to the milk and to the butter made from it.

The great advantage of using Sweet Clover as a forage is its earliness, being some two weeks to a month ahead of alfalfa and the common clovers in regard to the time that stock can be turned on to it in the spring. Furthermore, it is not so susceptible to drought nor so likely to winter-kill, and also, Sweet Clover as a forage plant, as a general experience, does not cause bloat as is the case with most other legumes. This is thought to be due to the presence of the coumarin. Some cases of bloat, nevertheless, have been reported.

Altogether, there is great promise for Sweet Clover as a pasture and hay crop.

Following are some figures relative to the composition of Sweet Clover from analysis of samples collected in 1914. Included for comparison is the composition of some other common pasture and hay crops.

TABLE I.—COMPOSITION OF SWEET CLOVER, AND OF SOME OTHER PLANTS FOR COMPARISON.

Note:—Figured on the dry basis

Kind of Crops.	Stage of Growth when Cut.	Ash. %	Protein. %	Fat. %	Soluble Carbo-hydrates. %	Fibre, %
Sweet Clover	First sign of bloom	8.92	15.80	3.02	43.81	28.45
Sweet Clover	One-third in bloom	6.48	14.65	2.75	41.52	34.60
Sweet Clover	In full bloom	6.55	12.30	2.52	43.53	35.10
Sweet Clover	First sign of bloom	9.04	16.20	2.91	44.55	27.40
Sweet Clover	One-half in bloom	9.62	16.10	3.21	38.42	32.65
Sweet Clover	In full bloom	7.63	15.40	3.15	38.12	35.70
*Alfalfa or Lucerne	Buds formed	8.59	19.11	4.23	39.89	28.18
*Alfalfa or Lucerne	One third in bloom	7.24	15.52	3.51	41.67	32.06
*Alfalfa or Lucerne	A little past full bloom	7.01	13.89	2.61	38.82	37.67
†Red Clover	In bloom	8.33	15.65	5.68	42.69	27.65
†Alsike	....	9.19	14.20	3.21	45.05	28.35
†Timothy	In full bloom	5.29	7.06	3.53	49.32	34.80

* Ontario Agricultural College Bulletin No. 111.

† American Analysis.

Note:—The last six samples were grown on the Ontario Agricultural College farm, while the first six samples were grown on private farms.

From the table it will be noted that Sweet Clover, like the other legumes given, is a splendid source of protein, that most expensive of animal nutrients, and for which our legumes are so highly prized (compare with timothy, a grass, included in the table for this purpose, with its low per cent. of protein). In this constituent Sweet Clover compares very favourably with alfalfa, red clover, and alsike; and in the other constituents, viz., ash, fat, soluble carbohydrates and fibre there is no appreciable difference. All of them are rich in fibre, the woody part of plants, and the least valuable of animal nutrients furnished by plants to animals. Altogether, no particular preference can be mentioned respecting any one of the four legumes listed in the table in regard to the percentage of food constituents furnished by them—Sweet Clover is equal to any of the others in all respects.

Fig. 3. A field of Sweet Clover on June 5th, ten days before it was cut for hay.

The percentage composition, however, does not tell everything. A most important point to consider in connection with the composition is the yield per acre, for it is only in this way that we can arrive at the comparative absolute amount of each of the food constituents obtainable from each of these given plants. It is a common practice among the farmers of some parts of this Province to cut the first crop of alfalfa for hay, let the second mature for seed, and pasture the balance of the season. If then, we take the weight of hay got from the first cutting of all the crops and the percentage composition given in Table I, and from this data calculate the weight of the various food nutrients supplied by each crop, we get the amounts found in Table II.

TABLE II.—YIELD PER ACRE OF HAY AND ITS CONTAINED NUTRIENTS AND FUEL VALUE, AS GIVEN BY SWEET CLOVER, ALFALFA, RED CLOVER, ALSIKE AND TIMOTHY.

Kind of Crop.	Yield of Hay Lbs. per Acre.	Ash Lbs. per Acre.	Protein Lbs. per Acre.	Fat Lbs. per Acre.	Soluble Carbo-hydrates Lbs. per Acre	Fibre Lbs. per Acre.	Fuel Value Cals. per Acre.
1. Sweet Clover, first cutting	9,170	742	1,320	245	3,640	2,305	14,535,000
2. Alfalfa, first cutting	4,295	332	739	164	1,505	1,090	6,892,000
3. Alfalfa, first cutting	5,160	399	888	197	1,805	1,310	8,276,000
4. Red Clover	4,000	300	563	205	1,540	995	6,626,000
5. Alsike	4,000	331	511	116	1,625	1,020	6,359,500
6. Timothy	4,500	214	286	143	2,000	1,410	7,473,500

From the foregoing it will be seen that Sweet Clover furnishes a much larger amount of the animal nutrients than alfalfa or the other legumes and a very much greater quantity than does timothy. If we wish to take into consideration all the growth for the year, then Sweet Clover, red clover, and alsike should be credited with about one-half more of each of the nutrients. This is assuming that the second cutting will give on the average 50 per cent. of the weight of material in the first cutting. Alfalfa will give a second and third cutting, which, together, usually amounts to about three-quarters of the first. But even if we add 50 per cent. to the amount of each constituent derived from the first cutting of Sweet Clover, red clover and alsike, and 75 per cent. to that got from the first cutting of alfalfa, the Sweet Clover still furnishes a greater quantity of nourishment per acre than any one of the other crops included in the comparison.

It is, of course, difficult to compare crops in this way, unless they have all been produced under much the same conditions, Nos. 3, 4, 5, and 6, are the average yields as given on the College experimental plots, No. 3 being the average of seventeen years, and Nos. 4, 5 and 6, the average of five years' test. These figures have been obtained from the various reports of the Experimentalist. Samples 1 and 2 are the result of one year's experiment only, but they are of particular interest in that both the Sweet Clover and the alfalfa in this case were produced in the same season, and on the same soil and on adjoining plots, and are, therefore, strictly comparable. Sweet Clover has not been experimented with extensively on the College farm, but in the year 1892, it is reported that a yield of 13,760 lbs. of hay per acre, was obtained, a figure almost the same as that given for Sweet Clover in the table, should the second cutting be included.

There seems to be strong evidence that Sweet Clover is a very heavy producer of animal nutrients, exceeding most other farm fodder crops in this respect. It should compare favourably, therefore, with these other plants as a hay and pasture plant.

As a Bee Pasture. On account of the prolonged blooming season—from June until frost in the autumn—Sweet Clover proves an ideal honey plant. The honey obtained is colourless and of a fine flavour. The name of this plant, *Melilotus,* comes from the Greek and means honey or syrup of Lotus. Hence at the time the plant was named it was recognized as a leading source of honey.

As a Soiling Crop. Abundant green feed is furnished by this plant, as much as 30.65 tons per acre being produced.* This is much higher than the average crop would be, but is an indication of the enormous amount of food furnished. Excellent silage can be made also.

As a Green Manure. The consensus of opinion, gleaned from the experience of practical farmers, is that Sweet Clover is one of the greatest of green manures, perhaps surpassing every other crop for this purpose. On account of the abundant growth produced, by ploughing it under a large amount of humus-forming material (dry matter) very helpful in ameliorating heavy clay and light, sandy soils, and for improving the water absorbing and holding power of all soils, is supplied to a soil. In Australia, raw white sand has, by the use of Sweet Clover as a green manure, been changed to a rich dark brown, almost black loam, in the course of five or six years.† Furthermore, this plant, in common with all other legumes,

*Ontario Agricultural College Report, p. 114.
†Ohio Bulletin, 244, p. 64.

Fig. 4. A field of Sweet Clover just past full bloom on July 30th, showing the immense growth produced in the second year. This stands five feet in height and would form abundance of humus if plowed under, besides supplying a great deal of nitrogen which it has absorbed from the air.

Fig. 5. Two typical plants of *Melilotus alba* taken on June 11th of the second year, showing the characteristic development of root and stem. The plant on the left was produced on a clay loam soil, and the one on the right on a light sand. The root is what is known as a tap root; the left-hand one is ten inches long, and the right-hand one thirty inches long. (See context for discussion of this.)

gathers nitrogen from the air and thus is an enricher of the soil in this element, the most costly and one of the most highly prized of fertilizer constituents. The roots extend to a great depth, reaching three and four feet or more in many cases, and are of a fleshy nature. These break and open the sub-soil, bring up mineral constituents from the lower reaches of the soil and beyond the reach of shallow-rooted plants, and on the death of the plant and the subsequent decay of these roots, a great deal of humus is left in the soil. The soil is also left more porous and open (especially valuable in heavy clay soils), and the surface soil is rendered much richer in mineral matter (potash and phosphoric acid) brought from the sub-soil by the long, deeply penetrating roots. We find that the quantity of these roots left in the top foot amounts to from one-half to one ton of dry matter per acre, and when we consider that it is possible to have from 1½ to 6 tons of dry matter in the tops per acre to incorporate into the soil along with these roots it can easily be seen what immense value a crop of Sweet Clover ploughed under would have as a fertilizer alone, not to mention the marked physical improvement that would be effected at the same time. There would be carried into the soil by a crop of Sweet Clover in this way from 100 to 350 lbs. of nitrogen per acre, the greater portion of which has come from the air and is thus a distinct gain in fertility.

As an improver of barren and of worn-out and depleted soils there is abundant evidence to show that Sweet Clover is without a peer. Washed lands where the top fertile soil has been removed are soon again brought to a state of productivity by this plant, and, further, this plant appears to be about the only kind of vegetation which will establish itself on such situations.

Taken altogether, Sweet Clover, as a green manure and soil renovator and improver, promises well to become a boon to the Ontario farmer when once the present prejudice stigmatizing it as a weed and as a useless plant is overcome. This can only be done, of course, by familiarization and trial.

Following is a table showing the amount of humus-forming and fertilizing material found in Sweet Clover. The season in which these samples were taken (1914) was very dry during the months of June and July in this district, and therefore, the quantities given are much below the amount that would be given in an average season. However, the figures shown will give some idea regarding the value of Sweet Clover as a manure.

TABLE III.—DRY MATTER (OR HUMUS-FORMING MATERIAL) AND FERTILIZING CONSTITUENTS IN SWEET CLOVER, AS FOUND IN TOPS (STEMS AND LEAVES) AND ROOTS (IN TOP FOOT OF SOIL) AND IN TOTAL CROP (ROOTS, STEMS AND LEAVES), AT TWO DIFFERENT STAGES OF GROWTH AND ON TWO TYPES OF SOIL.

No.	Stage of Growth.	Part of Plant.	Lbs. of Dry Matter per Acre.	Percentage of				Lbs. per Acre of			
				Nitrogen N	Phosphorus P_2O_5	Potassium K_2O	Calcium Ca O	Nitrogen N	Phosphorus P_2O_5	Potassium K_2O	Calcium Ca O
1	Flower buds just forming......	Tops....................	5,860	2.79	.561	2.31	2.23	163.5	32.9	135.4	131.0
2	Flower buds just forming......	Roots....................	2,015	1.57	.344	1.46	1.14	31.6	6.9	29.4	23.0
		Total Crop........	7,875					195.1	39.8	164.8	154.0
3	Seed well filled................	Tops....................	6,255	1.92	.437	1.57	2.00	120.0	27.3	98.2	125.0
4	Seed well filled................	Roots....................	2,215	1.40	.239	1.33	.775	31.0	5.3	29.5	17.2
		Total Crop........	8,470					151.0	32.6	127.7	142.2
5	Flower buds just forming......	Tops....................	3,320	2.71	.551	2.23	2.12	90.0	18.3	73.0	70.4
6	Flower buds just forming......	Roots....................	898	1.57	.311	1.55	.843	14.1	2.8	13.9	7.6
		Total Crop........	4,218					104.1	21.1	86.9	78.0
7	Seed well filled................	Tops....................	7,260	2.50	.449	1.50	1.80	181.5	32.6	108.9	131.0
8	Seed well filled................	Roots....................	1,810	1.22	.265	1.29	.752	22.1	4.8	23.4	13.6
		Total Crop........	9,070					203.6	37.4	132.3	144.6

Note.—These samples were grown on private farms, the first four on sandy soil and the last four on clay loam.

It will be noted that the amount of dry matter or humus-forming material in the stems and leaves ranges between 3,320 to 7,260 lbs. per acre, and in the roots from 898 to 2,215 lbs. per acre; and from 4,218 to 9,070 lbs. per acre in the total crop. The amount of nitrogen in the stems and leaves ranges between 90 to 181.5 lbs., and in the roots from 14.1 lbs. to 31.6 lbs. per acre; and in the total crop from 104.1 to 203.6 lbs. per acre. A great part of the dry matter and a large part of the nitrogen are derived from the atmosphere and thus make a distinct addition, in fertility, to the soil. Phosphorus ranges from 18.3 to 32.9 lbs. in the tops and 2.8 to 6.9 lbs. in the roots, per acre; potassium from 73.0 lbs. to 135.4 lbs. in the tops per acre, and from 13.9 lbs. to 29.5 lbs. per acre in the roots; and the calcium from 70.4 lbs. to 131 lbs. in the tops, and to from 7.6 to 23.0 lbs. in the roots, per acre. In the total crop phosphorus ranges between 21.1 to 39.8, potassium from 86.9 to 164.8, and calcium from 78. to 154. lbs. per acre, respectively. A large part of these three constituents is brought from the sub-soil by the long roots and are eventually left in the surface soil which is thereby enriched greatly for shallow-rooted plants, such as the grasses. They are, furthermore, left here in a much more available form than that in which they originally existed.

Fig. 6. Sweet Clover growing on blow sand, which is otherwise practically bare of vegetation, except for a few horsetail and Canada thistle. This sand is rich in lime (calcareous).

OTHER USES OF SWEET CLOVER.*

In China, Melilotus officinalis is used as a fibre plant for the manufacture of rope; used as a vegetable in much the same manner as we use spinach; and is also utilized for the preparation of coumarin, its principal aromatic flavour, this being used in perfumery. In India it is also used as a vegetable. In Switzerland the dried flowers of Melilotus Azureus are powdered, worked up into a paste and used in curd to give an odour or flavour to Schapziger cheese. The French use the Melilotus alba as a textile plant in the manufacture of cloth and cordage. It is also probable that Sweet Clover could be used for the production of pulp to be used in the manufacture of paper.

*Ohio Bulletin, 244.

SOILS ADAPTED TO THE PRODUCTION OF SWEET CLOVER.

Sweet Clover seems to have no particular choice of soil and in this respect is unlike other plants. Consequently, it is widely adaptable, and extensively disseminated. It is found growing on heavy clay and on sharp, clear sand and on all soils intermediate between these. The only things which seem to prevent it introducing itself is sourness or acidity in the soil or an overcharge of alkali, particularly black alkali. Neither of these conditions are prevalent in Ontario. It is a lime-loving plant, like all other legumes, and does best when lime is abundant in the soil—it reaches perfection of growth on rotten limestone as in old limestone quarries, and along railway tracks and on gravel knolls where lime is usually plentiful. A soil lacking in lime would have to be given an application of this material in the form of air-slaked lime, or ground limestone, before it would produce Sweet Clover, or for that matter, any other legume, successfully.

Fig. 7. A nearer view of same as in Fig. 6, showing the luxuriant growth, the clover being rank and standing thirty inches high on the 11th June, in spite of the fact that the season in this particular district was exceedingly dry.

An advantage attached to Sweet Clover is that it will grow on very wet or very dry soils. It is to be found taking a stand where the soil is practically waterlogged and also on soils which are too dry to produce any other kind of provender.

THE HANDLING OF SWEET CLOVER.

For Securing a Stand. The most essential thing to observe in seeding Sweet Clover is to have the seed bed thoroughly compacted, with just sufficient loose soil on top to allow of the seed being properly covered. It may be sown in the spring, alone or along with a nurse crop, much like red clover, or in late summer or early fall, like alfalfa. Of the hulled seed, about 20-25 lbs. per acre should be used, and of the unhulled seed about five pounds more. Much of the seed may not germinate the same year on account of the hard seed coats, hence a generous application of seed is advisable. When a nurse crop is used the latter should not be sown too thickly, else it will tend to smother the young clover seedlings.

Sweet Clover may not do well on soil that has never produced it before, because of the lack of the nodule forming bacteria. In this case it would be advisable to inoculate the seed by means of a culture obtained from the Ontario Agricultural College, or with soil from a place which has been or is producing Sweet Clover.

For Hay. Sweet Clover must, like alfalfa, be cut at the proper time, or else it becomes too woody and stemmy for first-class hay. The proper stage for cutting seems to be about the time the first blossom is ready to appear. The growth of the first year produces the best hay, as in its first season's growth this plant does not produce bloom and has not the same tendency to become fibrous as it has in the second year; but the second year's growth will give good hay if taken in time. Two crops can be secured the second year. However, in taking off the first crop, care must be exercised not to cut too low but to raise the cutting bar to such a height that some of the lower branches will be left uncut, otherwise the second crop will be either destroyed or greatly interfered with. If cut for hay the fall of the first season, it should in no case be mown until the crown sprouts begin to appear on top of the roots about an inch below the surface of the soil.

Fig. 8. Just after the first cutting of Sweet Clover has been removed for hay on June 15th. Observe that it has been cut high enough to leave abundance of young growth to produce the second crop. This is very essential.

Sweet Clover is hard to cure on account of the fairly large stems and because of the fact that it has to be cut at a time when there is a considerable amount of moisture present in it. Furthermore, if care be not exercised during the curing process a great part of the leaves will be lost and in this way the better part of the hay be wasted. Any severe handling at this time, such as tedding and raking, should be done, therefore, when the hay is still a little tough. However, any one familiar with the process of curing alfalfa will understand this thoroughly for this plant is much like Sweet Clover in these respects, being hard to cure and difficult to handle without considerable loss of leaves.

The following two tables (IV and V) show the effect of age on the proximate composition of Sweet Clover; also the effect on the digestibility of the protein, and on the yield of total nutrients and digestible protein per acre. They will, therefore, give some idea as to the proper time to cut this plant for hay-making purposes.

TABLE IV.—SHOWING THE COMPOSITION OF SWEET CLOVER, AND THE DIGESTIBILITY OF ITS PROTEIN, TAKEN FROM TWO DIFFERENT TYPES OF SOIL, AND CUT AT SIX DIFFERENT STAGES OF MATURITY.

Note.—Figured on air-dry basis.

Sample.	Date of Cutting.	Stage of Maturity and Height in Inches.	% Water.	% Ash.	% Protein (N x 6.25)	% Fat.	% Soluble Carbo-hydrates.	% Fibre.	Digestive Co-efficient of the Protein.	Fuel Value per 100 grams Cals.
A	June 5	Before bud formation, 24 in.	7.26	9.08	19.19	3.07	39.33	22.07	88.1	359
A_1	June 11	Buds formed, 28 in.	7.15	8.23	16.98	3.09	38.85	25.70	86.6	363
A_2	June 18	First bloom appearing, 33 in.	6.44	8.35	14.75	2.83	41.02	26.61	84.0	364
A_3	June 25	One-third in bloom, 36 in.	6.99	6.02	13.63	2.56	38.65	32.15	82.7	370
A_4	July 7	In full bloom, 44 in.	5.96	6.16	11.56	2.37	41.05	33.00	78.5	373
A_5	July 30	Seed filled, 55 in.	7.07	5.76	11.16	2.15	40.96	33.50	77.7	371
B	June 5	Before bud formation, 24 in.	6.68	9.30	19.45	3.11	39.30	22.16	86.4	361
B_1	June 11	Buds formed, 30 in.	7.78	9.04	16.19	3.20	39.66	24.13	83.7	358
B_2	June 18	First bloom appearing, 36 in.	7.39	8.37	15.00	2.69	41.19	25.36	82.7	359
B_3	June 25	One-half in bloom, 40 in.	7.68	8.88	14.88	2.96	35.46	30.14	83.1	357
B_4	July 7	Full bloom (falling), 51 in.	6.93	7.10	14.31	2.93	35.52	33.21	80.9	368
B_5	July 30	Seed filled, 60 in.	6.47	5.09	14.63	2.37	36.03	35.41	81.9	375

Note.—The first six samples were grown on sand (calcareous); the last six samples on clay loam—all on private farms.

The foregoing table shows the rapid rise in percentage of fibre or woody matter which takes place during progress of the plant toward maturity. The increase in one case is from 22.07 to 33.5 (= 11.43) and in the other case from 22.16 to 35.41 (= 13.25) per cent.; and associated with this rise in fibre is a corresponding decrease in the percentage of all the other nutrient constituents—ash, protein, fat and soluble carbohydrates. This change takes place most noticeably after the bloom begins to appear.

Now there are no objections to the changes noted above as taking place in composition during approaching maturity up to a certain limit, because the total amount of nutrients are not changed in so far as absolute quantity of yield per acre is concerned as can be seen by consulting Table V below. In fact for ruminant animals particularly, a more or less bulky and fibrous ration is highly desirable as aiding to fill the large and commodious stomach, in the secretion and distribution of the digestive juices and thereby digestion, and in assisting to maintain the general health of the animal. But if the fibre becomes too prominent, particularly for non-ruminants, the value of the food is lowered not only because more food has to be eaten in order to ingest a sufficient quantity of the other nutrients (which entails, of course, consumption of energy), but because the animal in its endeavor to digest the difficultly digestible fibre, expends a great deal of energy needlessly. It is claimed that the amount of energy obtainable from fibre after it is digested is not equal to the energy expended in its digestion. This latter is notably true of fibre from more or less mature plants because it has then become quite hardened and coarse, whereas in young plants, the fibre is still sufficiently succulent to lend itself more or less easy of digestion by the enzymes of the alimentary tract.

Not only does the fibre increase in quantity during advancing maturity, but the protein, the most valuable nutrient constituent of the plant and for which substance the plants of the legume family are so highly prized, becomes less digestible. The digestibility of the protein in the *A* samples was lowered from 88.1 to 77.7 and in the *B* samples from 86.4 to 81.95. That is, out of 100 lbs. of protein eaten, that many pounds of protein, viz.: 88.1, 77.7, 86.4 and 81.95—would be digested and absorbed. In the first case, therefore, out of every 100 lbs. of protein in the Sweet Clover 11.9 lbs. and 13.6 lbs. would be wasted, respectively, should the clover be cut just before the budding stage; whereas 22.3 lbs. and 18.05 lbs. respectively, would be excreted unabsorbed should the clover be cut at the stage when the plant has gone to seed. This, of course, is a costly waste.

TABLE V.—THE TOTAL WEIGHT OF NUTRIENTS, AND THE AMOUNT OF DIGESTIBLE PROTEIN, FURNISHED BY ONE ACRE OF SWEET CLOVER, AT SIX DIFFERENT STAGES OF MATURITY.

No.	Date of Cutting.	Stage of Maturity.	Green Weight Lbs. per Acre.	Air-dry Weight Lbs. per Acre.	Lbs. per Acre of Protein.	Fat.	Soluble Carbo-hydrates.	Fibre.	Ash.	Digestible Protein Lbs. per Acre.
B	June 5	Just before flower buds had formed	16,940	2,816	548	87.6	1,107	624	262	473
B_1	June 11	Flower buds formed	12,100	3,297	534	105.5	1,308	795	298	447
B_2	June 18	First bloom appearing	7,865	3,547	532	95.4	1,461	899	297	440
B_3	June 25	One-half in bloom	11,610	3,654	544	108.2	1,296	1,102	303	452
B_4	July 7	Full bloom	17,550	5,078	727	149.0	1,803	1,686	361	588
B_5	July 30	Seed filled and beginning to ripen	13,920	7,763	1,136	184.0	2,798	2,749	395	931

Looking over Table V it will be noted that although Table IV shows a decrease in the percentage of ash, protein, fat and soluble carbohydrates, still the yield of these substances per acre is largely increased as the plant goes toward maturity. This, needless to say is explained by the great increase in dry matter during that time, an increase amounting to 4,947 lbs. (7,763—2,816) or 175 per cent. between June 5th and July 30th. This might indicate that the later stage would be the desirable time for taking the crop off for hay. But if the figures showing green weight and air-dry weight be compared, it will be noted that the plant changes from a very succulent state to a very non-succulent state in passing from the pre-flowering stage to the seeding stage, a fact which when coupled with the large increase in fibre (4.4 times) during the same time, indicates that the plant changes from a tender herbaceous succulent state at the time just before bloom appears, to a hardened woody dry state at the time the seed is developed, a change from a tasty, appetizing condition to a tasteless, non-attractive one. This change is gradual but progressive from the first to the last.

Fig. 9. The second crop in full bloom on July 30th, a month and a half after the first crop was removed for hay. This second crop is reserved for seed. This is the same field as shown in Fig. 8.

Summing up the information imparted by the data contained in Tables IV and V, it can be stated that the proper time to cut Sweet Clover for hay, is before full bloom; preferably, as before stated, about the time the first blossoms are to appear. At this time a reasonable amount of nutrients has been accumulated in the plant per acre, it is still succulent and tender but not too succulent to make it excessively difficult to cure, and lastly, the bitter principle, coumarin, which exists most abundantly in the flowers and which gives the strong smell and objectionable taste to the hay, is largely gotten rid of by thus cutting before the bloom is on.

For Pasture. To be used successfully for pasturage Sweet Clover must be pastured sufficiently heavy and close to keep from getting too far advanced and to keep abundance of fresh and tender growth coming on at all times. If it gets ahead of the stock it becomes too coarse and fibrous to be relished. Should such happen it is a wise plan to clip it back to a height of 6 to 8 inches. Some men of experience claim that stock should be turned on when the plants have reached a height of about 4 inches. For permanent pasture some plants must, however, be allowed to go to seed the second year, enough to reseed the field; or seed must be sown. If this is not done the plants, being biennial, will run out at the end of that time.

The nutrient value of this plant as a pasturage is shown by a reference to the tables showing its composition.

For Seed Production. For the production of seed the first crop of the second year can be allowed to go to maturity, although it would perhaps be more economical and practical to take the first cutting off for hay and to allow only the second crop to mature for seed. It should be harvested when three-quarters of the seed pods become dark. Harvesting can be done with a binder and further operations carried on the same as with other grain crops. Handling should be avoided when the straw is very dry as the seed will shell badly at such a time and much would be lost. Threshing and hulling should be carried on, however, when thoroughly dry. A yield of from 2 to 8 bushels per acre can be obtained.

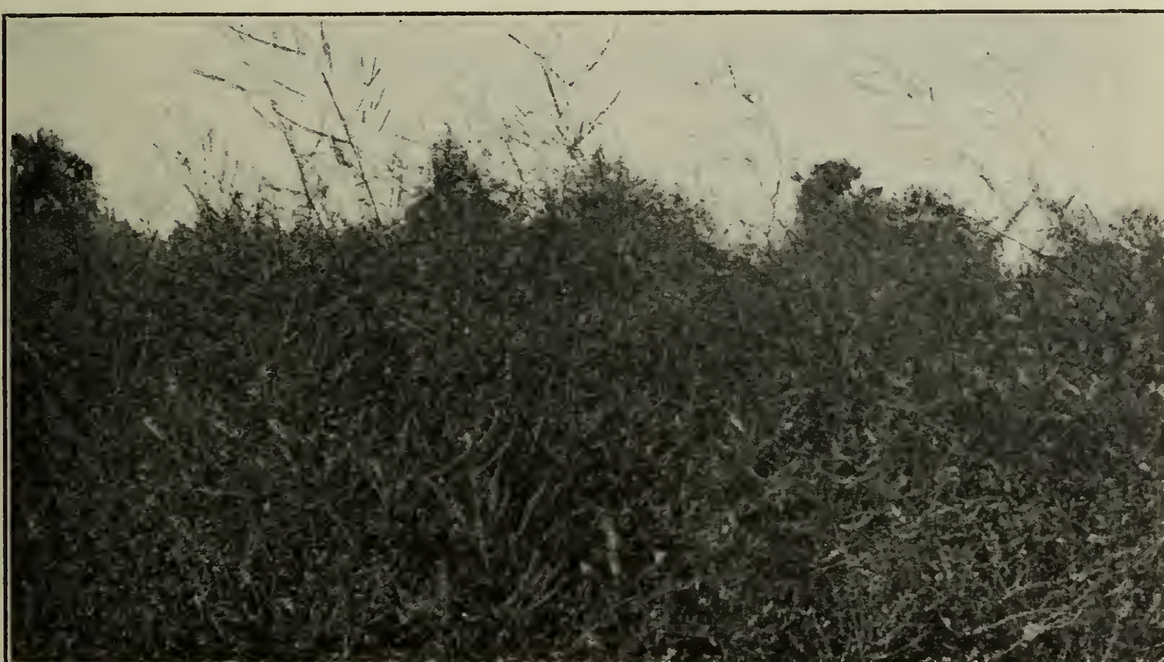

Fig. 10. The second year's growth, five feet high and well ladened with seed, on July 30th. Some bloom still in evidence, although most of the seed is well filled and beginning to ripen.

CONCLUSION.

After a general survey of the whole field wherein Sweet Clover could serve as a farm crop we cannot but conclude that this plant gives much promise of value. It is a plant which is widely distributed and widely adaptable. By reference to publications on the subject, by correspondence, by conversation with different farmers and men engaged in agricultural work, and by personal observation and experience we find this plant to be growing in all countries and on all types of soil. Furthermore, in addition to its great adaptability, we find it actually to have found a place on the farm in many foreign countries and in a few sections in our own country. Not only has this usefulness been found but a knowledge of this fact is spreading. At this time in the province of Ontario, quite a number of farmers are trying out this new crop on their own farms in order to demonstrate to themselves whether or not it has any virtue. It is beyond the experimental stage with some farmers already, and these, who have now grown it on their farms for several seasons, are convinced and are enthusiastic for its future. Soon there will be a more widespread knowledge concerning the agricultural value of this plant.

Up to date Sweet Clover seems to have immense value as a soil improver and herein, perhaps, lies its main virtue. It will establish itself on very poor soils, soils which are naturally poor or which have become so by a system of exhaustive cropping or otherwise, and on soils which would otherwise produce practically no growth, such as alkali soil and blow sand, and give surprising yields. Not only does it give growth where otherwise there would practically be none, but, what is just as important, it eventually puts these same soils into such an improved state of fertility and tilth that other crops which before were impossible can then be successfully produced. This will be of inestimable value to our worn out or impoverished lands and to our bad lands sections.

But, in addition to its green manuring value, much value is attached to Sweet Clover as a pasture and hay crop. This is of particular value in very dry climes or seasons or to those sections of low fertility, for here, otherwise, practically no provender would be available and nothing would exist but a barren waste. Furthermore, there are other values attached, particularly that as a bee pasture or honey plant.

Finally, although there appears to be no question as to the value of Sweet Clover, conservatism is to be urged. It is never wise to take up a new thing in a hurry. Everything has to be learned in regard to this new plant and failure might be the result of some very simple mistake due to inexperience. If failure results the logical outcome, of course, is condemnation, and condemnation under these conditions is very often undeserved. It is desirable, therefore, that small areas only be seeded to this plant in the beginning until its management and value be determined, and then it can be gone into with greater assurance or discarded altogether, as the farmer concerned may see fit.

APPENDIX.

Containing evidence of the world-wide distribution of Sweet Clover and its great adaptability to different soils and soil conditions and to differences in climate. Also containing opinions, based on experience and observation, in regard to the agricultural uses of Sweet Clover and the best methods of handling it for obtaining satisfactory results.

Foreign.*

England: Both species (M. alba and M. officinalis) are common throughout England. Considered too coarse for hay. Thrives on poor sandy soil.

Scotland: Known well in Scotland, though not considered of much agricultural value. A small amount is a valuable admixture in hay as it imparts to the whole a sweet agreeable odour.

Germany: Both species are growing in Germany and are used for binding the soil on banks and slopes and also as a green manure.

Russia: Sweet Clover is an excellent soil-manuring plant and a nitrogen collector. Manuring by means of plowing under Sweet Clover gives the subsequent crop a dark green tinge, such as is given by Chili Saltpetre (Sodium nitrate). This plant to be grown with success needs, above all, the presence of lime in the soil. This plant contains coumarin which imparts to the milk and butter of cows that have eaten it a fine taste.

Austria: Farmers easily produce good crops of Sweet Clover, giving feed for their cattle, especially in years of scarcity of other forage.

Hungary: Melilotus officinalis prospers and provides good pasture for sheep on the driest and most barren slopes, such as occur along the Adriatic. By reason of its modest requirement of water it can be advantageously grown on very dry soil where other legumes cannot thrive.

Italy: When used as a hay care should be taken to cut it at the exact period of maturity for if cut too soon it is hard to dry, and if cut late it is tough. Adapted to mediocre dry calcareous (rich in lime) soils, or poor dry soil, such as is found in the dunes.

Belgium: Serviceable for planting in poor gravelly soils. It affords pasture for sheep and is used as a fertilizing plant.

Switzerland: White melilot is much used in this country for agricultural purposes, particularly as hay. Farmers are very appreciative of it.

India: A promising weed. The want of green fodder is keenly felt in parts of the central provinces from December to June. Melilotus alba germinates early in November, grows to a height of 3 feet and is relished by both cattle and horses.

China: It is eaten with relish by pigs, which thrive on it.

Australia: Although it is a good grazing plant, its principal virtue lies in its power to fertilize and bring into use poor, sandy soil. Raw white sand in the course

*Taken from Ohio Bulletin, No. 244.

of five or six years has been changed into a rich dark-brown, almost black, loam capable of growing good crops of oats, lucerne, etc., by the use of Sweet Clover. The reason for this lies in the power of the melilot as a legume to absorb nitrogen from the air and deposit it in the soil.

South America: Sweet Clover grows in wet or moist places, in lowlands and deserted river bottoms. Animals do not leave it in view long except in inaccessible places.

United States.

*Illinois: "Its value is beginning to be recognized by many of the farmers of this State both as a fodder and hay crop and as a soil renovating crop."

*Wisconsin: "It grows luxuriantly along the roadsides throughout Wisconsin. The stalks are so watery that it cannot be cured easily into hay. I understand that if it is in a pasture and cattle are forced to eat it by being left on a small area for a considerable length of time that they become accustomed to it."

*Indiana: "While it grows luxuriantly along the roadsides and in all kinds of waste places, we have found it hard to start under cultivation. So far I am not convinced that this plant can take the place of alfalfa as a forage crop, or such rapid growing annuals as cowpeas and soy beans for soil improvement in this part of the country."

†Ohio: "Most of these cultivated plants (red clover, rye, cowpeas, soy beans, buckwheat) will not thrive under the adverse conditions where their use as humus-forming materials is most needed. Therefore, a hardy, vigorous growing, soil-poverty withstanding plant is needed. Sweet Clover is such a plant and also possesses the distinct advantage of being a legume, *i.e.*, a nitrogen gathering plant. It also affords a nutritious herbage for horses, cattle, sheep and swine. . . . It thrives best in soils rich in lime and requires inoculation in order to do well under some conditions."

‡Nebraska: "The general experience of farmers is that stock must acquire a taste for Sweet Clover before eating it readily. Very little difficulty is experienced, however, in getting stock to eat it and when they have once acquired the taste it affords excellent pasture. To make good pasture it should be grazed sufficiently close to prevent a coarse growth. . . . In addition to increasing the available nitrogen, Sweet Clover has an abundant root development, which greatly increases the organic matter in the soil. . . . On very thin or wornout soils an entire crop of Sweet Clover can profitably be plowed under for green manure. . . . Being shallower rooted, Sweet Clover does not dry out the subsoil to as great a depth as does alfalfa, and for this reason succeeding crops in the rotation are not so likely to suffer from lack of moisture."

§Missouri: "A great deal of interest is being manifested in this crop by Missouri farmers and, while some still consider it a pest, others are apparently obtaining good results with it. . . . The chief value of Sweet Clover for Missouri conditions is as a green manuring crop. . . . Some farmers regard it

*Extracts from letters received.
†Ohio Bulletin, 244.
‡Nebraska Extension Bulletin, 22.
§Missouri Experimental Station pamphlet.

as practically worthless as a hay or pasture crop, while others have apparently had good success with feeding it."

*Kentucky: In seeding Sweet Clover "the ground should be thoroughly firmed down and the seed covered to a depth of about one-half inch. . . . Sweet Clover does not stand the winter well unless it makes a good growth before cold weather. For this reason it is not safe to sow it late."

†Iowa: "As a whole, the use of Sweet Clover for green manuring purposes in Iowa is strongly to be advocated. . . . It grows best on soils rich in lime and it has been claimed that its roots decay much more rapidly than those of other legumes."

Canada.

Prince Edward Island: "Sweet Clover is not a native in this Province. It is found, however, growing as a weed in very limited quantities. The species occurring is Melilotus alba. Where found it grows vigorously, but I know of no instance where it is grown as a crop. . . . There are some farmers who show some interest in it, but as a general rule the plant is regarded altogether in the light of a weed."—W. Davison, late Instructor in Field Husbandry, Dept. of Agri., Charlottetown, P.E.I.

Nova Scotia: "Sweet Clover occurs in this Province to a very limited extent; in fact, to such a limited extent that very few farmers know the plant except by name. Owing to the advertising which this plant has received during the past winter, a number of farmers throughout Nova Scotia have this past spring seeded an acre or more with this crop. I am of the impression that they will be disappointed in results, but there is no use in anticipating the matter as it is being given an extended test and we will be able to observe facts later."—M. Cumming, Principal, College of Agriculture, Truro, Nova Scotia.

New Brunswick: "White Sweet Clover and Yellow Sweet Clover both occur quite commonly in this Province, the former the more abundantly of the two. Very little use has been made of either as agricultural plants, though a great many farmers have become interested in them lately on account of the publicity which has been given them by the agricultural press. The White Sweet Clover may be quite extensively tried during the next few years. A few farmers have tried it already, but, so far as I can learn, with rather indifferent success. It is found growing chiefly along railroad embankments and roadsides, but, though looked upon as a wild plant, it is not regarded as a harmful weed."—R. Newton, Director of Agricultural Schools, Province of New Brunswick.

Quebec: "Whe have grown the white flowered, that is, the Melilotus alba, at the College for five or six years and have found it extremely valuable as a renovator of poor soils. Ordinarily we get from 10 to 14 tons of green crop per acre, and one year we obtained as high as 22 tons to the acre on poor land. It has always been our practice to plow this crop under when it reaches the height of about 4 feet as it will decompose quite readily if turned under at this stage. When found growing wild, however, it not infrequently exceeds 6 feet in height. The yellow flowered (Melilotus officinalis) is not grown to any considerable extent in this Province, but one finds occasional plants in the fields and by the roadside. Very little Sweet

*Kentucky Bulletin, 178.
†Iowa Circular, 10.

Clover is found growing wild north and west of the line from Hawkesbury to Valleyfield, but as one gets east it has been my observation that the amount increases, and in the vicinity of St. Hyacinthe, Quebec, there are large tracts given over almost wholly to the growing of this crop. Here the land is very heavy and wet and it appears that the Sweet Clover is the only clover that will come through satisfactorily. Farmers in this district use it largely for pasture and also for hay. In this Province the man who does not have Sweet Clover on his farm always regards it as a most noxious weed, while the man whose fields are completely over-run with it speaks in high praise of it. For the past six or seven years I have taken the position that if properly handled Sweet Clover can be used to great advantage, especially in renovating our poorer and heavier soils."—L. S. Klinck, late Prof. of Cereal Husbandry, Macdonald College, Quebec.

"We have it growing in abundance on the railway, in fence corners and old pasture, etc., about Ste. Annes. My experience with it as a pasture crop extends over only one year. Last year I rented a farm in the vicinity with the idea of using it for pasture. It contained a mixture of grass for the most part, but on about 12 acres nothing but Sweet Clover was growing. The cattle did not go to pasture very early so that a very rank growth had been made by the clover when they were turned in. For the greater part of the season the clover was allowed to grow and, as far as I could see, served no purpose other than for brushing off the flies through the summer. This was not true, however, of the scattered plants and bunches of plants mixed with the other grass, because they seemed to eat the tops off this, although there was no particular desire shown for it. Later in the fall, and especially after the first frost, which arrived in early September, the cattle seemed to take to the Sweet Clover and in spite of the fact that there was no scarcity of grass generally. Although most of it was becoming somewhat coarse they seemed to relish the Sweet Clover very much, and the result was that before they were brought in the twelve-acre forest of Sweet Clover had been completely demolished and, while we are not able to furnish figures in regard to gains, etc., there is no doubt in my mind that the cattle did extremely well when they were eating the clover almost exclusively. I may say they started at first by picking off the tops, gradually stripping the leaves and stalks as well. We have not had a chance to try out sheep, but I am inclined to think that the sheep would take to the Sweet Clover kindly and do well on it. . . . I am anxious for more experience before I make up my mind definitely in regard to it for pasture, but certainly our results of last year suggest value. The plant on this particular farm is the white flowered variety. . . . We have not tried making it into hay. This year I had hoped to make a test of it for silage purposes, but as yet we have not been able to manage it."—H. Barton, Professor of Animal Husbandry, Macdonald College, Quebec.

Manitoba: "Sweet Clover is prevalent nearly all over the Province, but more especially is it prevalent in the Red River Valley on our heaviest soil. There are two varieties, one white, the other yellow. The white one is the more vigorous grower, occasionally reaching the height of eight feet; the yellow variety does not grow so luxuriantly.

"I had occasion to visit a district about fifty miles south of this city (Winnipeg), where a large amount of Sweet Clover grows, and I had the first experience of it being used as pasture for cows. I told you in my last letter that I had no knowledge of any of our domestic animals using this plant, in any shape as fodder, but on the trip I have mentioned I personally saw a large number of cows and young stock feeding on the Sweet Clover.

"The farmers told me that they did not find it necessary this year to cut down, rake up and burn this plant as they had in previous years, their cattle having apparently got over their dislike for the plant.

"I asked several what results they got from the use of this plant as a milk producer, and asked if it kept the cattle in good condition. The reply was, that their cattle milked better and that they got a higher percentage of butter fat than when the cattle feed on the prairie pasture, and they kept in good thrifty condition. I might add that there is a great deal of curiosity in our more progressive farmers' minds as to what would be the possible outcome of sowing this as fodder, and I believe we will have a good many experiments tried in the near future to decide whether it will be beneficial to grow this plant to any great extent for fodder. This plant may prove a very valuable friend to the people of this Province when it comes to be cultivated as a fodder crop, and also for its beneficial effect on our heavy soil in the Red River Valley."—R. G. O'Malley, Provincial Noxious Weed Inspector.

Manitoba: "There is more or less Sweet Clover scattered throughout the Province chiefly as a roadside weed. From personal observations I would say that it is principally of the white variety (M. alba.), although I have also seen the yellow variety (M. officinalis) growing side by side with the white. In such cases, however, the M. alba appeared to possess the more vigorous growth. From enquiries I have made I would say that this plant owes its introduction to the fact that a few farmers believed it to possess value as a forage plant and sowed small areas of it years ago, in some cases as long as twenty years. From these sources it has been allowed to spread along the roadsides and waste places and has been looked upon as a weed, although not a noxious one. Sweet Clover has also been sent in on several occasions lately as a weed occurring in alfalfa, in this case being mostly the M. officinalis. The plants sent in have been very healthy, vigorous specimens. I am not aware that the plant has been used to any extent as hay, pasture, etc., but I have no doubt that a number of men have sown it this year with the idea of using it in some such way. . . . I believe that there have been some areas as large as ten acres sown this year. There has not been any work done on the College Farm with Sweet Clover, but we have a plot sown to it this year in the hope of obtaining some knowledge as to its adaptation to our conditions."—Jas. H. Bridge, Dept. of Field Husbandry, Manitoba Agri. College, Winnipeg.

Saskatchewan: "None of the species of Melilotus is found in this Province, except in isolated cases. I know of several small towns in which the yellow-blossomed sort, Melilotus officinalis, is found growing as a weed along the sides of the road and in other waste places. Melilotus alba may also be seen in similar conditions but in smaller quantities. The former has often been observed as an impurity in alfalfa. Neither of these is used as a farm crop in this Province, nor have they been used to any extent as a green manure crop. Both are looked upon with disfavour, not because they have proven themselves weeds or unfit for forage, but because of the rather unsavoury reputation they both possess."—J. Bracken, Professor of Field Husbandry, University of Saskatchewan, Saskatoon.

British Columbia: "With reference to Sweet Clover, would say that this plant is growing quite luxuriantly in several different parts of this Province. It does not encroach on the cultivated areas, and is regarded with indifference. We, however, are of the opinion that it will prove to be very valuable in several districts, principally for green manure. So far as I have observed, there are no large areas, but the distribution is wide, chiefly in the interior of the Province. Up to the present time have not noticed it growing on Vancouver Island or on the Lower Mainland. We intend to use the crop for green manuring on several of our Farm Management Stations next season. The most common variety is the Melilotus alba. I have noticed but one patch of the Melilotus officinalis."—J. C. Ready, Soil and Crop Instructor, Dept. of Agri., Victoria, B.C.

"Melilotus alba is the leading species in this Province. I am pleased to say that it is not at all common in this district, and where found is treated very much the same as any other weed. It grows best, probably, in the Upper Country, where land is irrigated. It is found all along the irrigation ditches and a certain amount of it in the alfalfa fields, where it is treated as a weed and a bad one. The general impression in the country is against it, with the exception of the bee people. . . . When one sees it grow and going to seed along the irrigation ditches in the open range, untouched by cattle, it would appear that it is not relished as much by stock as is alfalfa."—P. H. Moore, Superintendent Agassiz Experimental Farm, Agassiz, B.C.

Ontario.

In the reports from counties wherein representatives of the Department of Agriculture are stationed and which represent all parts of the Province only two report Sweet Clover as not occurring, viz., the districts of Kenora and Thunder Bay. All others report it as occurring, as a rule both varieties, alba and officinalis, being mentioned. It appears to be growing on all types of soil from the light to the heavy and from the dry soils to those in need of drainage. It is rarely mentioned as a bad weed, and seldom stated to be found growing in cultivated areas in the wild state. Following are extracts from the letters of several Representatives:—

Essex: "There is a great deal of Sweet Clover growing in this county along the roadside and in uncultivated fields, but there is no one yet that I know of growing it commercially. It grows exceptionally well and to the best advantage here on clay loam. It has been deemed a bad weed until recently, when a number of farmers are beginning to realize that if handled properly it may be used to considerable advantage in the way of regenerating wornout soil. While a certain amount can be noticed growing in cultivated fields, still where a reasonable rotation is followed it gives no trouble in this respect."—W. E. J. Edwards.

Kent: "There are both varieties of Sweet Clover, the yellow and the white, with a tendency in the heavy clay sections for yellow to predominate. It is found in all parts of the county, in the gravels, loams and heavy clays, but it is, if anything, more heavily established in the clay districts. It is generally deemed a weed, very troublesome on roadsides, but not to any extent where proper rotation and cultivation methods are in vogue. We have fields that have been uncultivated for some years completely overrun with the yellow variety. In fact, in some cases it is being pastured very profitably. There has as yet, as far as I have been able to ascertain, none of it been cut for hay, nor have there been any definite steps taken up on farms to introduce it as a crop."—W. T. Hunter.

Elgin: "Both White and Yellow Sweet Clover are found here, growing best on well-drained clay soils. It does, however, make some growth on light soils. By many this clover is considered a weed of only slight importance. It is certainly growing spontaneously in waste lands and in some cultivated fields.

"Mr. John Lunn, Fingal, is the only man I know who is cultivating the plant. He finds White Clover the better, grows it in a mixture with red clover, alsike and blue grass and finds that as a pasture horses and cattle are fond of it and pigs and sheep prefer it to alfalfa. Mr. Lunn has been growing Sweet Clover for two years and recommends it as a pasture entirely irrespective of the fact that he is a bee keeper. When sowing it alone Mr. Lunn used 15 lbs. of seed to the acre, from which he got three loads at first cutting and one bushel of seed at second cutting. When pastured it is ready for use early in June."—P. E. Culverhouse.

Northumberland: "In reply to yours of the 24th ulto. *re* Sweet Clover in this county, I cannot say that it is very strongly established here. There is some of the white variety (Melilotus alba) growing along roadways, especially those nearer the railroads, and in unused places, but it is not very common through Northumberland and the yellow variety (Melilotus officinalis) is comparatively scarce. It is not found growing spontaneously in cultivated fields and is not counted as a bad weed. The soil where I have seen it is clay and clay-loam in nature. . . . Recent praises of Sweet Clover and an observation that some cattle eat it along the roadways have led a few whom I know to contemplate trying it on a small scale as a fodder crop."—R. S. Beckett.

Carleton: "We find Sweet Clover growing more or less generally throughout the county. It grows on the roadsides, in waste places and cultivated lands. While quite common throughout the county it is not cultivated. On the farm of Lorne Groves at Kinburn, Sweet Clover appeared in one of his fields after seeding down with clover and grass seed about five years ago. It has continued to spread spontaneously throughout this ten-acre field since that time, and Mr. Groves has already taken off and cured for hay a crop of Sweet Clover averaging two tons, or better, for the ten-acre field. The Sweet Clover was, last year, in his grain crop and he found that the stock was very fond of the straw from that field on account of the large amount of Sweet Clover it contained. Mr. Groves is at present feeding the green Sweet Clover to his horses, and states that 'they are fond of it.' . . . The variety of Sweet Clover which Mr. Groves has taken off for hay is the Yellow Sweet Clover (Melilotus officinalis)."—W. D. Jackson.

Manitoulin: "Following your circular *re* Sweet Clover, I might say that there is no Sweet Clover cultivated here and only a small amount of it growing wild. It is growing mostly on sandy or gravelly soils and is deemed a weed, though not a very bad one."—I. F. Metcalf.

Durham: "Sweet Clover grows in various parts of the county, both the white and yellow varieties, but is usually recognized as a weed. I have seen it growing on soils varying from light sand to heavy clay; on the roadside, and in uncultivated fields and also in cultivated fields. In so far as I know, the plant is not being cultivated in this county."—R. S. Duncan.

Simcoe: "Sweet Clover has not been cultivated and in its natural state is not growing in sufficient quantities in this county to cause people to regard it as a weed. In some places waste land is infested to a certain extent and odd plants are found at times in meadow land. I have seen some of the yellow variety, but the white is much more common."—J. Laughland.

Haldimand: "Sweet Clover grows in every township of Haldimand. We have both the yellow and the white-flowered varieties, the white being much more common as it is much hardier. The yellow appears only in occasional small patches. We find Sweet Clover growing on all the different kinds of soil in our county, some of which in the vicinity of Dunnville is very sandy, but the majority of which is heavy clay. It seems to be most abundant on the heavy clay soil, and particularly on the roadsides. . . . Sweet Clover is by a large majority of people deemed a troublesome weed. This last year or two, however, a few people of the county have realized the value of Sweet Clover and are growing it commercially. For some years a number of people have grown Sweet Clover which has been plowed in when a good growth was attained to give a seed bed of alfalfa. This spring quite an acreage of Sweet Clover was planted in this county, the main object being to get a crop of hay as well as seed. The majority of the growers claim that the seed crop will be the most profitable as they expect that for a few years at least there will be a very large demand for the seed in Ontario, principally for experimental purposes. It is claimed that Sweet Clover is very easily killed if cut close to the ground just as it has come into bloom. It is confined mostly to fence corners, roadsides and waste places, but it creeps into fields occasionally, particularly in our alfalfa fields and, judging by the reports from a large number of samples which we had tested in Ottawa last year, the seed of Sweet Clover is quite prevalent in alfalfa seed grown in this county."—H. M. King.

Opinions of Some Ontario Farmers.

"I do not consider Sweet Clover a noxious weed. I have fifteen acres of the yellow variety and there is a good second crop on it now which I may thresh. The soil is clay loam. Cattle and horses eat it as well as alfalfa. It does not taint the milk."—Lorne Groves, Kinburn.

"I sowed Sweet Clover last April on light loam, alongside of red clover. The latter did not catch. I seeded this same field to alfalfa two years ago and lost all my seed.

"I do not consider Sweet Clover a noxious weed. Horses relish it."—T. M. Caton, Cherry Valley, 1914.

"I seed to Sweet Clover in the spring as you would ordinary clover. The seed bed is prepared the same and a nurse crop of oats or barley is used. The fifteen acres which I seeded this spring has a good catch and is growing very well. I expect it will be up into the oat and barley sheaves when they are cut.

"I do not consider it a bad or noxious weed. Even if it will not all die on plowing the roots will be taking some nitrogen from the air and that is what we want it to do. There is one way that it can be killed effectually, and that is by cutting in June with the mower or other implement which will cut it close to the ground. This I have observed time and again when we got the seed in other grass seed.

"It will grow on all kinds and conditions of soil, but seems to grow best on well-drained loam. No other plant will be found growing on as poor soils as it will.

"Our animals will not refuse to eat it. In fact, when I turned our cattle in on it last year after the grain crop was harvested they ate it in preference to the abundance of June grass that was growing along the fences and in a waste portion of the field. However, there may be some animals that would require a little education to make them eat it, but the effort would be small on the part of the teacher. I believe that it is as good a feed as is alfalfa, but cannot speak definitely on that point. It does taint the milk and butter, but the taint is anything but offensive. The taint is sweet and pleasant and will leave the butter after it has been made about three days.

"I have seeded with the white variety and much prefer it to the yellow.

"As Sweet Clover is only a biennial there will be only two years' crop off it unless it be allowed to go to seed. The first cutting of the second year should be made in June just as the first blossoms appear. If it is left later I notice that it has a tendency to get tough and woody. It should be cut in June with the binder so that the stubble will be left about six inches high. In this way one can get a second cutting in the year. If it is cut in June with the mower the whole field will be killed and the second cutting gone. If it grows well during the first year one may be able to take a cutting in the fall and use the mower without hurting it any. I notice that it should be sowed rather thickly so that the stalks will not grow too thick and coarse. What I seeded this year was at the rate of fifteen pounds per acre."—Thomas H. Binnie, Sec. Grey County Board of Agr., Priceville.

"It is not a bad or noxious weed, for the simple reason that as you plow it under it is dead and done for, and does not spread over the fields like other weeds.

"It grows on any soil except those devoid of lime, thrives on blow away sand, stony land or stiff clay, conditions too adverse for other plants to thrive in; best results are obtained on good loam soils.

"As hay it is as good as alfalfa; pastured while young is good for all kinds of stock and yields a continuous supply of nutritious herbage which is a good milk producer; is a good honey plant; its one drawback as a plant for green feeding is the short time the plant would remain in the best condition for such purpose, against which it re-crops directly. While maturing it is a complete cover, so much so that it smothers almost all noxious weeds, including Canada thistles and sow thistles. For green manuring it excels by adding more humus than any other green manures.

"Animals are not always fond of it at first, but soon acquire the taste and ever after prefer it to other foods; they thrive on it as well as on alfalfa or other clovers; no taint has been noticed on milk or butter from its use.

"We grow the white-flowered variety only, preferring it for its vigour and sureness of crop.

"Sweet Clover is indifferent to the time of sowing and the preparation of the soil beyond any other field crop. It may be successfully sown in winter, spring, summer or fall; must not be covered deep, harrowing is hurtful. For pasture or seed 12 pounds per acre is enough, and for hay 16 pounds.

"If sown alone a crop of hay may be cut the first year, but late; if with other crop some pasture will be afforded the first year and it will fully crop the second year.

"Our method has been to sow with grain, pasture in the fall and let go to seed the second season, with satisfactory results. We know of it being cut early for hay and good seed crop obtained after, the same season. In fact, we know no other crop so indifferent to its soil, cultivation, seeding and treatment and that would produce such results."—Wm. Linton, Sr., Aurora.

"I can give you a little more information about Sweet Clover than last year. It grew well, and averaged between three and four tons to the acre. We sowed 5 lbs. on one-fifth of an acre, and off that fifth of an acre cut three-quarters of a ton of dry hay and have been feeding a horse on it. The horse is working hard every day and is in good condition, feeding off the hay from that plot since the 6th of June.

"All we have is now from two to three feet high and white with blossom; we expect a nice bunch of seed. I sowed three acres this year and will sow fifteen acres next spring. It will grow where alfalfa is a failure. I sowed the larger plot where the year before I had sowed $22.00 worth of alfalfa and that was no good, and the Sweet Clover was three feet high in June.

"All stock will eat it readily."—T. M. Caton, Cherry Valley (Aug. 3rd, 1915).

"Our seed turned out well. We cut it with the binder and had 15 bags of seed, each weighing 250 pounds, and sold it at $14.00 per bushel.

"This year's crop has been cut for hay, 33 big loads. Some we cut too late and it killed out, but what we sowed with the buckwheat last year is coming on for seed, being about two feet high now.

"Our stock prefer it to any other feed and seldom leave the barn, although the other pasture is good."—Rocliffe Lindon, Vandorf (July 27th, 1915).

"I sowed some Sweet Clover on hillsides on a grazing farm a year ago this spring. It made an early start this spring and the stock seemed to be very fond of it. They had a big range of natural grass to feed on, but there seemed to be something about the Sweet Clover they liked, for they kept it grazed off short and they had abundance of natural grass. I never had cattle put on so much gain in weight before. I seeded fourteen acres on fall wheat this spring; it is about six inches high now and expect it will give good pasture after the wheat is removed. The different farmers who have tried it in this section think it will prove a very valuable crop."—Julius Holm, Cherry Grove Farm, Walkerton.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 236

Home Canning of Fruits and Vegetables

By

E. L. DAVIES
Demonstrator in Bacteriology

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ONTARIO AGRICULTURAL COLLEGE

Home Canning

OF

Fruits and Vegetables

E. L. Davies, B.S.A.

INTRODUCTION.

It is only of comparatively recent years that the process of canning fruits and vegetables has been placed on a scientific basis. Preservation of foods of all kinds has been practised for many centuries, although the modern methods were not introduced until early in the nineteenth century, and even at that time the reasons for certain manipulations could not be satisfactorily explained.

As early as the seventeenth century it had been observed that there were plants and animals so minute that they could not be observed without the aid of a powerful microscope. As the years passed, our knowledge of these minute plant organisms increased, and about the middle of the nineteenth century it was shown that some caused disease, others fermentation, and others putrefaction; in fact, that these organisms were of immense importance in nature.

The organisms concerned in the process of canning, or food preservation, are those which produce fermentation or putrefaction in the materials after they have been put away in the jar. Such organisms may be divided into three groups—moulds, yeasts and bacteria.

Moulds.

A white, green or black furry growth, commonly found on spoiled foods, especially on bread kept in damp places, cheese and canned fruits.

Some of these moulds may cause distinct alcoholic fermentation in canned fruit, and at the same time impart a "mouldy" flavour to the material.

The moulds reproduce themselves by spores. These are very small light bodies which are easily carried in the air. When they settle on favourable materials they germinate and produce the typical mould plant. Mould spores are found very commonly on ripe fruit.

Yeasts.

Yeasts are common in every household, being used in breadmaking, and are usually the cause of fermenting canned fruits.

They are very minute plants which are quite invisible to the naked eye. If they gain entrance to substances containing sugar and enough moisture they immediately begin to produce alcoholic fermentation. Yeasts are carried in the air, and are found on most ripe fruits.

The yeasts reproduce themselves by a process of "budding," that is a very small cell appears on the surface of a mature cell, which rapidly grows larger until the size of the mother cell. During growth and multiplication certain enzymes are produced, the enzymes being substances of a chemical nature which decompose the sugars, alcohol and gas being produced.

Bacteria.

These plants are much more minute than either moulds or yeasts, and can only be observed with a powerful microscope. Bacteria vary in size, but it may be said that from 10,000 to 15,000 can be placed end to end, and 30,000 to 50,000 placed side by side, within the space of one inch.

Bacteria reproduce themselves by fission, that is the cell divides into two equal parts. Such division, or reproduction takes place, under normal conditions, once every 30 to 45 minutes, and within 24 hours the progeny of one cell may amount to millions. As these bacteria grow they decompose the material upon which they are growing, such changes in foods being known as putrefaction or decay.

Many bacteria produce very hardy and resistant bodies within the cell, known as spores. These spores are surrounded by a heavy covering or wall, which makes them very resistant to heat, light and chemicals. They are formed by the bacteria when the conditions for growth become unfavourable, as lack of food, moisture, etc., and thus serve as a means of tiding the organism over conditions which would otherwise result in death. As soon as the conditions become favourable the spore germinates, an active cell is formed, and the rapid reproduction soon leads to the presence of millions of cells in the material.

Due to their light weight bacteria, and spores of bacteria, are very prevalent in the air, being carried about by air currents. If the air is heavily laden with dust the numbers are greatly increased, every particle of dust carrying hundreds of bacteria. Anything exposed to the air is soon contaminated with these minute organisms, and if the substance is favourable for growth, the bacteria are soon present in large numbers and make themselves known by the changes they bring about.

The souring of milk is due to bacteria entering from outside sources, on dust or dirt, etc. Putrefaction of foods is brought about by a similar cause. Canned goods are often spoiled by the action of bacteria.

PREPARATION FOR CANNING.

It has been shown that a single cell, or a single spore, can set up fermentation, putrefaction, or spoilage of foods. Also that everything the housekeeper works with, utensils and fruit and vegetables, carries the organisms. This is especially so with the fruits and vegetables. This being the case all care possible must be taken to remove as many organisms as possible and when the fruit is put in the jars those organisms remaining must be killed.

The first part is accomplished by thorough cleanliness; that is, dust and soil must be very carefully washed off the fruit or vegetable to be canned. By removing dust or soil the greatest source of contamination is removed, since these materials abound in spores and active cells. Bruised or cracked fruit should be avoided if possible, since the yeasts and mould will soon penetrate the tissues and are not easily removed. Rough or cracked vegetables should never be used, especially is this the case with tomatoes, where the soil easily penetrates the tissues and cannot be washed out.

The jars, or containers to be used should be thoroughly scalded before use with hot water.

SCALDING AND BLANCHING.

Scalding means dipping in boiling water momentarily, or having boiling water thrown over the products.

Blanching means holding the products in boiling water for a certain length of time.

Scalding and blanching are done for several reasons. (*a*) To cleanse the products by removing dust, dirt or organisms; (*b*) To remove certain slimy or sticky substances which are present, as in peas and asparagus, which if not removed will give a thick, slimy, green and somewhat objectionable syrup; (*c*) To loosen the skins, as on peaches, tomatoes, etc.; (*d*) To somewhat reduce the bulk of the product, thus avoiding too much shrinkage in the jar.

Times for scalding and blanching the different products are given in the tables at the end.

STERILISATION.

This means the complete absence of living organisms in the canned products. It has been stated that however much care is taken in the cleaning and blanching process the products will still contain some bacteria which if not killed will cause spoilage. These few remaining organisms are enough to cause the damage, and are, as a rule, the most difficult to get rid of because they are often protected in the tissues of the product. There are several methods of ridding the canned material of these organisms, that is of sterilising it. The methods vary with the fruit or vegetable to be canned.

Sterilisation Under Steam Pressure.

This method is only applicable where a pressure boiler is at hand and even then great care must be observed if glass jars are to be used or the losses by cracking will be heavy. If tin cans are to be used the methods go beyond the scope of this bulletin and cannot be discussed.

Sterilisation under pressure renders possible the destruction of spores and active organisms within a comparatively short time, but it has the disadvantage that many of the tender fruits lose their shape and the texture is spoiled.

Intermittent Sterilisation.

This is the method advised for the housekeeper. It is applicable to fruits and vegetables, especially the latter, and can be carried out with absolute success in an ordinary wash boiler to which has been fitted some form of false bottom.

The method consists of heating the products to be canned, in jars, at boiling point for a given period of time, on one, two, or three successive days, the times advised having been determined by actual experiment.

The advantages of this method over any others open to the housekeeper are:

(*a*) Sterilisation is thorough. The product once in the jar is not open to contamination with spores or active organisms, as it is when the product is stewed in open kettles and then filled into the jar.

(*b*) The exposure to temperature may be more satisfactorily varied, so that over or under cooking is minimized.

(*c*) Tender fruits, as raspberries, have a minimum amount of handling, and heating is not so violent. The berries, therefore, retain their natural shape, color and appearance more satisfactorily.

(*d*) Experiments have determined the amount of heat necessary to destroy these organisms, some products needing much less time than others.

(*e*) It enables the canning of vegetables, as peas, beans, corn and tomatoes, which were previously canned only with difficulty.

Explanation of Intermittent Sterilisation.

As previously stated, intermittent sterilisation means heating the products in the container for a definite period of time, on one, two or three successive days.

The method is based on the fact that certain bacteria form very hardy spores. These spores are so resistant to ordinary boiling temperature that in some instances they are not killed by three or four hours, or more, exposure. If fruit and vegetables are exposed to such long heat the texture and shape is apt to be materially changed, the tender fruits especially are reduced to a more or less pulp, and the attractive appearance of the natural fruit is lost.

To overcome this difficulty the process of intermittent sterilisation is advised. The heat applied the first day kills all moulds, yeasts, and active (vegetative) bacterial cells, but not the spores. In the twenty-four hours elapsing between the first and second heating most of the spores germinate, that is, they form the active vegetative cells, and are killed by the second application of heat. A third heating is given after another twenty-four hours' interval, to kill any cells which have formed from spores which had not germinated when the second heating was given.

Thus in three comparatively short periods of heating (15-30 minutes) results are obtained which by constant boiling would require several hours. This form of sterilisation demands more care and attention, but is the only method offering success with vegetables. Most fruits demand only one heating for a brief interval.

Long Exposure to Boiling.

Boiling for extended periods of time has been advised by some writers for vegetables, but experiments conducted in the Department of Bacteriology have shown a large percentage of failures in every case. This is explained by the presence of very resistant spore forms, which are common in the soil. Therefore, exposure of vegetables or fruit to long periods of boiling cannot be advised, such products are more successfully canned by the intermittent method.

Chemicals—Preserving Powders.

Many brands of so-called "Preserving Powders" are found on the market. Small doses may not be immediately harmful to the healthy adult, but continued doses may have detrimental effect on the health. With a child or an invalid the effect may be dangerous. For these reasons, though in many cases the powders do prevent spoilage, their use is not recommended.

Why Some Products Need More Heat to Sterilise Them Than Others.

Different products demand different periods of exposure to heat to be sterilised. This fact is due to several causes which work hand in hand.

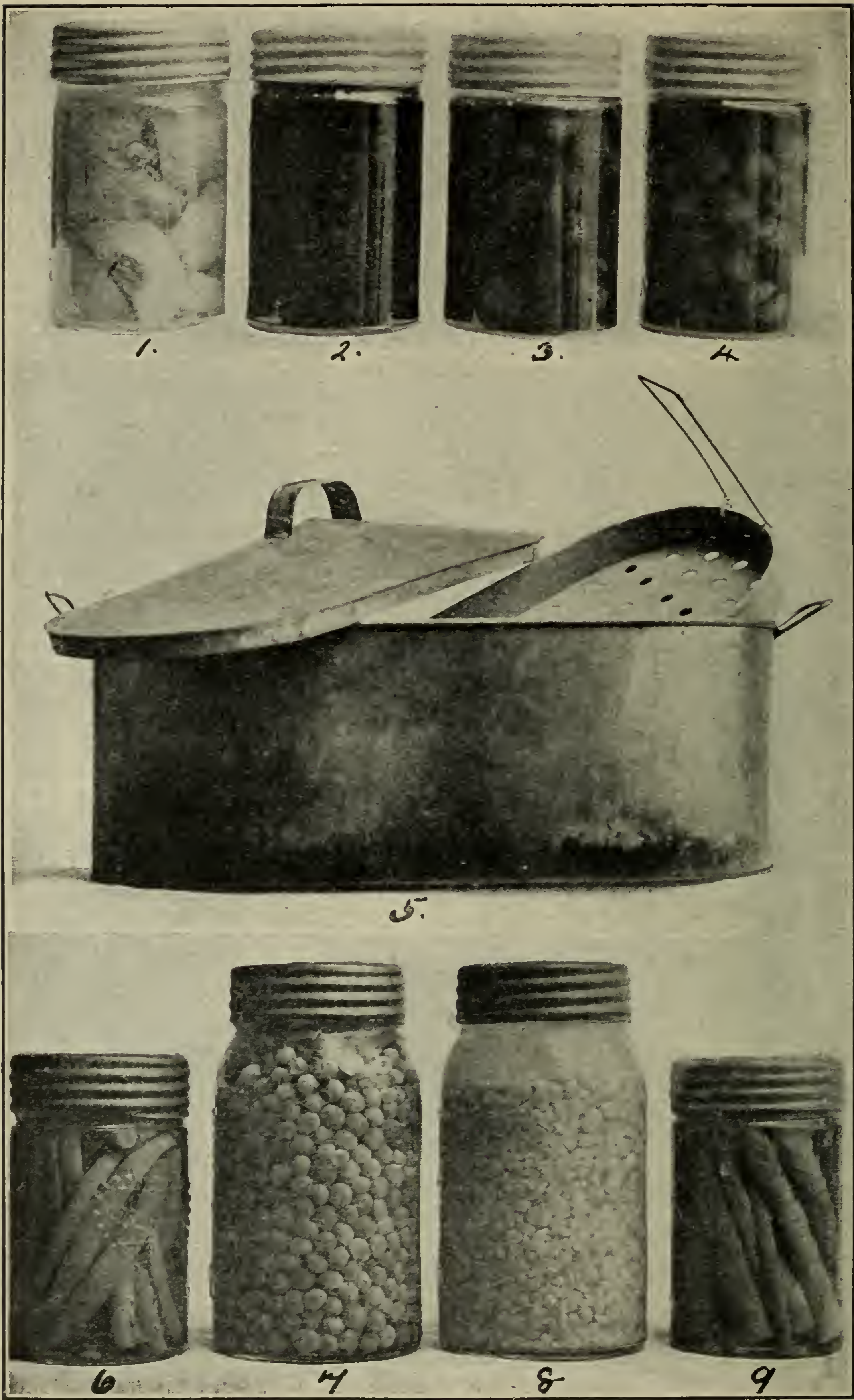
(1) Some are cleaner than others, therefore contain fewer spore forms. Those products taken from the soil, such as beans, peas and asparagus, are much more difficult to sterilise, because the soil is the source of many very resistant spore-forming organisms. Thorough washing and blanching does not remove all the spores.

(2) The character of the fruit or vegetable itself. Some are more acid than others, as tomatoes. Bacteria and yeasts do not develop as well in materials so high in acid. The acidity and heat together have a tendency to destroy the organisms more easily. Products such as asparagus, peas, beans, and some of the sweeter fruits, afford a splendid medium for the development of organisms.

Firm fruit and vegetables are less open to the entrance of organisms to the tissues. Soft and easily-broken products, as tomatoes and grapes, are often found cracked when picked. Soil or dust gaining entrance to the tissues by these cracks is washed out only with great difficulty. Protection to the organisms by the tissues thus entered makes sterilisation more difficult.

(3) *Density of the Syrup.* The amount of sugar in the syrup of canned fruits has a great influence on the time necessary for sterilisation.

When the concentration of sugar in a syrup reaches a certain point, bacteria, moulds and yeasts do not develop readily. This is due to the absence of sufficient moisture. The concentration of sugar used with most fruits is so high that bacteria are unable to develop, but is not high enough to prevent the growth of yeasts and moulds. This being the case the most difficult part of sterilisation, the destruction of bacteria, is eliminated. Yeasts and moulds, which can develop in such concentrated solutions, are killed by less exposure to heat than are the bacteria. Thus fruits canned with heavy syrups are sterilised more easily than products in which the bacteria can develop.



1. Pint jar of peaches. 2. Pint jar of raspberries. 3. Pint jar of strawberries. 4. Pint jar of cherries. 5. Wash boiler fitted with perforated false bottom, used for sterilising jars of fruit and vegetables. 6. Pint jar of butter beans. 7. Quart jar of green peas. 8. Quart jar of young corn. 9. Pint jar of asparagus.

DIRECTIONS FOR CANNING.

Jars.

Any jars which can be sealed tightly may be used. It is advisable to use new ings each year. The jars should be thoroughly scalded with boiling water before use.

Boiler.

The ordinary wash boiler may be used to which has been fitted some form of alse bottom. The false bottom is necessary to keep the jars from the direct heat f the fire, which otherwise would cause cracking. Galvanized sheet iron serves ery well for this purpose. It should be made to fit the boiler easily and should e perforated with ½-inch holes to allow diffusion of water, and should be kept ½-¾ inches off the bottom of the boiler by means of projecting ridges or feet. onvenience is increased by having a wire handle at each end of the false bottom rojecting above the water, by which, after heating, the jars can be lifted out all ogether, the false bottom serving as a rack.

Quality of Fruit or Vegetable.

For reasons stated before, the product to be canned should be fresh and of ood quality. Bruised or damaged products should be avoided.

Scalded.

Products having skins to be removed, as tomatoes or peaches, should be dipped n boiling water one-half to one minute, or have boiling water poured over them.

Blanching.

Blanching is done by holding the product for several minutes in boiling water. This removes various substances which spoil the quality of the canned product and with vegetables is an aid to the removal of soil bacteria. After blanching, products should be dipped in cold water to regain their former firmness.

Syrups and Salting.

The syrup to be used varies with the kind of fruit and according to taste. The following syrups were found quite satisfactory in experiments.

Soft and delicately-flavoured fruits, as strawberries, some cherries and raspberries, should be canned in a dense syrup, made of sugar two parts, water one part. With this syrup the natural colour is retained.

Currants, peaches, plums, quinces, sweet cherries, apricots, etc., should be canned in a syrup of medium density, made up of sugar one part, water one part.

For fruit requiring a light syrup, one part of sugar to one and one-half parts water is satisfactory. The syrup is made by dissolving the sugar in hot water, any scum forming on the surface should be removed.

The syrup should be added to the fruit in the jar while hot.

Vegetables are of better flavour if the water added is salted to taste before filling the jar.

Fruit and Syrup in Jar.

The jar should be well filled with fruit, often slight pressure is used to advantage. This does away with excessive empty space due to shrinkage. Large or firm fruits and vegetables, as peaches, and beans, should be cut so that they will pack more closely.

When the fruit is packed, the jar should be stood in warm water to heat the glass ready for the hot syrup. The syrup should be hot when poured over the fruit, and the jar well filled, although jars only partly filled are just as safe and as easily sterilised. The cap and rubber ring are then put on and sealed tightly.

Sterilisation.

The boiler is filled with enough cold water to come an inch or two above the false bottom, or enough water to prevent it boiling dry. More water is unnecessary, it takes much longer to heat, and steam will do the heating as well as the water.

Just before the jars are stood in the boiler, with the water cold, the tops are slightly loosened to allow for expansion. The cover of the boiler should fit closely to prevent unnecessary loss of steam. Time of heating should be taken from the moment the water reaches the boiling point.

When the time is up the boiler should be removed from the heat, but not opened for five or ten minutes. Then the covers should be screwed down tightly, the jars taken from the water and placed on a wood surface away from cold draughts. If the tops are closed immediately the heat is turned off, the pressure becomes very high and may cause trouble with leaky rubbers. It is advisable to stand the jars upside down for the cooling period, then any leaks of air can be observed. If the product only calls for one period of heat, the jars must be observed closely, if leaks occur, as shown by bubbling of air into the jar, the rubber should be changed and sterilisation repeated.

Products to be heated on a second or third time are treated as for the first heating, at intervals of 20-24 hours. Care must be taken to unscrew the top slightly to allow for expansion.

It has been previously stated that the air carries with it numerous mould spores, yeasts and bacteria. Therefore it must be clear that *once the process of sterilisation has been begun, under no condition should the jar be opened to the air.* If air gains admittance by leaks or by removal of the top of the jar, then the work is undone and sterilisation must be repeated. Even the smallest air leak affords space for the passage of such minute organisms as are being dealt with.

Paraffining.

Dipping the head of the jar in paraffin is advised by some, but this is quite unnecessary and only increases the work of canning, and later in washing the jar.

TIME TABLE FOR FRUITS.

Product.	Treatment.	Scald or Blanch.	Syrup.		Sterilisation.
			Sugar.	Water.	
Apples......	Peel, core, halve or quarter	....	1 part	1 part	Bring water to boil ½ minute. Allow jars to stand in boiler 20 minutes. Seal tightly.
Apricots....	Halve, pit or pack whole.	1 to 2 mins.	1 part	1 part	Water boiling 5 to 10 mins. according to ripeness of fruit.
Blackberries.	Wash and pick over......	....	1 part	½ part	As apples.
Blueberries..	As blackberries.........	....	....	....	....
Cherries (sour).	Wash, stem and pit......	....	1 part	½ part	As apples.
Cherries (sweet).	Wash, stem and pit......	....	1 part	1 part	As apples.
Peaches.....	Skin, halve or quarter; pit or pack whole.....	1 to 2 mins.	1 part	1 part	As apricots.
Pears.......	Peel, halve or quarter, core..................	....	1 part	1 part	As apples.
Plums......	Pack whole or pit........	....	1 part	1 part	As apples.
Raspberries.	Hull....................	....	1 part	½ part	As apples.
Strawberries	Hull....................	....	1 part	½ part	As apples.

TIME TABLE FOR VEGETABLES.

Product.	* Treatment.	Blanch.	Sterilisation.
Asparagus....	Wash, cut to jar length.........	5 to 7 mins.	30 minutes on 3 successive days.
Beans (string).	String, cut up or pack whole....	5 to 10 mins.	As asparagus.
Corn (off cob)..	Cut from cob after blanching....	10 to 15 mins.	As asparagus.
Peas..........	Hull..........................	5 to 10 mins.	As asparagus.
Tomatoes.....	Skin, core, halve or quarter.....	1 to 2 mins.	15 minutes on 3 days.†

* Salting to taste.

† 20 minutes on 2 days has been successful, but cannot be recommended without reserve.

BULLETIN 237 MARCH, 1916

Ontario Department of Agriculture

FRUIT BRANCH

The Grape in Ontario

F. M. CLEMENT

INTRODUCTION.

The following pages are written with the hope that they may serve as a help and guide to those who have not had an extended experience with vineyards and to others who may desire to study the subject a little more fully. Only a small part of the experimental work under way at the Vineland Experiment Station is here reported because it is largely new. It is hoped that some time in the not too distant future, the different phases of grape growing may be dealt with in detail in special bulletins.

Vineyard in early spring before growth has started. Notice the peach bloom in the distance.

If the experienced grape grower obtains from these pages helpful suggestions here and there, and the new men get hints that help them to develop more fully their vineyards, the hopes of the writers will have been fulfilled.

No attempt is made to present new material, but rather to present a practical outline of grape growing in Ontario. The information has been gathered from talks and discussions with growers in Ontario and parts of New York State and from practical experience. The field work has been done largely by Mr. L. R. Jones, who has charge of the grape investigations at the Station.

HISTORY AND STATUS OF THE GRAPE.

The grape is one of the oldest and most popular of our fruits. Its culture dates back to prehistoric times. Seeds have been found in the remains of the Swiss Lake dwellings of the Bronze period and entombed with the mummies of Egypt. In later days, it was cultivated by the Greeks and Romans, and the instructions for cultivation by Virgil are as authentic as ours to-day. Notice his instructions:—

> "With iron teeth and rakes and prongs to move
> The crusted earth, and loosen it above,
> Then exercise they sturdy steers to plow
> Between the vines," etc.

and also:

> "And let thy hand supply the pruning knife,
> And crop luxuriant stragglers, nor be loth
> To strip the branches of their leafy growth," etc.

One species, *Vitus vinifera,* is grown in Europe. From this has been made wines for centuries, and from it to-day are made the raisins of commerce. Eastern American viticulturists have not been able to grow this species successfully, though recent experiments seem to indicate that with the best care and the application of the most modern cultural methods, there are some hopes of success. This species is also the grape of commerce of California. The grapes of Eastern America and Ontario have been developed largely from native species (*Vitus labrusca*), with here and there a sprinkling of European blood. The "Rogers" varieties, so familiar to all, are the result of crosses between a large fruited variety known locally as Carter or Mammoth Globe (*Labrusca*) fertilized by pollen secured from Black Hamburg and White Chasselas (*Vinifera*). The greater number of the remaining varieties, including Concord and Worden, are pure American varieties. Large quantities of grapes are imported from California into Canada, but these grapes being of the European type and consequently of a distinct quality and flavor, do not come in direct competition with our native grapes. The Easterner prefers the Eastern grape which he can obtain in quantity, but at the same time uses the California product for special dessert purposes. The imported product is firm, sweet, little subject to rot and of good quality, and may be found on the fruit stands of our cities at all times during the grape season. The price of the imported product is necessarily high, being from ten to twenty cents per pound retail, while the home product sells from twenty to thirty-five cents an eight pound basket retail.

Following is the quantity and value of the grapes imported into Canada during past years:—

Year.	Quantity.	Value.
1895	977,754 lbs.	$ 56,118
1900	936,344 "	55,327
1910	3,502,989 "	221,887
1914	7,712,447 "	490,128
1915	6,200,160 "	317,183

From the following list it will also be noticed that the heaviest import months are our heaviest shipping months:—

Month.	1913–14	Value.	1914–15	Value.
April	1,564 lbs.	$ 728	5,378 lbs.	$ 1,268
May	195 "	186	287 "	230
June	130 "	203	496 "	163
July	192 "	80	16,580 "	1,620
August	328,051 "	19,327	493,742 "	24,614
September	1,419,993 "	67,871	1,308,378 "	51,433
October	2,189,579 "	118,916	1,583,569 "	52,486
November	3,010,946 "	216,962	2,058,283 "	129,528
December	695,683 "	57,614	596,164 "	42,091
January	40,406 "	4,112	109,816 "	10,348
February	20,931 "	2,804	14,513 "	1,839
March	4,777 "	1,325	12,954 "	1,563

We are not particularly concerned with the details of the development of the grape industry in America, but it might possibly be of interest to note the development in Ontario. As late as 1880, the Province was credited with not more than 400 acres of commercial grapes. By 1890, this area had increased to 2,400 acres, and by 1901, to 5,750 acres. The census of 1911 does not give directly the number of acres in Ontario, but the Ontario Bureau of Industries credits Ontario with 11,586 acres, and the 1914 Bureau of Industries credits Ontario with 10,850 acres. The figures of the last few years show a steady small decrease in area possibly due to the taking out of grapes in isolated sections.

The following is a list of counties showing the acreage in each:—

Lincoln	5,071	acres.
Wentworth	2,790	"
Welland	926	"
Essex	275	"
Halton	184	acres.
Peel	168	"
Kent	134	"

The other counties have still smaller acreages. These figures would seem to indicate that the commercial grape areas of Ontario are largely on the lake shore between Niagara and Toronto, and on the north shore of Lake Erie in the two most south-westerly counties.

Grapes are used largely for the manufacture of fermented wine, for the manufacture of grape juice, and for dessert and jelly purposes. Where the European varieties are grown they are used quite largely for the production of currants and raisins. All our common varieties are used more or less largely for the first named purposes. We have no variety that will dry to make raisins or currants.

As stated previously, great importations for purposes largely to supply the fruit stand trade, amount for the year ending March, 1915, to 6,200,160 lbs., valued at $317,183.00.

Great Britain	635,276	lbs., valued at	$48,086.00
United States	5,533,640	lbs., valued at	266,886.00
Spain	31,244	lbs., valued at	2,211.00

This is an average value of more than five cents per pound for 6,200,160 pounds, or more than 3,100 tons, which is equal to the production of more than a thousand acres in Ontario in a good season. There is a possibility that this shortage may be made up some day, but not likely in the very immediate future.

In the same connection also it is interesting to note something of the raisin industry. Raisins are dried grapes prepared and packed in a special way. Last year Canada imported for consumption as follows:—

Source.	Quantity.	Value.
From Great Britain	226,601 lbs.	$ 11,648
" United States	16,100,284 "	1,060,375
" Spain	4,099,927 "	252,636
" Turkey	1,584,289 "	80,368
" Other countries	606,836 "	36,733
	22,617,937 lbs.	1,441,760

As shown previously, the counties of the Niagara Peninsula—Lincoln, Welland and Wentworth—are the leading grape centres. The first record of planting that has been brought to the attention of the writers is that of the small area set out on the farm now owned by Mr. Porter Adams, at Queenston, in the Township of Niagara, in the year 1857. The next year, Mr. W. D. Kitchen and Mr. J. R. Pettit planted some vines on their farms at Grimsby. In 1862, Mr. Wm. Read, of Port Dalhousie, planted three acres of Concord, Hartford Prolific and Delaware, and in the same year Mr. Peter Wright, of Stamford, planted three acres of Isabella. In 1863, Mr. Lusee, Mr. J. M. Stewart, Henry Lottridge, and Christopher Biggar, all planted small vineyards. In 1868, Mr. F. G. Stewart, of Stamford, planted two and a half acres of Concord and Delaware, and Mr. Prest, of the same place, planted an acre of Delaware, Concord and Hartford Prolific. In 1869, Mr. Walter Kerr, of Drummondville, planted two acres of Concord and Delaware. In 1873, Mr. D. J. Lowry, of St. Davids, set out 200 Concord, 50 Isabella, 50 Diana and 15 Delaware vines. These were set in rows sixteen feet apart and the plants twelve feet apart, and were trained to chestnut stakes seven feet high. No special stimulus seems to have been given the industry until about 1882, when the much advertised "Niagara" variety was introduced. Vines of this variety were sold at $1.25 each, and all cuttings had to be returned to the company. In spite of the high cost, a great deal of money was made from this variety during the years following its introduction.

Crops, as a rule, were uniformly good, and the disease and insects of to-day were scarcely, if at all, noticeable.

As shown previously, from this time on the growth was rapid, but though more than thirty-five years have passed and many vineyards may be considered old, and many of our best growers may be considered of long standing, the industry is still in its infancy.

SITES AND SOILS.

From the examination of the table of acreages by counties it has been seen that the grape centres are largely in those sections that are, more or less, protected from the greater extremes of heat and cold. This indicates that the best varieties are somewhat tender. They will, however, thrive fairly well without winter protection in the greater part of Western Ontario, and especially near the large bodies of water. Some thrive also on the north shore of Lake Ontario, but the plantings are almost entirely gardens.

Confining ourselves to the commercial centres, we find that grapes are grown on a great variety of soils under varied conditions. Two points, however, must always be kept in mind: first, the danger of loss from late spring frosts; second, the danger of loss from non-maturity in the fall. A third point might be mentioned also, that of protection from insects and diseases.

The danger from frosts is largely one of situation or site. The low-lying, flat land suffers first. Cold air settles in the hollows and basins hold cold air on cool nights much the same as basins accumulate and hold water. Elevated lands, on the other hand, are always more or less affected by air currents. Wind blows over them and cool air flows down their sides.

Large bodies of water also have a modifying effect on the atmosphere, holding in check the extreme cold of winter, delaying blossoming in the spring—and it might be added also, delaying ripening in the fall. Deep hollows and ravines also tend to draw off the cool air, and it is seldom, if ever, that vines on the hill tops are injured. The danger of loss from non-maturity in the fall is largely the result of a short growing season, cool nights and days, or most likely too cold soil. It might also be a question of too rich soil or soil that is unbalanced in its fertilizing ingredients.

A short growing season is one that cannot be overcome except by planting earlier and quicker-maturing varieties. Cool nights and days often occur at a time when warm days are most needed, and cannot be overcome by direct means. The sowing of a quick-growing cover crop, such as five pecks of oats to the acre, may assist a little, but ceasing cultivation and allowing the weeds to grow and the canes to ripen, is often all that can be done. This was all that could be done in the season of 1915. Warm weather very late in the season hastened maturity a great deal.

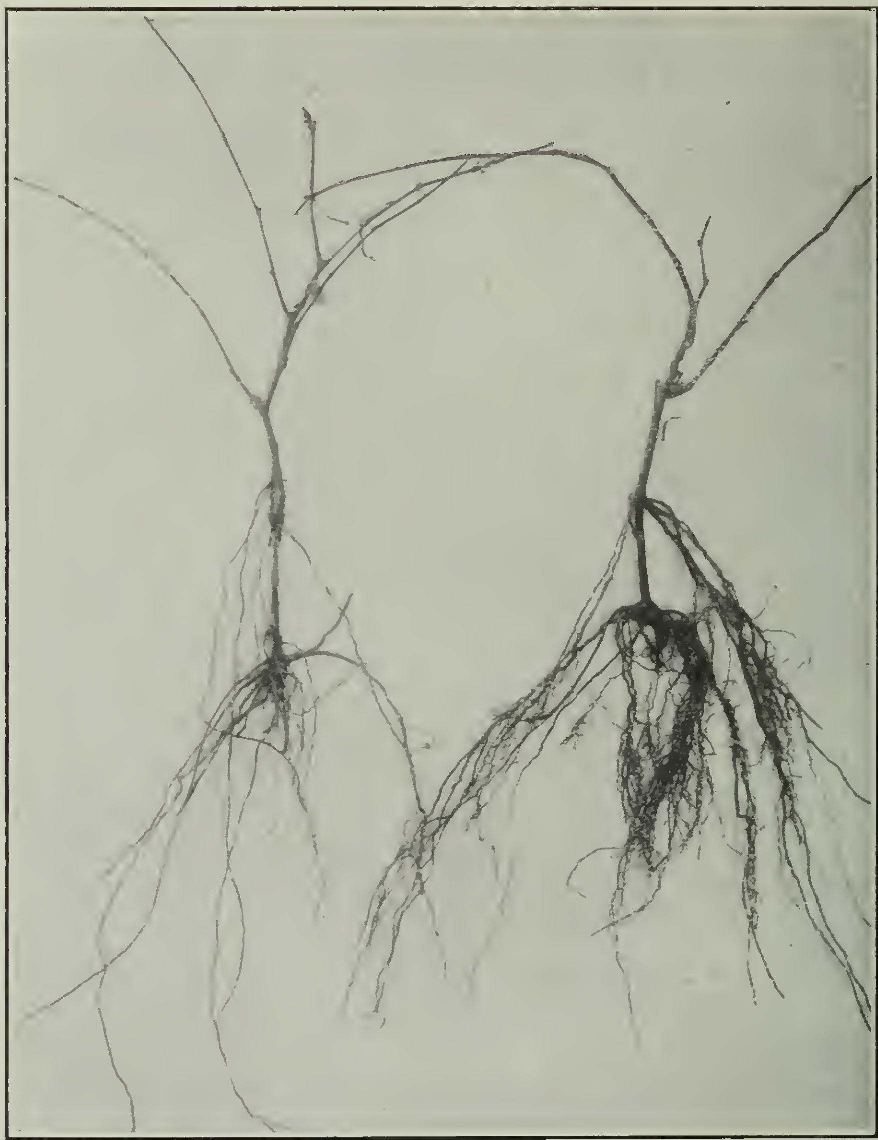
As stated before, cold soil is most often the main cause of slow maturity. Coldness is largely due to the water content of the soil. Grapes thrive best on the warmer soils, are sweeter and mature much quicker. A moist, cool sand, the ideal for strawberries and raspberries, invariably fails to ripen the grape. On the other hand, the harder, heavier clays ripen the grapes early as a rule. An exception will be mentioned later. Underdrainage will make the cool sands warmer, but the undertaking is considered inadvisable as these soils are more valuable when planted to small fruits.

Two types of soil give large crops of high quality grapes. These are the silty soils in the various townships found below the escarpment in the Niagara Peninsula, and the soils of the first ledge of the escarpment mapped in the soil survey work as Dunkirk clay loam. The former is of a grey or black color and from six to nine inches deep underlaid with a heavy subsoil of bluish or drab colored clay. Where the proportion of organic matter is greatest, the soil is darkest and most open and friable. This type of soil is derived from glacial lake deposits and occupies low-lying areas. The latter soil is dark brown to greyish brown clay and clay loam, about eight inches in depth, somewhat hard and cracks on drying. Owing to its nature, it is usually easy of drainage, but the subsoil is hard and impervious to water. The grit and gravel well mixed with the greater part of this soil tend to keep it more loose and open than it otherwise would be. The exception to these two types of grape soils is found in the warm, drier sands such as are found in the Fonthill district and scattered in various other parts of the grape-growing areas.

A part of the grape soils of New York State are of this nature. Warmer, drier, natural conditions, tend to early ripening and good quality. The quantity is possibly somewhat lower, but the warmth is an insurance against non-maturity.

NURSERY STOCK.

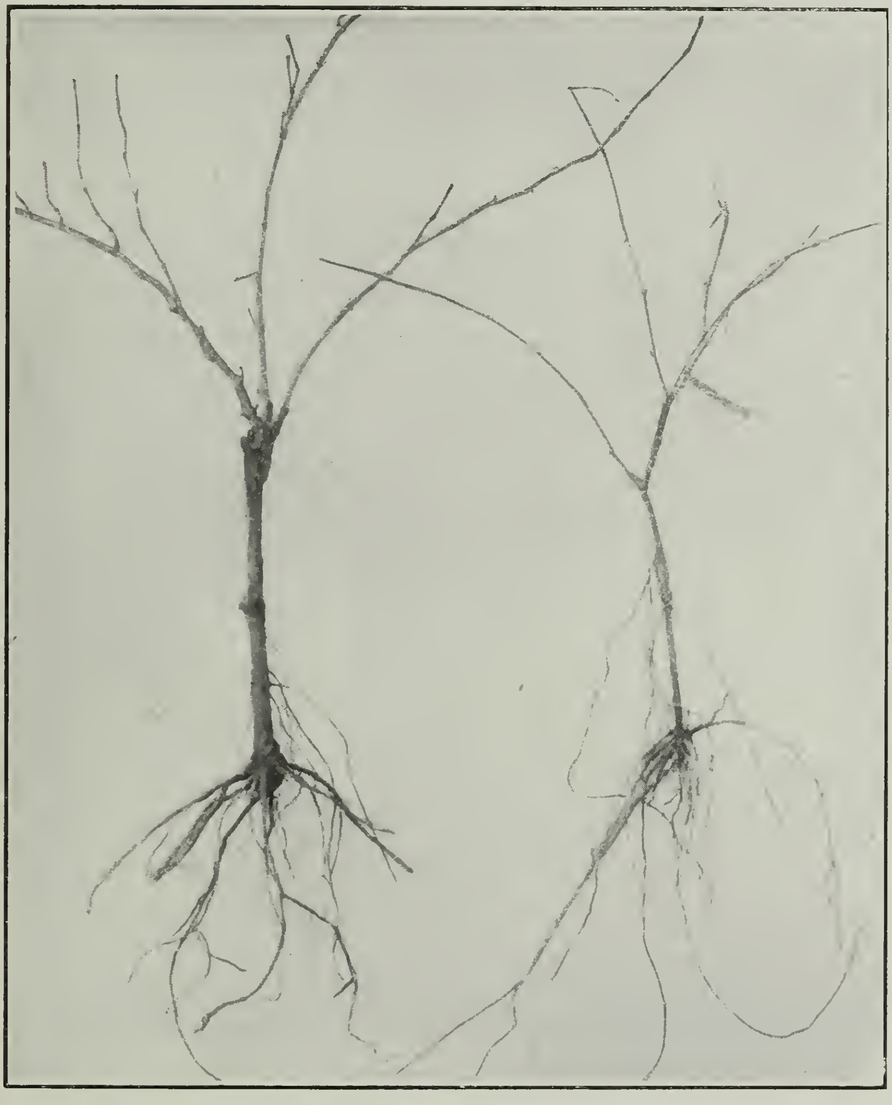
In ordinary nursery practice grape vines are propagated from cuttings. The cuttings may be prepared any time after the vines are dormant, but, other things



Concord vines one and two years of age as they are **received from the nursery.**

equal, and provided they are afterwards well cared for the sooner they are taken after the vines become dormant the better. The majority of grape growers do not grow their own vines but buy them from nurserymen. A few of the large nurserymen grow their own vines to propagate from; others gather their cuttings from nearby commercial and varietal vineyards.

The wood for cuttings is gathered from the vineyards shortly after pruning. Cuttings are made from well-matured wood of the same season's growth; and preferably from medium-sized, short-jointed wood. Cuttings are usually made three buds, or about ten to twelve inches long. A slanting cut is made just below the lowest eye, and another about an inch above the third or fourth bud. The cuttings are then tied in bundles of convenient size, the buds all turned the same way; and then heeled in or buried in trenches, butt ends up, and covered with three to six inches of soil. Inverting the bundles causes the butts to callus while the top remains dormant. Hence, the cuttings are ready to send out rootlets as soon as planted. If the tops were not inverted in this way, the shoots would start before the roots could support them.



Muscat and Concord one-year-old vines as received from the nursery.

In the spring, as soon as the soil is dry, warm enough and thoroughly worked, these cuttings are set two to three inches apart in furrows three to four feet apart. The furrows are usually made on a slight slant, and are deep, so that, when the cuttings are placed in them only the upper bud projects above the surface. The cuttings are hoed and cultivated frequently during the summer, and by fall the young vines will usually have made a strong growth.

When the young vines have properly matured their wood, about November first, they are plowed out. The vines are then gathered in bundles of convenient size for a man to handle and are taken to storage cellars. Here bundles of vines of different varieties are packed in separate bins. The vines are usually piled in two tiers with the tops out and the roots in. By this method the roots are prevented from drying out, and air is allowed to circulate around the tops, thus holding mildew in check. Of course, the new storage cellars are equipped with a proper system of ventilation by means of which the moisture content and temperature of the air can be controlled.

While in the cellars the vines are graded as No. 1's, No. 2's, and culls. Any two-year-old vines on hand are also divided into these three grades. Cuttings which have made a strong, well-balanced growth of root and top are classed as No. 1 year-old vines. A No. 2 year-old vine has made a somewhat weaker growth or the top may be a little over-developed compared to the root system. Culls are those vines which do not fall in either grade, and are usually discarded.

Those vines which are not sold in the spring are replanted and sold the following year as two-year-olds. In a few cases vines of the standard varieties, and some of the weaker-growing kinds are allowed to grow in the nursery for two years before being sold.

From this description the grower will readily see that for commercial plantings first-class one-year-old vines are to be preferred to first-class two-year-olds. Most large growers realize this, but to the small, inexperienced planters the larger, two-year-old vines look more promising.

Very frequently the grower does not place enough importance on the selection of first-class stock. To many the lower price of the poorer grade appeals strongly. Nevertheless, in purchasing vines it must always be borne in mind that the young vines are the foundation stock upon which the vineyard is to be built; and, if poor vines are planted, the vineyard will be handicapped right from the start.

Immediately on receiving the vines from a nursery the bundles should be opened, the vines spread out, and heeled in in some sheltered spot. The earth should be well mounded up to the vines and care taken not to mix the varieties.

PLANTING.

Land to be planted to grapes should be thoroughly prepared and in a good state of tilth. It is poor practice to set vines in sod land which has been plowed-under the previous fall, because, when the furrows are plowed in the spring for planting the sod will be turned up. If grapes must be set on such land, it should be summer fallowed in August preceding planting, and plowed again at the time of planting. To thoroughly prepare and clean the land for grapes it is best to grow some hoed or grain crop the year before planting.

As soon as the land is dry enough to work in the spring, it should be cultivated with a disc and worked both ways with a spring tooth cultivator.

Vines may be planted from as soon as the soil is in good tilth in the spring until about the first of June. The earlier the vines are set the better, because this enables them to become well established in the soil before the heat of the summer comes on.

The young vines must be pruned before planting. If the vine has several canes, all but one should be removed and this one should be shortened to two buds. This pruning makes the vine less liable to dry out before rooting, and forces the growth from the lower buds which produce more vigorous shoots.

The roots should also be thinned and cut back to about nine inches. Long roots are of no advantage to the young vine, because they are not the feeding roots, and are of no use until they develop feeding roots.

Previous to planting, the vineyard must be staked to show the location of the rows. Needless to say, care must be experienced in making these rows straight. The ease of all subsequent vineyard practices depends more or less upon this. Then to facilitate striking a straight furrow in which to set the vines, stakes may be set at frequent intervals along these rows. As deep a furrow as possible is made the first time and then by returning in the same furrow it can be made about ten to twelve inches deep, which is sufficient for the vines. Where the soil is shallow, it may be necessary to dig all holes instead of using the plow except for marking.

As soon as the furrow is made, planting should be begun, and should follow up the plow all the time. A rod cut to a length equal to the distance apart of the vines in the row is used to show the position of the vines. One man usually does the planting, but in case of large plantings two men are often used, and a boy supplies them with vines, which have already been pruned.

In planting, the roots of the vine should be spread out carefully, and the ground firmly tramped over them and beyond them to a distance of eighteen inches. The vines must be set so that the two buds left on the cane are just above the ground. If the vines are set deep enough, the roots of the young vines spread out, and the soil well firmed over them the grower can count on most of his vines taking.

The distances of the planting vary very much throughout the grape district. They range from 12 x 10 and 10 x 10 to as close as 8 x 8 and 8 x 7. These differences are due to variations in the soil, and variations in the vigor of the varieties of grapes. Vines planted on the lighter, sandy soils, require more feeding space than the same varieties planted on clay or clay loam. Such varieties as the Niagara and Lindley are far more vigorous, requiring longer pruning than either Moore Early or Delaware; and hence, must be farther apart in the rows than these latter varieties.

The distance between the row has been practically fixed to nine or ten feet, the smallest space in which a waggon can pass conveniently down the rows to gather the fruit.

For the Standard varieties, as Concord, Niagara, Vergennes, Worden and any of the Roger's varieties, a space of nine and a half to ten feet between the rows and nine feet in the rows is recommended. For the less vigorous, smaller growing varieties, as Moore Early and Delaware, a space of nine and a half to ten feet between the rows and seven or eight feet in the row is sufficient on average grape soil.

The practice of setting the vines 10 x 4 ft. or 10 x 5 ft., with the idea of removing every other vine after the fourth or fifth year is not to be recommended. Although this system of planting would, if vines could be purchased at two and a half cents each, considerably lessen the cost of establishing a vineyard, it is not practical because the grower will not remove the extra vines at the proper time, with the result that the whole lot are injured by being cramped into too small a space.

A practical plan to increase the yield per acre is to plant the rows closer, eight feet apart. By this means enough ground will be gained over the regular ten-foot planting to set an extra row of vines every fourth row. The difficulty of gathering the fruit with a standard waggon can be overcome by using a special grape truck which measures four feet ten inches over all in width. Because of the cross reaches used on these trucks they can be turned easily in a space fifteen feet wide. These trucks cost $70 f.o.b. the manufacturers.

Alleys.—In vineyards which are to cover an area of five or more acres, alleys running crosswise the rows should be provided at certain intervals. These facilitate cultivation and make shorter hauls possible during the picking season. These alleys should be wide enough to permit turning with a two-horse waggon.

CULTURAL METHODS.

Cultivation.

Frequent and thorough cultivation throughout the growing season is absolutely necessary for the best growth of the vines and the production of the crop in normal seasons. The first operation in the spring as soon as the soil is dry enough to work is to plow away from the vines. A single horse plow is used to turn the first two furrows away from the vines, and the remainder of the ground is turned over with a gang plow which does the work quicker and more evenly than a single plow. A furrow three inches deep is sufficient to turn over the surface soil, and still not deep enough to disturb the surface roots of the vine. It is very important that roots of well-established vines should not be torn up or carelessly exposed by deep plowing. They usually extend to some distance from the vines, and their loss might weaken the vine permanently. In some cases where the soil is friable and there is not any cover crop to plow under the disc may be used instead of the plow to loosen the soil in the spring. The grape hoe and hand hoe should now be used to work the soil away from the vines. Subsequent cultivation at least every two weeks during the summer should be given the soil with the disc or spring-tooth harrow. Especial care should be taken to cultivate in seasons of drought and before the soil has become caked and crusted after heavy rains.

All cultivation should be stopped by the first of August to give the vines a chance to ripen their wood and fruit before freezing. Fall plowing up to the vines may be done at this time, or later after the crop is off. The disadvantages of early plowing are: that some fruit may be torn from the vines by the plow or horses; and, that the soil is left in too rough a condition for the pickers to walk and work quickly along the rows, and for the waggon gathering the fruit to be driven over easily.

Intercropping.

The growing of such crops as early potatoes, cabbage, and tomatoes between the rows of a newly set vineyard will in no wise retard the growth of the vines, provided these crops are not planted closer than three feet to the vines and that the soil is well cultivated. Such crops as corn which shade the vines and check the circulation of air should never be planted in a vineyard. After the first year no crop, other than the cover crop, should be planted in the rows because from then on the vines are able to utilize all the available plant food themselves.

Mulching.

The mulching of young vines late in the fall with strawy manure is a practice to be recommended. The manure not only serves as a protection, but, when plowed under in the spring improves the physical condition of the soil.

Fertilizing.

The problem of the use of commercial fertilizers in vineyards is one which involves so many other factors that it is impossible to give general advice which will suit the individual cases of the growers. As a general rule the vineyards of this district do not need commercial fertilizers. What they do need in cases where the crops are decreasing and the wood growth is weak, is better drainage, and more thorough and frequent cultivation to make available the elements of plant food already in the soil.

On the heavier types of clay and clay loam soils frequent applications of strawy barnyard manure are necessary to improve the physical condition and add humus to the soil. An application of ten tons to the acre every three to four years is usually sufficient. This manure should be spread well over the row and not heaped around the trunk of the vine, because the feeding rootlets of the vine come from the larger roots and are not produced directly from the trunk of the vine. When applying barnyard manure, it must be borne in mind that a large percentage of the plant food it supplies is nitrogen, and, that frequent and liberal applications will produce an excessive wood growth and diminish the crop of fruit. No experimental data is available illustrating the value of applications of commercial fertilizer.

Cover-Cropping.

Cover crops are not generally used in the vineyards of the grape sections. A large percentage of the plantings have been made on mountain wash, and black clay loam soils which are rich in humus. Nevertheless, there are many cases where the use of a cover crop in the vineyard would solve the very problem which is perhaps puzzling the grower.

The functions of cover crops are to check growth, thus giving the vine time to ripen its wood before freezing; to utilize the nitrates available in the soil after the vine has ceased growth, and in this manner prevent the leaching of these valuable elements of plant food from hillsides which are exposed to washing during the winter and spring months; to add humus to the soil, and also nitrogen when a leguminous plant is used; and lastly, to hold the snow thus preventing deep freezing in the vineyards.

Some of the best cover crops to use are: Rye and Vetch, Rye, Oats, Buckwheat or Oats and Clover. These should be sown about August 1st and at the rate of:

Buckwheat—1 bushel 48 lbs. per acre.
Oats—1 to 1¼ bushels, 34 to 42½ lbs. per acre.
Rye—1 bushel 56 lbs. per acre.
Oats and Clover—Oats, 1 bushel; Clover, 15 lbs. per acre.
Rye and Vetch—Rye, 1 bushel; Vetch, 12½ lbs. per acre.

When sowing a space of eighteen to twenty inches should be left on each side of the row of vines to give a clear space for the pickers to walk in. These crops should be plowed under in the spring at the regular time of working the land.

TRELLISING.

Trellises are used to support the vines and furnish a means of uniformly distributing the growth, foliage, and crop of the vine.

To enable the trunks of young vines to make a strong straight growth they must be tied to the trellis the second year after planting. This means that the posting and wiring of the vineyard must be done while the vines are making their first season's growth.

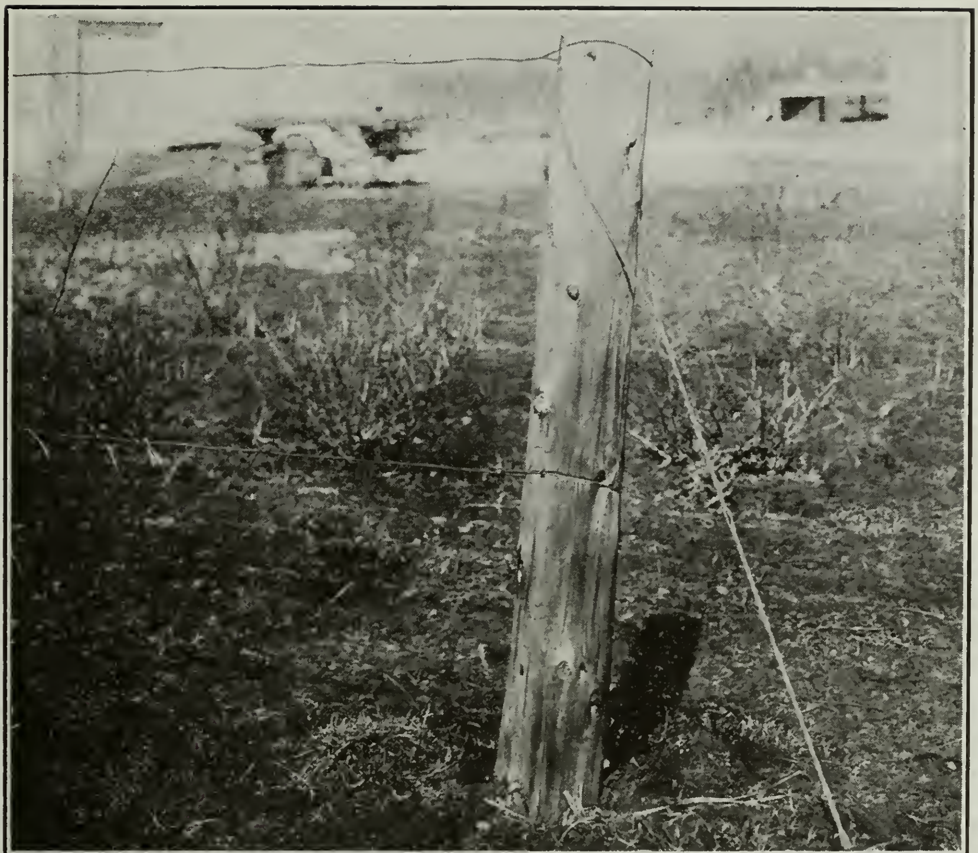
Well cured cedar posts are the best to use, and the most economical in the end. The end posts should be at least five inches in diameter and eight and a half feet long, the intermediate posts three inches in diameter and six and a half to seven feet long. A trellis made of good cedar posts, the butts of which have been tarred before setting, will last about twenty years. The posts should be set from twenty-four to thirty feet apart, depending on the distance apart the vines are planted in the rows; and from two and a half to three feet deep.

There are many methods of setting and supporting the end posts. In any case the end post must be set four to four and a half feet deep to enable it to withstand

The method of bracing the end posts in the vineyard at the Vineland Experiment Station.

heaving, and to support the weight of the vines and fruit. Perhaps the oldest method is that of bracing the end post with a rail or scantling from another post set about eight feet away in the row. The brace should reach from a point about a foot above the ground on the second post to within eighteen inches of the top of the end posts. To complete the bracing a guy must be passed from about six inches of the top of the second post to a short distance from the ground on the end post. This method is one of the strongest and most satisfactory. The high cost of scantling for braces and also the cost of an extra post are the factors which are against its more general use.

Another method which is being much used because of its low cost is that of guying the end post. The post is set in a hole at a slight angle, some large, heavy stones may be placed in the bottom and the rest of the hole filled and packed with soil. The post is then guyed with a strong galvanized wire, one end of which is



Post anchored to rocks buried several feet in the ground. This is by many considered the best method of bracing.

Another method of bracing. Notice the slope to the anchored post.

fastened to the post one foot from the top and the other end to a stone, or short post buried three and a half feet to four feet in the soil and from four to five feet from the post which is as near to the post as it is possible to get without decreasing its purchase. Besides the small original cost of setting these guys they furnish strong support to the posts while they last. The wires, however, are a nuisance in cultivating. The implements will not only often hitch into them, sometimes breaking them off; but the wires are bound to rust and break, and it is hard and expensive to replace them. Another point is that the head rows of the vineyard are much more difficult to keep clean when this method of supporting the end posts is used, than when they are braced or set in cement.

Still another method which is being used to some extent is that of setting the end posts in cement. The holes are made as deep as for the other methods, but the

A common patent used for taking up the slack in the wire.

A very common method of taking up the slack in the wire.

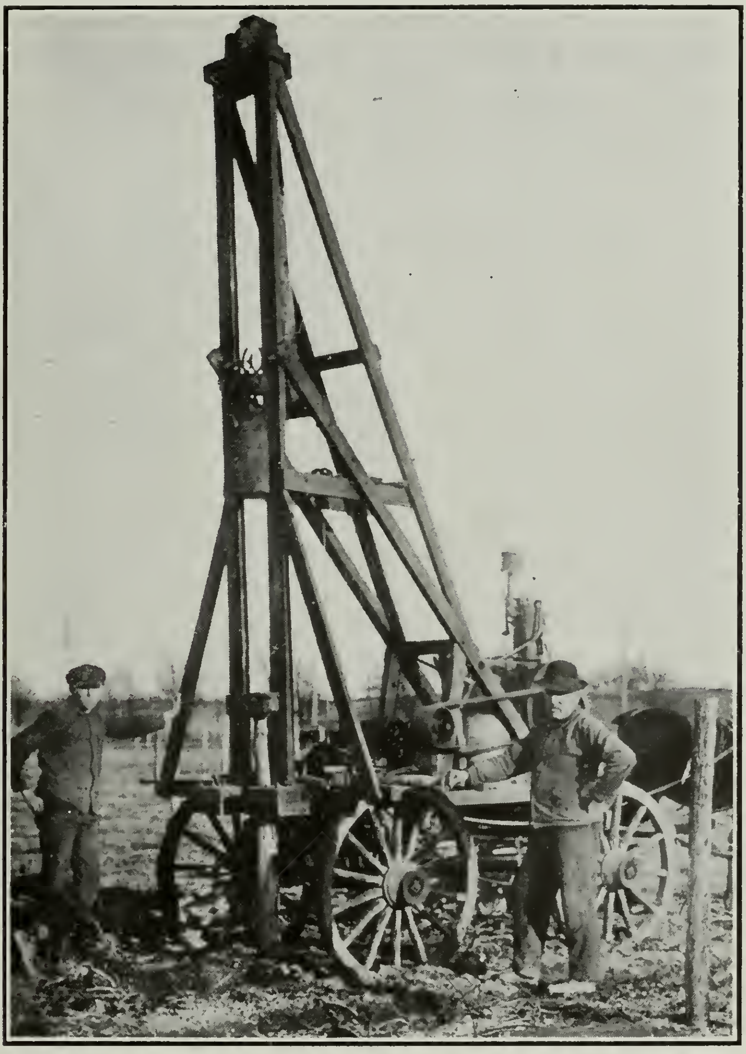
bottoms are cut out to twice the usual diameter. This is done to give the cement and post more of a purchase on the surrounding soil. Notches are cut with an axe on each side of the butt end of the post to enable the cement to hold the post firmly when it sets. When the cement is mixed with sand and rubble in the proportion of five sand and rubble to one of cement, it is found that one bag will do about four holes. About two feet of this concrete in the bottom of the hole will hold the post. To prevent the post rotting the hole may be filled slightly above the surface of the soil. With the end posts set in concrete the trellises present a very neat appearance; they are strong, and it is easy to keep the dead rows of the vineyard clean. In certain clay loam, and clay soils, these posts will heave so badly in the spring that it is only a few years before they are out of the ground entirely.

The cost of well-cured, clear cedar posts will vary from fifteen to twenty-five cents, depending on the number and size bought.

Wire.

No. 9 galvanized wire is the proper size to use. A lighter wire gives way too soon.

Two wires are usually sufficient to train the vine on. The first one is put thirty inches above the ground and the second thirty inches above the first. In some special cases three and even four wires are used. If the trellis is made with the three wires they should be spaced twenty inches apart up the post. This would bring the third wire to a height of five feet above the ground. In the case of four wires on a six-foot trellis, the first two may be put fifteen inches apart on the post.



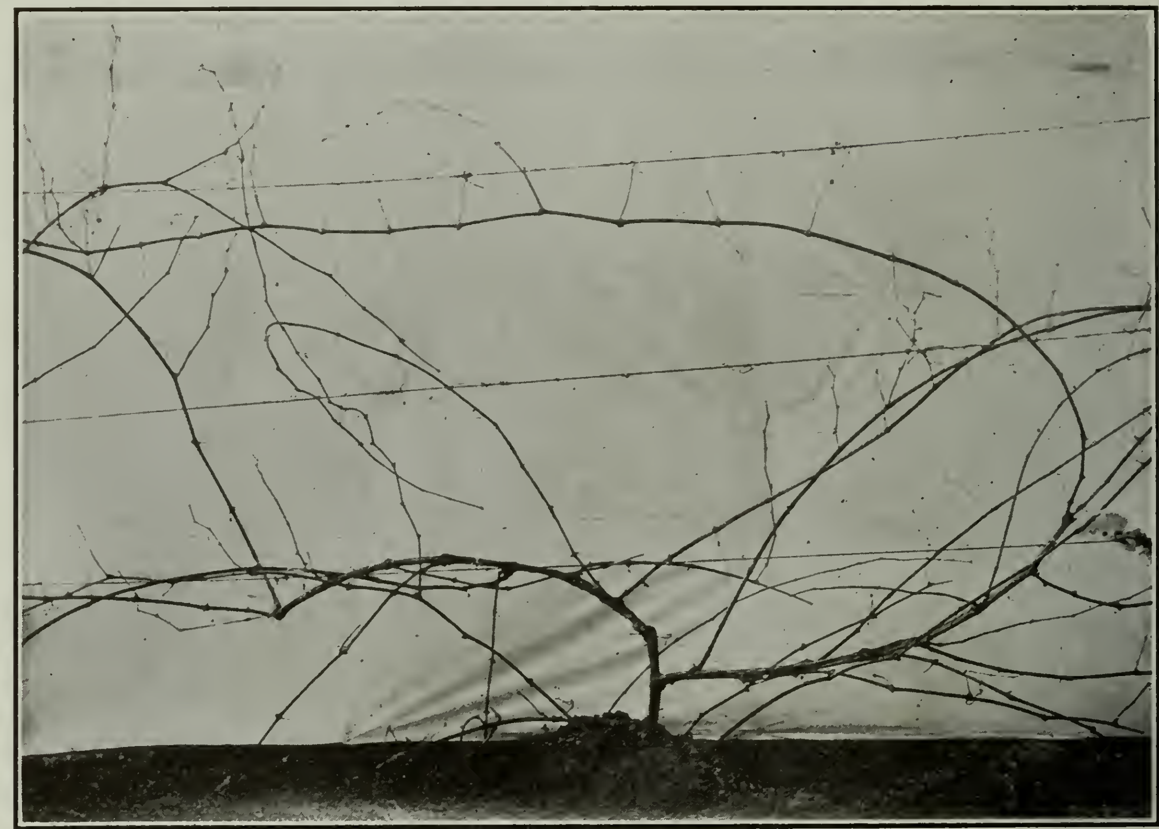
A " driver " at work on the farm of a prominent grower near St. Catharines.

The space between the wires may be increased in proportion to the length of the posts.

Wiring a vineyard may be done very quickly. Quarter inch holes are bored in the end posts, the same direction as the wire is to be strung, and at the distances the wires are to be above the ground. When the wire is stretched along the row both ends of it are passed through these holes in each end post and made fast to the wire tightener. Many simple devices are in use for tightening the wire. One of the most common is a block of hard wood one and a half by one and a half inches square and eight or nine inches long with a quarter inch hole bored through the middle of it. The wire is passed through the hole in the stick and made fast; then it is tightened by turning the block with a monkey wrench. The tautness of the wire, together with its shape, keeps the block in place.

In another method a small iron reel is fastened to the end post directly opposite the hole bored for the wire. When the wire is strung it is passed through the hole, made fast to the axle of the reel, and tightened by turning the reel with a special detachable handle. A small "dog" attached to the outside of the reel prevents it from unwinding.

When stapling the wires to the posts space should be left to allow the free passage of the wire when it is slackened in the fall and tightened in the spring. Unless the wire is regularly slackened in the fall, it and the posts will be subjected to an undue strain when the already taut wire contracts with the cold weather. This strain will in time either loosen the posts or break the wire.



A vine that looked difficult to prune.

Number of Feet to the Pound of Different Sized Wire*

No. 9.—Feet to the Pound.... 17.95	No. 11.—Feet to the Pound.... 27.34
No. 10.— " " " 22.33	No. 12.— " " " 34.29

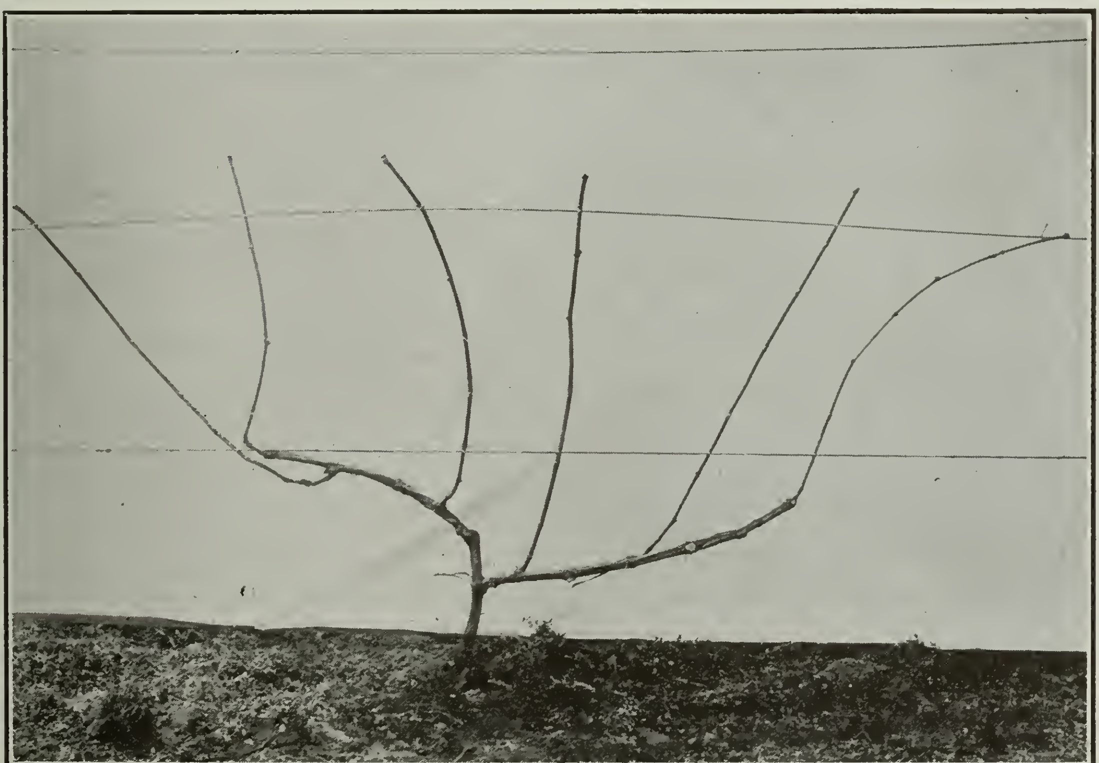
PRUNING AND TRAINING.

The objects of pruning are to restrict the growth of the vine sufficiently to enable it to produce the maximum quantity and quality of fruit year after year without injury to the vigor of the vine; to economize in space and to facilitate cultivation, spraying and harvesting.

With young vines the main or only object in pruning is to develop a framework of the proper form. Young vines, which are pruned with this in view, are not

*Oregon Bulletin No. 120.

only stronger and have straight trunks, but they bear earlier, and the subsequent crops are larger than those from vines which have not been cared for. The proper treatment of the young vine at the close of its first season's growth is to cut it back to two buds. In the spring, when shoots are produced, all excepting the two strongest should be rubbed off when they are about nine inches long, or before they begin to get woody. As these shoots grow they should be trained to the wires in such a way as to make a strong, straight growth. All suckers and secondary shoots which are produced below the first wire should be rubbed off. If this is done carefully, the grower will rarely be troubled with suckers, and shoots coming out here on these vines when they are mature. After the third season's growth the vine is pruned to suit the system of training which is to be followed; and from then on it is treated as a mature vine.

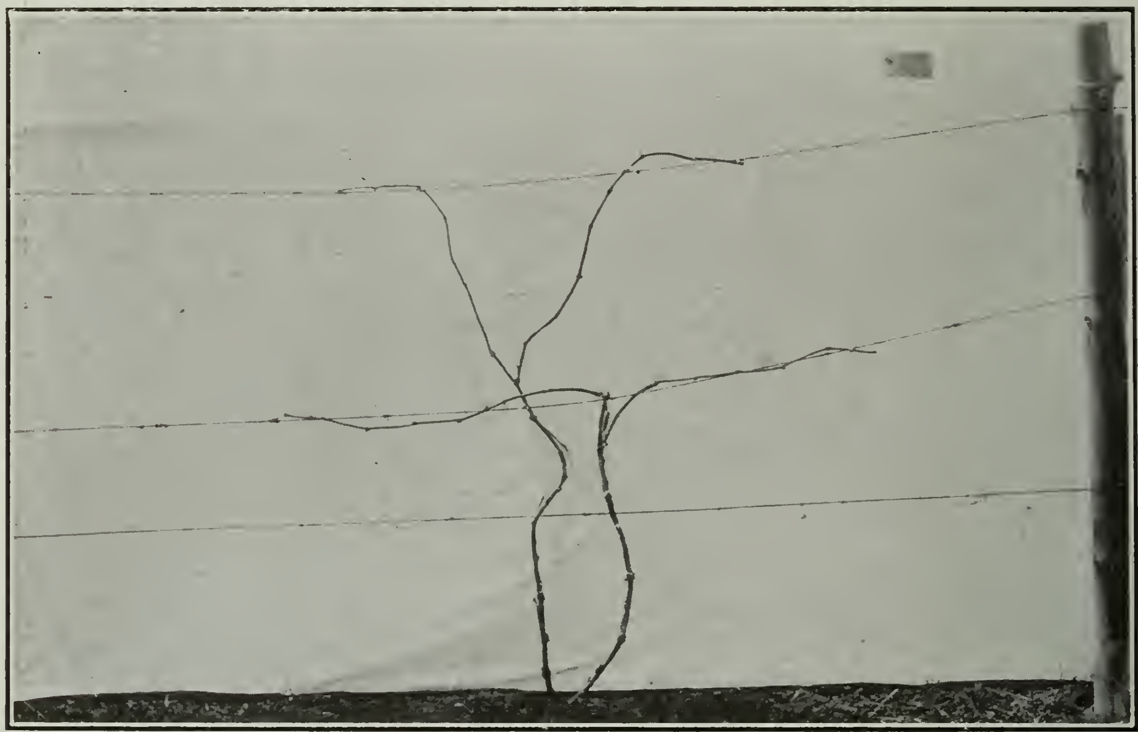


The same vine pruned and tied.

Pruning may be done any time after the leaves have fallen from the vines until the vines begin to "bleed" in the spring. The usual practice throughout the Province is to do most of the pruning during the months of January, February and March. Any time during these months will be quite satisfactory except on very cold days, when the vines are very brittle from heavy freezing and on such other days as it is impossible for a man to work conveniently and to good advantage out-of-doors. The usual plan in the Niagara District is to prune the grapes first during the winter months, leaving the peaches till the warmer days of early spring.

Different systems of pruning are followed by different individuals, but, except for the general advantage of uniformity of work and appearance, no distinct advantage seems to be gained. The proper number of buds on the canes well selected and distributed seems to give as great a quantity of good fruit as where a definite system based on certain rules is laid down. The best pruners seem to be able to size up a vine, select certain canes and prune accordingly.

In the very next vine other canes spaced very differently may be chosen. In the absence of definite experimental evidence, it is perhaps not well to make a definite statement on pruning, but the discussion might be carried still further. No fixed number of buds or certain length of cane can be said to give most fruit. These vary with the variety. A Delaware cane may be very short, twenty-four to thirty inches, and still have eight to ten healthy buds, while a Concord may be twice the length and have no more buds. The general rule of twenty-eight to forty buds per mature vine may be laid down, but it depends on the variety and the distance apart the vines are planted. Some growers in Michigan and in New York leave many more buds, or from forty to sixty per vine. The medium sized yet thrifty canes, about the thickness of a lead pencil, are considered best, though it has not been established that the larger canes, sometimes called "bull" canes, are not of equal value. General opinion, however, is that they are not as good. Experience also seems to



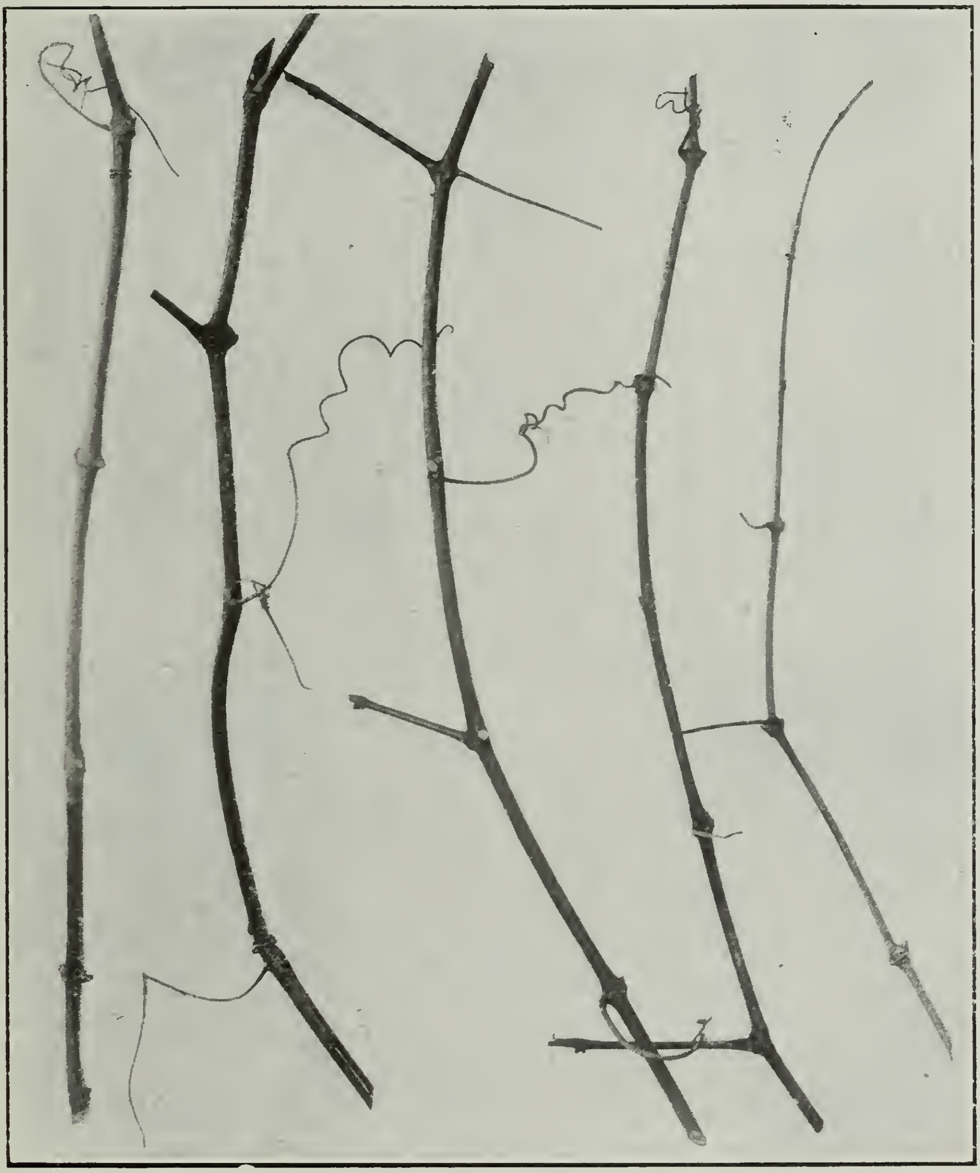
A young vine being pruned on the Improved Kniffin System. This is approaching the ideal, but there is much room for improvement.

point to the fact that the best fruiting buds are not at the base of the cane, but rather are included in the fourth to seventh buds.

One other point to remember is that the fruit is always borne on shoots that have sprung from canes produced the previous year. This is why it is highly essential to prune a grape heavily. No fruit spurs are produced.

More than a dozen so-called systems of pruning are in practice and mentioned in various books and bulletins, but the most commonly used in Ontario are the Kniffin, Improved Kniffin, Fan System and Arm System, or a combination of the Arm and Horizontal System. Which is the best for general use the writers are not prepared to state, as each system has its particular merits. It is claimed for the Kniffin that the largest bunches and highest quality are produced; for the Improved Kniffin, that is, when the main stem is divided below the first wire, the food supply is more evenly divided between the upper and lower arms; for the Fan system is claimed an evener distribution of bearing wood, a greater weight of fruit, though the bunches may be smaller; and for the Arm system, an equal quantity of fruit, high up from the ground where it is least affected by disease. Ease and rapidity of pruning are also claimed for this system.

It is sometimes necessary to renew an old vine because the trunk has become crooked and bent, and has deteriorated from disease. This can, very often, if not always, be effected by bringing a new lateral from near the ground if the root is healthy. Part of the crop may be lost for a year or two, but the attempt is worth while.



Cuttings from new wood showing the buds from which springs the growth on which fruit is produced.

Usually the only pruning tool that is necessary is a pair of hand clippers, but if any old wood is to be cut out an ordinary pruning saw may be necessary.

Tying.

Tying is a vineyard operation which naturally follows pruning, and which should be completed before growth starts in the spring. Tying should not be done when the canes are frozen, because then they are brittle and break very easily. But this operation cannot be delayed until after growth starts because then many of the shoots and buds may be rubbed off in handling the canes.

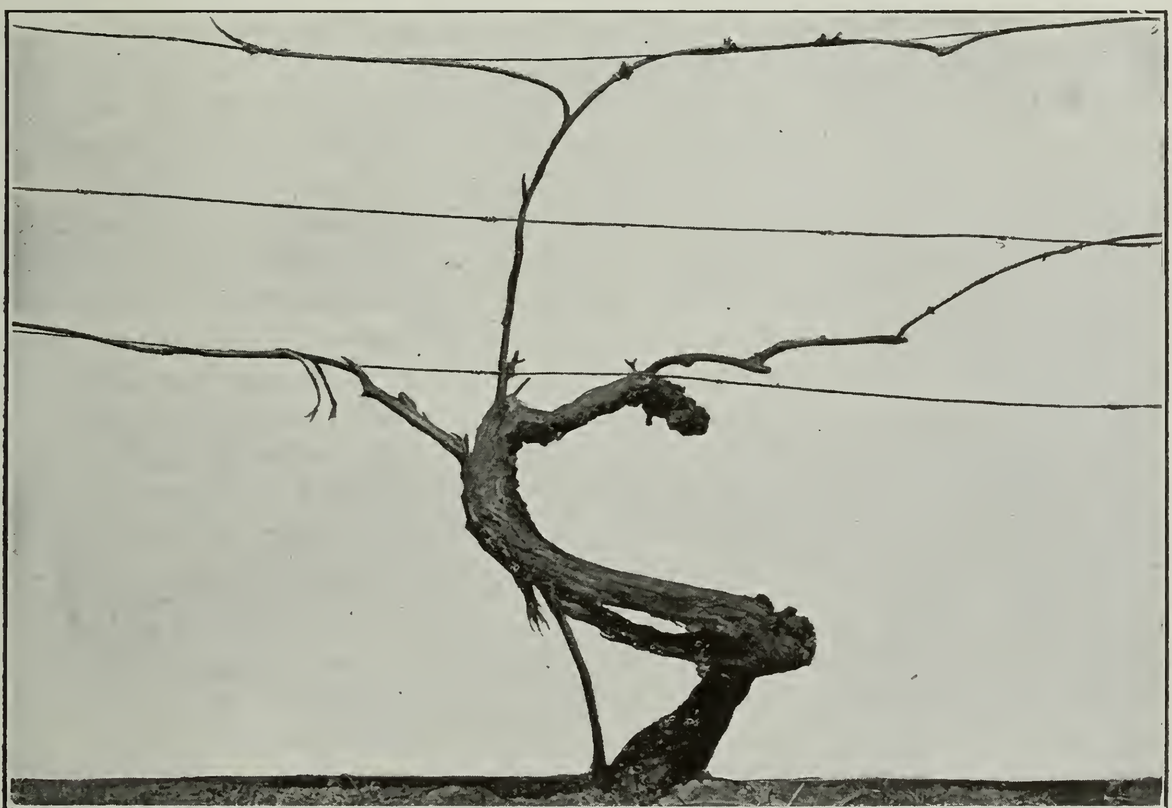

Concord in blossom.


Concord in fruit. All of the fruit produced on the cane is not shown.

Grape twine is used by most of the growers for tying, and is by far the best material. Fine wire is also used to some extent, but this is not as satisfactory in many respects. Wire cannot be used to secure the trunk and main arms of the vine to the trellis, because of the danger of girdling and killing the vines. But when carefully used wire gives very satisfactory results in tying the fruiting canes. It holds the cane securely, and can be tied a little more rapidly than grape twine.

In vineyards which are subject to heavy winds grape rope is used to secure the trunk and arms of the vine to the wires.

When tying a fruiting cane of a vine trained on either of the Kniffin systems to the trellis, it should be given one or two twists about the wire, depending on its length, and then tied securely at the end and again near the point where it leaves the arm. This wrapping of the cane about the wire secures the vine more



Notice the new cane being brought up from the root. This is to be used to renew the vine.

firmly to the trellis than merely stretching the cane along the wire. With the other systems of training, the Fan and Horizontal Arm, the canes are tied in upright positions to the trellis, and hence cannot be wrapped around the wires.

When tying with grape twine or grape rope the cord is given two turns around the wire, a knot made, and then the cane tied securely to the wire. By this method of tying, any slipping of the cord along the wire is prevented, and besides room for the expansion of the cane is allowed.

Wire used for tying is held in position parallel to the wire, then, while the cane is pressed tightly between the two wires, the ends of the fine grape wire are twisted securely around the wire of the trellis. When the fruiting canes are parallel to the wires, the fine tying wire is simply passed once around the wire of the trellis and the cane, and the ends twisted together and bent backwards.

It is false economy to hurry over the tying up of the vines, or to use material for tying which is not sufficiently strong or durable. This always results in much troublesome re-tying and often injured arms.

Summer Pruning.

Disbudding. Disbudding is practised on young vines which have not yet formed a stem in order to concentrate the growth into one or two shoots. The following year the stronger of these shoots will be selected to form the stem of the vine. In case of mature vines, disbudding consists in rubbing off all the buds on the lower part of the vine and on the trunk which are not needed for renewal purposes. This is done in order to concentrate the growth in the shoots above and prevent the production of shoots down below the first wire where they would eventually have to be cut off. These buds or young shoots should not be removed until they are from three to four inches long. Since there are many dormant and adventitious buds on the trunks of the vines, any attempt to remove the buds too early would force them out and necessitate going over the vineyard too often.

Suckering. Suckering is the removal of all the shoots which appear on the trunk of the vine at or below the surface of the soil. These suckers bear little or no fruit, and hence grow vigorously, appropriating much of the sap which should go to the vine. A great deal of time and expense will be saved if suckering is done carefully during the first four or five years of the vine's growth. After the fifth year very few suckers will be produced from vines which have been carefully suckered when they were young. Vines on which the work has been carelessly done will always produce an abundant growth of these underground shoots every year. Suckering should be done early in the summer before the shoots have become hard and woody; not only because of the fact that they diminish the vigor of the vine; but also, because if the shoots are left for the whole season, or for any length of time, they promote the production of dormant buds below the surface of the ground. These old suckers are more difficult to remove than are the young shoots, and, if imperfectly removed the remaining part becomes an underground spur which will be a source of perennial trouble.

Topping. Topping, or the removal of two or more feet from the end of growing shoots, during the month of August is a common practice in the Niagara district. It is done to admit light to the fruit, thus increasing its color, and also to control mildew by permitting a better circulation of air through the vine. Since topping is done towards the latter part of the summer a great number of leaves are removed, which is very weakening to the vine. In the case of very vigorous vines this may not be serious, but, if severe topping is practised annually it is bound to weaken even the strongest vines. In general this practice has the tendency of increasing the size of the fruit at the expense of the quality.

In certain seasons when excessive growth is produced because of a prolonged rainy season, it may become necessary to resort to topping to admit sufficient light to color the fruit, or to check the spread of mildew; but never in a normal season. At least seven or eight leaves should be left above the fruit when topping in August. The grower should, however, be able to maintain the equilibrium of his vine by increasing or diminishing the amount of fruiting wood left when pruning without having to resort to this weakening practice of topping.

VARIETIES.

Concord is the most popular and widely grown grape in the Province. It is in demand for wine, grape juice and dessert. It adapts itself readily to varying conditions of soil and climate. Though one of the lowest in sugar and somewhat high in acid, the flavor is such that the fruit is relished. It is one of the heaviest yielding varieties; blue in color with a heavy bloom; quite large bunch and medium-sized berry with good shipping qualities. For grape juice, the sugar and acid content is such that it gives the beverage a most pleasing and sprightly flavor with invigorating qualities. The Concord is the standard in grapes to which other varieties are compared. It is largely self-fertile, but to insure strong pollination it is better planted near some other varieties.

Worden is a seedling of Concord, but not nearly so popular as its parent. Being from seven to ten days earlier than the Concord, it is largely planted in the earlier sections for shipment to the Western markets early in the season. The berry and bunch are both larger than the Concord. The color is blue with a heavy bloom. Ordinarily, it is not as heavy a bearer as the Concord, but some claim it is worth more money because of its earliness. It is not adapted to so wide a range of soil and the berries have the bad habit of splitting in unfavorable weather conditions, such as continued rainfall. The quality is equal to or better than the Concord. It is largely self-fertile, but is better cross-fertilized.

Champion is losing, if it has not already completely lost, its popularity. Its only good quality is its earliness. Because it colors, and consequently looks very attractive before it ripens, it has been put on the market very early. Really being green, it has lost its popularity because of its extremely poor quality. When fully ripe, it is almost black in color, is very soft and shells badly. The variety has only its earliness to commend it.

Niagara is the most popular white grape, but like the Champion, has suffered from being cut before it is ripe. It has also suffered because of being advertised too highly when first introduced. This variety, however, still holds a good place, and if it was permitted to fully ripen before being marketed, it would undoubtedly regain some of its lost popularity as a dessert grape. It is a heavy cropper but not entirely disease resistant.

Campbell Early is the most popular of our early grapes. It has suffered somewhat from being marketed when it has obtained color without being fully mature. When fully ripened, it is of excellent quality. It is blue in color with medium heavy bloom. It bears as heavily as the Concord, ripens about ten days to two weeks earlier and is larger in both bunch and berry. It is firm and ships well. It is largely self-fertile, but to insure a crop should be planted with other varieties.

Moore Early was at one time a very popular variety, but has given way somewhat to the more heavily producing Campbell. The berry is large, but the bunch is sometimes loose. The berry also sometimes cracks and shells badly. It is adapted to loose, open, well-drained soils and, being a few days earlier than Campbell, is, under ideal conditions, a good variety. The large blue berry with good bloom is very attractive. It stands shipment fairly well. Plant it with other varieties to insure cross-pollination.

Delaware is a grape of highest quality. The bunch and berry are small but attractive. The fruit is red, the vines are small and not very spreading, and for this reason must be planted close together. They are somewhat subject to attacks of mildew. The quantity of fruit produced per vine is not as high as the large blue varieties, but by planting closely, heavy yields per acre may be obtained. The price per basket usually runs from three to five cents higher for Delawares than for ordinary blue and white varieties.

Lindley (*Rogers 9*) is the most widely planted of the Rogers' varieties in Ontario. It is an example of quality; is red in color and brings from three to seven cents per basket more than the ordinary blues. The vine is fairly hardy, a strong grower, and is not as susceptible to mildew as most labrusca-vinifera hybrids. Ordinarily, it is a poor producer, because of its marked self-sterility, but when planted with or near other varieties is a good cropper. It is well worthy of more extensive planting.

Agawam (*Rogers 15*) is as popular as the Lindley, and by some considered a great deal more favorably. It is widely distributed and seems adapted to clay and clay loam soils. The fact that it is somewhat more self-fertile than most of the Rogers' makes it, under ordinary conditions, a better bearer, but not always. It is of high but not the highest quality. The vine is subject to mildew. The fruit is red in color and brings a high price because of its color and quality.

Salem (*Rogers 22*) is a good grape in most respects as either Lindley or Agawam, and is possibly of better quality than either. It is red in color ships well and is as good a bearer as any of the Rogers when near other varieties. Alone, it is self-sterile. It is also very subject to mildew. At the Vineland Experiment Station the few vines have borne exceptionally well and the variety is recommended for further planting.

Wilder (*Rogers 4*) is black in color with a heavy bloom and very attractive. The bunch and berry are both large, the vine is thrifty and strong growing, and though subject to mildew is not exceptionally so. It is self-sterile and consequently must be planted with other varieties. Its self-sterility is its greatest fault. This is one of the varieties that might be tested further.

Brighton is grown more or less generally wherever grapes are grown in Ontario. It is attractive, red in color, large bunch and of good quality. It ripens earlier than the Concord and though somewhat subject to mildew, is a little more resistant than the average of the Rogers varieties. Being self-sterile, it must of necessity be planted near pollen-bearing varieties. It is recommended for planting on a small scale in commercial vineyards. For the amateur, there is no more attractive variety.

Vergennes is one of the best Ontario grapes. The fruit is red and attractive when well ripened. It is an excellent shipper, and though not of the highest quality, compares very favorably with the best commercial varieties. Ordinarily, it bears very heavy crops, but sometimes does not ripen well. Because of late ripening and somewhat straggling habit of vine growth, it is not favored by some growers. However, the fact that the fruit ships and keeps well (it will keep till January) makes it quite popular. It is largely self-fertile.

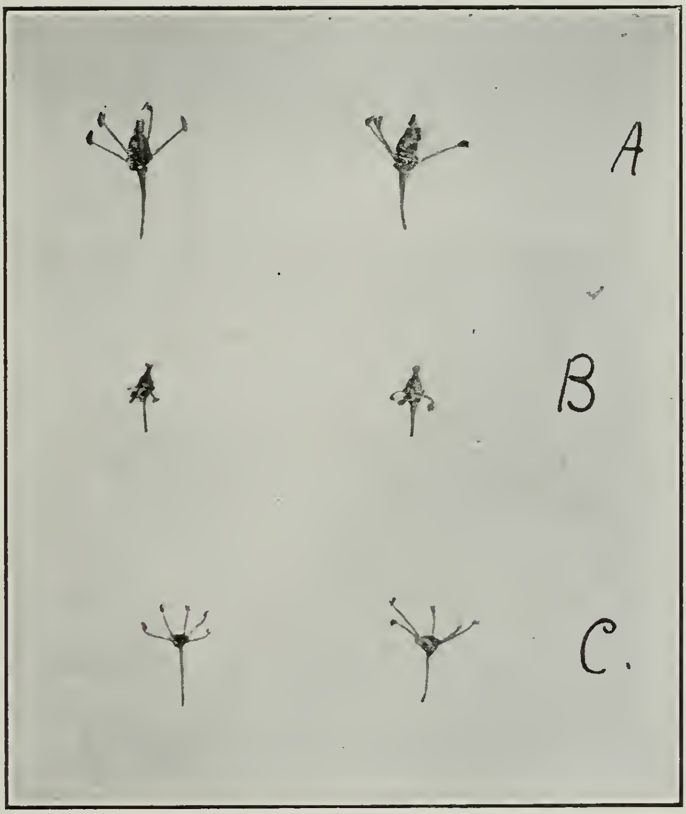
Other varieties that are quite commonly grown and are more or less popular are Winchell, Pocklington, Massasoit, Diamond, Catawba, Barry, etc. For descriptions of these varieties and others more or less commonly grown, see "Fruits of Ontario," published by the Ontario Department of Agriculture. This publication also gives an estimate of the commercial importance of these varieties.

The following varieties are recommended for general planting, both garden and commercial:

Black or Blue: Concord, Campbell, Worden, Moore, Wilder.
Red: Lindley, Agawam, Delaware, Vergennes, Salem, Brighton.
White: Diamond, Niagara, Winchell.

Pollination.

We are constantly faced with the problems of self-sterility. Some of the best varieties, those of the highest quality, as mentioned under "Varieties," in past seasons, have often failed to set heavy crops of fruit and many seasons have failed to set any fruit in quantity. Some other varieties "set" very regularly and bear good crops annually. The main reason for this apparent difference in the ability of varieties to bear crops is largely one of pollination. To understand the question at all fully, it is necessary to study the grape flower. These are of two types, perfect or hermaphrodite, and pistillate. In wild species there are vines that are staminate only. These latter produce pollen in abundance but cannot possibly set fruit. Varieties that have perfect flowers can set fruit from self-pollination,



A Perfect flowers.
B Pistillate flowers—stamens are degenerate in this case.
C Staminate flowers. The pistil is absent in this case.

but those that have only pistillate flowers, flowers that have female parts only, and consequently produce no pollen or only degenerate pollen, cannot possibly fertilize themselves, and must be cross-pollinated if fruit is to be produced. These varieties that are self-fertile are likely to "set" more fully if other pollen is near to cross-fertilize them. The case is not entirely hopeless though when other varieties are absent.

Some other factors also enter into pollination:

(a) Varieties to cross-pollinate must mature their blossoms at the same season or the stigmas must be receptive at the time the pollen is ripe and blowing. Records show that in the Station vineyard the blossoming season lasts about six days; that is, while the Champion blossoms were ready to pollinate on June 29th last year the Wilder and Vergennes were not ready until July 4th and 5th.

(b) The weather must be suitable. Damp, dark, cool weather, not only does not permit of the proper maturing and scattering of the pollen, but keeps bees and other insects from working. A grape crop may be greatly reduced by storms during the blossoming season. Bright weather is particularly important to the Rogers' varieties, and all others that must be cross-pollinated in order that fruit may be produced.

Pollination tests in the spring of 1915 gave the following results:

Variety	Degree of Self Fertility	Variety	Degree of Self Fertility
Brighton	7.1 %	Niagara	62 %
Campbell	60 %	Pocklington	77 %
Concord	66 %	Salem	00 %
Delaware	82 %	Vergennes	58 %
Lindley	00 %	Wilder	00 %
Massasoit	00 %	Winchell	90 %
Moore Early	57 %	Worden	75 %
Moyer	**00** %		

A, male; *B*, female. Clusters taken from *V. riparia.*

These figures, however, represent only one year's results and cannot be accepted as final. They are, though, fairly indicative of the degree of self-fertility. From data collected by Prof. S. A. Beach, formerly of the New York Experiment Station, at Geneva, our common varieties may be divided into the following classes:

Self-fertile: Campbell, Delaware, Moore, Niagara, Winchell.

Largely self-fertile: Agawam, Concord, Vergennes, Worden.

Self-sterile or nearly so: Brighton, Herbert, Massasoit, Salem, Wilder, Lindley.

The figures of percentages of fruit set on self-fertile and partly self-fertile varieties for this Station, are probably lower on an average than might be expected because of unfavorable weather conditions at the time of pollination. They are, nevertheless, fairly accurate, and can be relied on when making a selection of varieties.

One other point worthy of emphasis is the fact that though many varieties are self-fertile and will set good crops of fruit without the introduction of foreign pollen, it is an admitted fact that cross pollination, as a rule, is stronger than self-pollination, and for this reason, two varieties or more are better planted together than single varieties in isolated blocks.

The third leaf is showing. This is the time for the first spray.

SPRAYING.

Grape growers have not usually considered regular sprayings absolutely necessary. Experience has taught that fruit trees left unsprayed may be weakened to the attacks of insects or the fruit be made unsalable from the attacks of insects and disease, but the lessons have not yet been sufficiently emphasized when applied to the grape. Some growers spray once; some twice; some three times and more; but the great majority do not spray at all. The widespread attacks of mildew and rot favored by damp weather conditions last year (1915), strongly emphasized this point. The loss in some vineyards was as much as fifty per cent.; in others, even more, and the general quality of the grapes, with some exceptions, was not up to the usual standard. Grapes yield a steady income and it cannot be soo strongly emphasized that the sooner spraying methods become general, the sooner the general quality of the fruit will be advanced. The following sprayings are recommended:

1st. Use Bordeaux mixture, 4:4:40 when the third leaf begins to show.
2nd. Use Bordeaux mixture just before the blossoms open.
3rd. Use Bordeaux mixture just after the fruit is set.

Other sprayings must be judged largely by weather conditions or any sign of outbreak of disease. Rainy weather or damp conditions are conducive to the growth of all fungi. Dry conditions or bright weather are adverse to the growth of fungi. The spray material, if possible, should be applied before, not after, a shower. If sufficient time elapses for the spray to dry there is no danger of it being washed off by the shower.

Folding table used when packing in the vineyard.

(1) Note carefully the times mentioned for spraying.
(2) Note carefully the mixture recommended.
(3) The work must be done thoroughly.

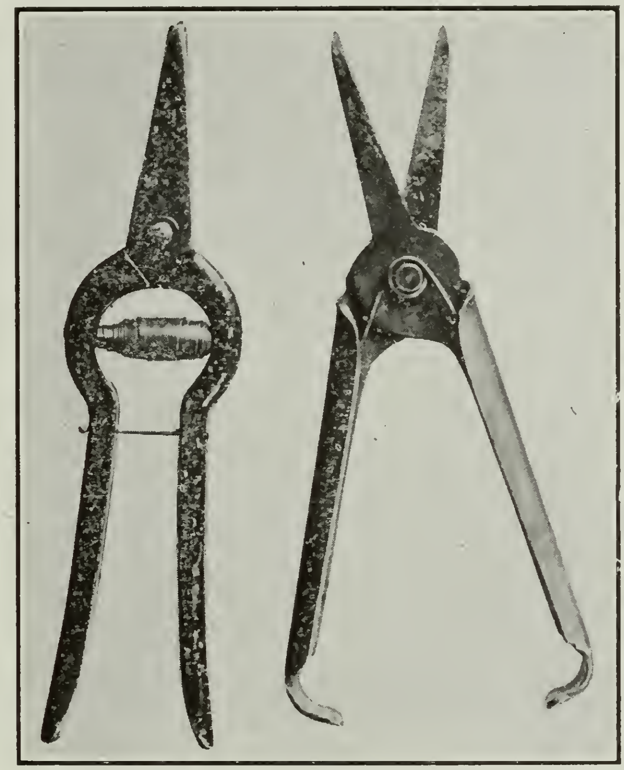
Specially constructed traction or power spraying machines are speedy and fairly satisfactory, but any hand or power pump suitable for spraying fruit trees can be used. For special sprays and treatments see paragraphs under "Insects and Diseases."

The quantity of spray required to cover a mature vine just breaking into leaf is from one-quarter to one-half gallon. For the second spray, when the leaves are much farther advanced, three-quarters to one gallon per vine is necessary to cover thoroughly. This latter amount will be also required for subsequent sprayings. The time required to do the work depends entirely on the kind of pump and number of nozzles used. The quantity of spray applied and the thoroughness and completeness of the work are the determining factors in disease and insect control.

HARVESTING.

The cutting is done largely by women and girls who cut by the basket. Usually the baskets are filled, drawn to the packing house and the tops levelled and covered. A few growers are repacking in packing house, discarding such bunches as would depreciate the value of the pack. A method that has been adopted with success in some of the large vineyards of New York State is to pack in the vineyard directly from a small folding table especially made for the purpose.

This style of packing table, which is commonly used throughout the Chautauqua district, was invented by an old grape grower of Portland, N.Y. The table



Cutting shears that might be used instead of a knife.

is carried along the row and the grapes are cut and packed directly into baskets. Of course, baskets have previously been distributed through the vineyard, so that it is only necessary for the packer to carry the table along the row. The use of this table makes packing in the vineyard possible, and hence does away with the necessity of handling the grapes twice. Since these tables are easily folded up, they can be stored in quite a small space at the close of the season.

The workers usually use knives with small sharp blades for cutting, but cutting shears are more satisfactory. When once the cutter has become accustomed to them they are quicker than the knife. Also less damage is done the bunch because it is not necessary to grasp it so tightly.

MARKETS

The demand for grapes is from a number of sources: for fermented wine, for grape juice, for jelly and for dessert. In past years, the fermented wine industry has taken a fair share of the grapes produced. According to the 1911 census, in that year Canada produced approximately 860,000 gallons. In late years, production has fallen off somewhat.

Grape juice manufacture is not new in Canada, but it is new on a large scale. Concords are used almost entirely, and these must be well ripened and of uniform quality. A good price, usually higher than current market price, is paid, but the quality must be first-class or the fruit is rejected.

Grapes for jelly purposes are sold quite early in the season and before the fruit has reached full maturity. A large quantity of the fruit sold for dessert purposes early in the season can be used only for jelly purposes, because it is not sufficiently ripened to be eaten out of the hand.

The package used is almost entirely the six-quart Climax basket which holds approximately seven and a half pounds net of fruit.

THE PLACE OF THE GRAPE ON THE FARM.

The grape is grown most largely in districts of the Province where land is high-priced. The cherry and peach have received most attention because, generally speaking, these two fruits promise greater returns, and under favorable cultural and market conditions give high returns per acre. The grape, except by a few, has been given a lesser place but in spite of this has gradually shoved its way to the front.

A complete failure of the grape crop is almost unknown. Phenomenal yields, coupled with high prices are equally few but average yields, average prices and steady incomes are common. That is the place the grape holds.

Of all our vine and tree fruits it is subject to the least extremes of variation and yields the least varying income.

The lands on which it thrives best are those clay and clay loams that for the peach and cherry are not considered ideal. Planted on these with due consideration to drainage and atmospheric conditions, it matures its fruit at a season when the rush of the earlier fruits is over. When once established and given fairly intelligent care, it is only slightly subject to disease and the loss among the vines is reduced to a minimum. It fills almost to an ideal a place on the farm with various types of soils. The peach has its preference, the cherry its preference, and the other tree fruits their preferences. The grape has its preference also, but if the soil is dry it can be expected to yield profitably on a soil that for other fruits might be considered unfavorable.

THE EXPERIMENTAL VINEYARD.

The Experimental vineyard at the Vineland Experiment Station, contains spaces for 1,036 vines planted nine by eleven feet apart. This area, with the exception of forty-one spaces, has been filled during the past eight years. There are now under test one hundred and thirty-eight varieties, including twenty-four vinifera varieties on their own roots. One hundred and fifty vines are being used to compare the five different methods of training most commonly practiced in this district: Kniffin, on second and third wire; Kniffin on first and second wire; Improved Kniffin, Arm and Fan systems. Also five hundred and four vines representing eighteen commercial varieties are being used for the study of the correlation between the number of buds left when pruning and the vigor, productiveness and longevity of the vine. The vines are, in part, also used for self-fertility and self-sterility tests and for all breeding and improvement work undertaken at the Experiment Station.

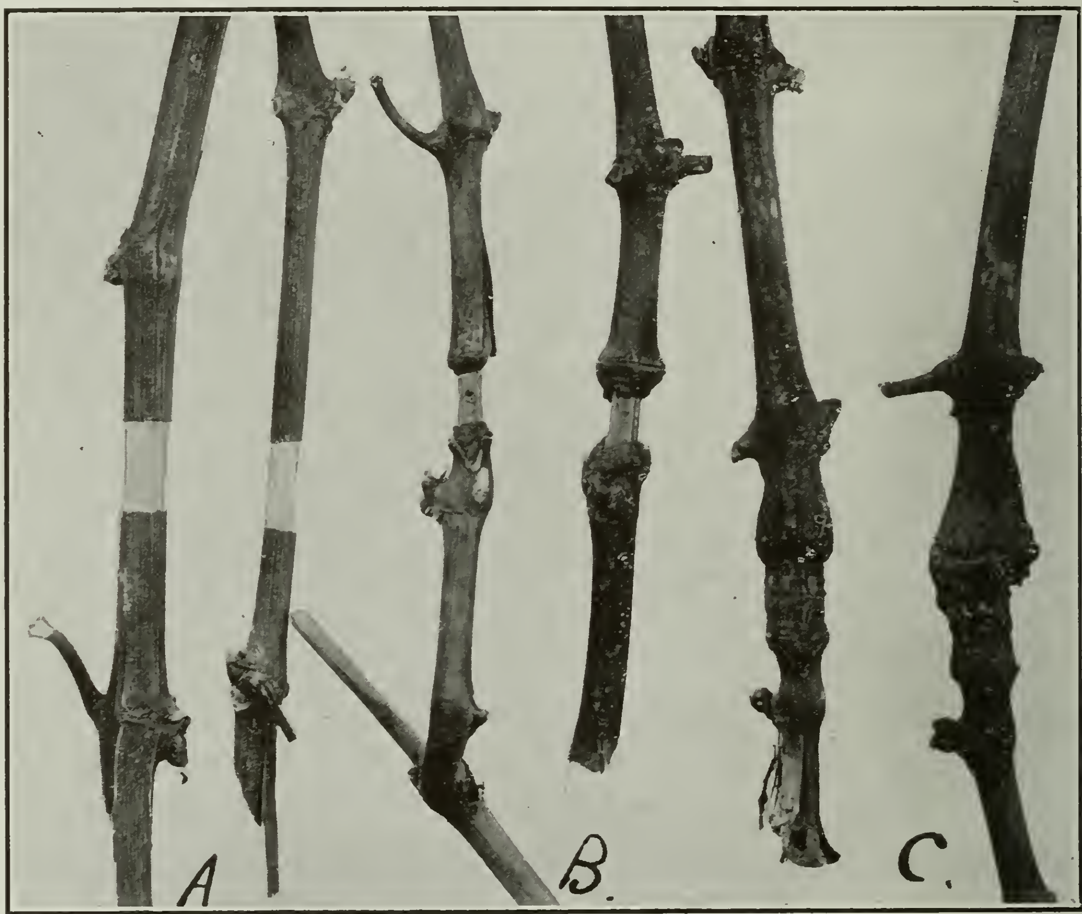
The following is the list of varieties under test:

Augustina.
Adobe Giant.
Australis.
Agawam (R. 15).
Aminia.
Amber Queen.
America.
Armalaga.
August Giant.
Black Morocco.
Brighton.
Barry.
Banner.
Bell.
Ben Hur.
Berckmans.
Bailey.
Bacchus.
Concord.
Cottage.
Campbell Early.
Chasselas de Fontainbleau.
Cornichon.
Catawba.
Chasselas Vibert.
Cynthiana.
Chasselas avec Royal.
Champion.
Carman.
Clinton.
Cloeta.
Charlton.
Colerain.
Captivator.
Carman.
Caco.
Creveling.
Dattier de Beyrouth.
Dog Ridge.
Diana.
Duchess.
Dracut Amber.
Delaware.
Diamond.
Emperor.
Early Victor.
Empire State.
Early Ohio.
Eaton.
Ellen Scott.
Ester.
Etta.
Eumelan.
Early Daisy.
Elvira.
Eclipse.
Feher Zagos.
Flame Tokay.
Fern Munson.
Golden Chasselas.
Golden Queen.
Green's Early.
Green Mountain.
Geneva.
Gaertner.
Golden Drop.
Herbemont.
Herbert.
Hartford.
Francis B. Hayes.
Hicks.
Headlight.
Hernito.
Hermann Jaeger.
Italian—Walker's.
Iona.
Ives.
Isabella.
Janesville.
Jessica.
King.
King Philip.
Lindley.
Lady Finger.
Lucile.
Lutie.
Lady Washington.
Last Rose.
Lukfata.
Malaga.
Mission.
Muscat.
Morocco.
Martha.
R. W. Munson.
Muench.
Moyer.
Muscat Blanc.
Manito.
Mericadel.
M. Riesling.
McPike.
Moore Early.
Massasoit (R. 3).
Merrimac.
Mary.
Niagara.
Nitodal.
Philippi.
Patricia.
Prentiss.
Perkins.
President.
Pierce.
Pense Malaga.
Pocklington.
Rose of Peru.
Requa.
Rockwood.
Rommel.
Rogers' 24.
Rogers' 36.
Rogers' 26.
Read's Hybrid.
Sabal Kanski.
Sauvignon Juane.
Salem (R. 22).
Thompson Seedless.
Telegraph.
Ulster Prolific.
Vergennes.
Worden.
White Cornichon.
Wyoming.
Woodruff Red.
Wilkins.
Wilder.

RINGING GRAPES.

Ringing is a practice followed by some growers to hasten the ripening of the fruit. It consists of removing a ring of bark one-half to three-quarters of an inch wide, sometimes narrower, from the cane below the bunches of grapes that it is expected will be affected by the operation. The sap is still able to flow upward through the undisturbed wood but is unable to return to the roots and main parts of the plant because of the disturbed union in the bark. Theoretically, the food supplies of plants taken in by the roots are carried to the leaves to be elaborated or made available to the plant. The removal of the bark prevents the return of the elaborated or digested food and consequently the bunches of grapes have an opportunity to make use of it. Experiments show that grapes treated in this way ripen from two days to two weeks earlier than normally. The bunches, generally speaking, are larger and more compact. In this way, exhibition grapes are secured, and in a few cases small growers are practicing it to induce earliness in order to receive the higher prices. The quality and flavor of the fruit is, however, much deteriorated, so much so, that the practice cannot be recommended even on a small scale. The cane, beyond the ringing, dies as is common with all girdled limbs or branches. The roots of the ringed plants must suffer also as the food elaborated in the particular leaves on the ringed canes is not permitted to return to build up the plant. All canes ringed on a vine in one season would likely cause the vine to die in a year or two, but it cannot be said that one or two ringed canes each year produces a marked loss of vigor in the plant.

The ringing may be done any time following the setting of the fruit or when the berries are about the size of grains of wheat, small peas or smaller. If done too early, the canes are apt to be broken by the wind.



A. Ringing completed.
B. A "ring" that has partly grown over by fall.
C. A "ring" that has completely grown over by fall.

In view of the fact that ringing so deteriorates the quality of the fruit, it is doubtful if the practice should be permitted at all. Even for exhibitions the advisability of the practice is doubtful.

The appearance of the grape and bunch is enhanced at the expense of the eating qualities.

GRAPES IN THE NORTH.

Grapes are of extreme interest to those who attempt to grow them either commercially or in the home garden. They bear early, respond readily to training and care, and in a few years will spread over a tree, the side of a building or an old fence if allowed to ramble. But most varieties are tender and in order to grow them successfully in the colder sections, they must receive special treatment. The main injury comes from winter freezing of the vines and buds or spring freezing of the young shoots after the buds have burst, due to late spring frosts. Under such conditions, it is necessary to cover the vines in winter. To facilitate this, it is necessary to keep the main trunk low or close to the ground. This may be done by cutting back to two or three buds or two short spurs bearing two buds each every time the vines are pruned for the first, second and third years. The vine will not be injured by severe cutting. When once the base or trunk is formed, the pruning is a simple matter. The Fan system or the Arm system of pruning must be followed as described and illustrated previously.

As soon as the grapes are harvested in the fall and the leaves have fallen, the pruning can be done. Cut away everything except the few canes that are to produce the fruit wood the following year. These canes should contain about forty buds in all. As soon as there is danger of the ground freezing lay the canes down flat and cover with earth. This is why it is necessary to keep the trunk short, not more than eight or ten inches high, and to use the Fan or Arm systems of pruning. It would be impracticable to attempt to cover a vine pruned after the Kniffin system.

Canes more than one year old do not bend readily without breaking. Leave the vines covered in the spring until the danger of severe frosts is over but before the buds have begun to swell. If left too long there is great danger of damaging the swelling buds. When the earth has been removed, tie up the vine as indicated previously.

For the colder districts where the vine must be covered but where ripening is certain, Prof. Macoun* recommends the following varieties:—

Black: Early Daisy, Manito, Moore Early, Merrimac.

Red: Moyer, Delaware, Brighton, Lindley.

White: Winchell, (Green Mountain), Moore Diamond.

For coldest district where ripening is not certain, Prof. Macoun recommends the following:

Black: Beta, Early Daisy, Manito, Moore Early, Jewel, Brant, Canada.

Red: Moyer.

White: Winchell (Green Mountain).

HOME MANUFACTURE OF GRAPE WINE.

Importance of Ripeness, Varieties Used.

Every housewife has an opportunity to make a small amount of pure grape wine. Because of the large amount of sugar found in ripe grapes their juice is one of the best natural materials from which to make this beverage. Ontario grapes, however, are not as rich in sugar as grapes grown in Britain, Spain and California. Hence it is especially important in producing grapes for wine either to choose hardy varieties that will keep their foliage and reach full maturity or to spray weaker varieties that they may remain healthy for an equal length of time. The Concord is the leading wine grape. The Niagara may be used to produce light colored wines. Rogers' varieties are too tender and too unproductive for commercial wine making. For home use they are of high quality.

Main Principles in Wine Making.

It is well known that grape juice or must ferments. When placed in a warm room bubbles rise to the surface. This fermentation is the work of yeasts. Yeasts are simply small plants, so small that they cannot be seen with the naked eye.

*Central Experimental Farm (Circular No. 11).

The chief article used by yeasts in their growth is sugar. This they change into alcohol, giving off bubbles of gas, called carbon dioxide. Fermentation may be done properly by *only one kind of yeast.* There are many other kinds of these small plants present on the surface of grape skins but most of these others produce bad flavors in wine. Mouldy grapes and grapes which have split or have been crushed by rough handling and allowed to stand around are rich in microscopic "plants" which will injure the wine.

The proper yeast is most abundant in juice produced from sound, ripe, and quickly and carefully handled grapes.

Method of Home Manufacture.

For very small amounts, 1-5 gallons, the sound, ripe grapes should be stemmed and then pressed into a pulp in a granite dish pan. Run off as much juice as possible and squeeze the remaining pulp through cheesecloth. Strain the whole through flannel. This part of the process may be done in a larger way if a cider press and pulper can be obtained.

Having obtained the clear must add granulated sugar three pounds for every gallon. Ontario grapes at their ripest do not contain quite enough sugar to insure a good wine.

Procure clean kegs or barrels of the proper size. A keg which has had good wine in it is best. Never use any vessel which has had sour material in it. Scald the keg and fill three-quarters full with the sweetened must. Do not plug tightly. Place in a room with a temperature of 65F. to 70F. A vigorous fermentation should start immediately and be completed in a week or ten days. This part of the fermentation completed rack the wine off the lees. This may readily be done by having a faucet in place one or two inches from the bottom of the keg and by running off the clear liquid at the proper time. The keg containing the clear wine should be kept at a moderate, even temperature. A slow fermentation will continue for five to six months. Rolling and shaking the cask from time to time assists fermentation by mixing air with the wine. If after six months fermentation is complete and yet the wine not as clear as is desired it would be advisable before racking a second time to mix in white of egg, one egg to fifteen gallons. Beat up the egg before mixing with the wine.

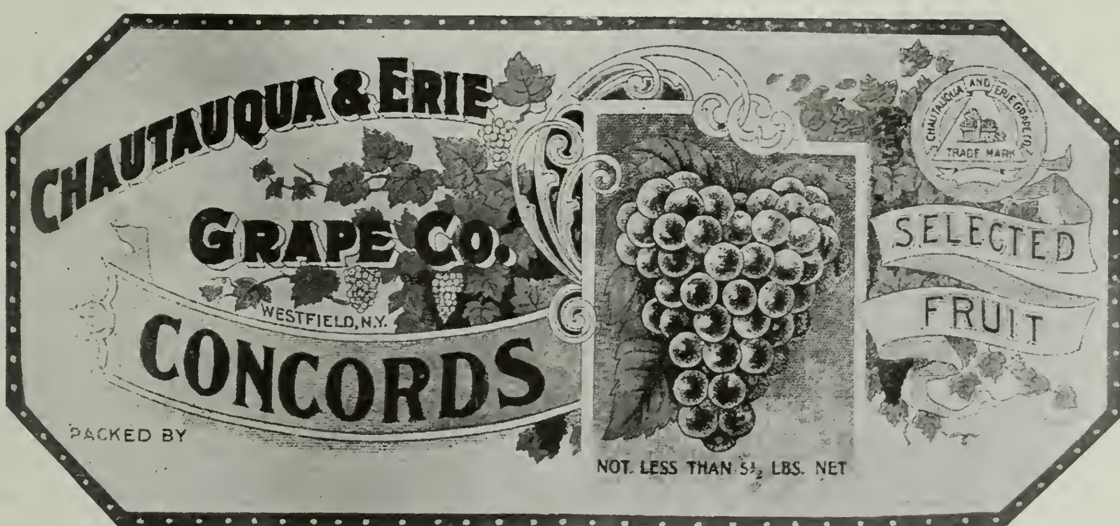
From now on the oftener the wine is racked off the lees or sediment, the clearer and finer will the wine become.

Home Manufacture of Grape Juice.

No beverage is more pleasing or healthful than unfermented grape juice. It has an attractive appearance and pleasing aroma. It is not only a beverage but a food also. It contains less sugar, has more carbohydrates largely in the form of sugar, but less protein and fat than milk. It is a drink that can be used in any place at any time. It is stimulating and refreshing. The flavor may vary according to the variety of grape from which the beverage is manufactured. Those unfermented juices that are considered best have a lively, fruity flavor and aroma, and are high in natural acid and not too rich in sugar. The American varieties are particularly favored in these respects, especially the Concord, which is used to the greatest extent commercially. Only clean, sound, well ripened, but not overripe grapes, should be used. These may be crushed either by hand or in an ordinary cider mill. Either a light-colored or dark-colored juice may be made.

If a light juice is desired, allow the juice to drain off, or if it does not drain off readily lend the necessary assistance by squeezing. A convenient strainer may be made from any clean cotton or soft sackcloth. Heat the strained juice in a double boiler to between 180° F. and 195° F. If possible, use a thermometer and under no conditions allow the temperature to go up to more than 200° F. A double boiler is advised to prevent direct contact with the fire. Remove from the fire, pour into glass or crockery vessels and allow to stand for twenty-four hours. Arrange a filter of heavy woolen or quite thick cloth and again filter. Pour the juice into clean bottles and prepare to sterilize before sealing. Any person familiar with home canning processes can now finish the task.

A good sterilizer is a wash boiler arranged with a board or slats in the bottom. Partly fill this with water about half way up the necks of the bottles. Slowly bring almost to a boil and then remove and cork at once. Use clean new corks that have been soaked in warm water for a few minutes. When red juice is required, heat the juice, pulp and all before extracting. Allow the pulp to drain but use little or no pressure. Put away the juice to settle and cool. Extra precautions may be taken to prevent fermentation by sealing the corks with wax. Like fruit when exposed to the air, moulds and germs get in and cause fermentation. If kept sealed, the product will keep indefinitely.



A label that is a guarantee of quality. Notice the words, "Not less than 5½ lbs. net."

A COMPARISON OF THE CHAUTAUQUA AND NIAGARA DISTRICTS FROM A VITICULTURAL STANDPOINT.

The Chautauqua and Niagara districts, when compared from a viticultural point of view present a very similar impression to that which is made by a comparison of the wheat industry of the Western Provinces to that of Ontario. In the West the production of wheat is the central, the main occupation of most farmers, while in Ontario we seldom find a farmer who devotes most of his land, time, and energy to wheat growing. Wheat here is no longer the special crop it is in the West, but takes its place as one of the general farm crops. Grape growing in the Niagara district, like wheat raising throughout Ontario, is not the central or main occupation of the fruit-growers as it is in the Chautauqua Belt; but, the grape as it is produced to-day is simply one of the important products of the fruit farms of the Niagara district.

Variations in topography and soil throughout the Niagara district are to some extent responsible for the fact that grapes are here produced in relatively small blocks when compared to the large acreages of the Chautauqua belt. This belt is a narrow strip of land some two to three miles wide bordering the south-eastern shore of Lake Erie, and reaching from about fifteen miles south of Buffalo through to Erie, Pa. The southern boundary of this strip of land is a high escarpment which runs parallel to the lake. This escarpment ranges from 500 to 700 feet above the plain and from 500 to 1,000 feet above the lake. The plain is gently rolling and descends rapidly from the bluff of the lake to the escarpment with a grade of from 100 to 200 feet to the mile, forming in most places well-marked foot-hills to the escarpment which forms its southern boundary.

Like the Chautauqua belt, the Niagara district comprises a narrow strip of land which is bordered on the north by Lake Ontario and on the south by a high escarpment. The plain is gently rolling, but does not ascend as rapidly from the bluff of the lake to the escarpment as does the Chautauqua plain. With the exception of a single range of hills just at the base of the escarpment the plain is unbroken by hills or gravel ridges.

The soils of the Niagara district vary much more than do the soils in the Chautauqua belt, and this proves to be one of the chief factors which have made grape growing on these Ontario farms simply one of the occupations. Very little of the land in the Chautauqua belt is unsuitable for grape culture. There are no large sections there as in the Niagara district which are specially suited for the production of some other fruits of great market value as: peaches, raspberries, and strawberries; and where it would not be practical to set out vines.

The climates of these districts are very much the same, but the air circulation in the Chautauqua belt is more marked than in the Niagara district. This is undoubtedly due to the fact that the Niagara plain does not rise from the bluff of the lake to the escarpment on as steep a grade as does the Chautauqua plain.

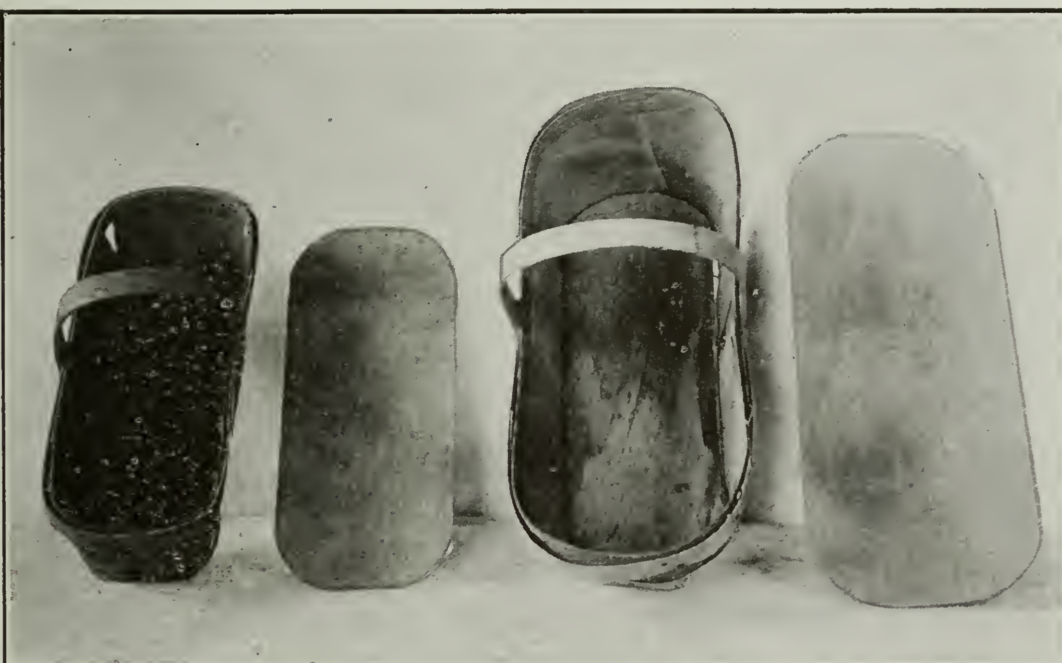
Vineyards of the two districts present strikingly different appearances, not only in size, but also in their plan, and the method of posting. Because of the expansion of the grape industry in recent years, these growers have utilized nearly all the available farm land for grape production. Instead of having the rows of vines ten by ten feet or even twelve by twelve feet apart in the vineyard, as they often are in the Niagara district, the vines are usually set out eight by eight and a half feet part. This distance of eight and a half feet between the rows has proved to be the most convenient distance for plowing with the three gang plow commonly used, and is plenty wide enough for other vineyard operations.

One of the points which a Niagara district grape grower is very particular about when setting a vineyard is the posting. For various reasons the Chautauqua grape grower appears to be quite slack about this point. As a general rule the posts are set shallow, and the end posts poorly braced from a short stake driven in the ground about six feet away in the row. Perhaps this apparent carelessness is due to the shallowness of the soil; or, it may be due to the fact that such large numbers of posts have to be set and looked after each year that the men grow careless about them. Again, the posts used in this district are of chestnut or locust and do not give as long service as do the cedar posts generally used in the Niagara district.

Along with these large vineyards we find that the vineyard operations are carried out on a much larger scale than they are in the Niagara district. Pruning is usually begun as soon as the leaves have fallen in the fall and continued until growth starts in the spring. Many growers often prune after the vines have commenced to bleed. There are a few gangs of experienced pruners who work in the district, but many of the growers prune their own vines. Although there are various systems of pruning followed in both districts the Niagara growers favor some form of the drooping type, as the Kniffin system, while the Chautauqua growers favor the upright types, such as the high renewal system. This difference is due to the fact that the soils of the Chautauqua belt are more shallow, and possibly less fertile than those of the Niagara district, thus necessitating that the vines be trained in that position in which they will make the most growth. On the other hand, the Niagara growers tend to check the growth of their vines by using some form of the drooping type. In both districts it is the general practice to keep the vineyards thoroughly cultivated during the growing season; and for this purpose the disc and spring toothed cultivators are the most popular implements.

Because of the gravelly or shaley character of a large part of the soils in the Chautauqua belt it has become necessary to make use of cover crops, commercial fertilizers, and manures to maintain the fertility. But still the use of the cover crops and commercial fertilizers cannot be said to have become general practice.

Since the Chautauqua district is remarkably free from pests, spraying has not been generally practiced; and, only the best growers spray regularly. Spraying outfits especially made for use in vineyards are used by the large growers.

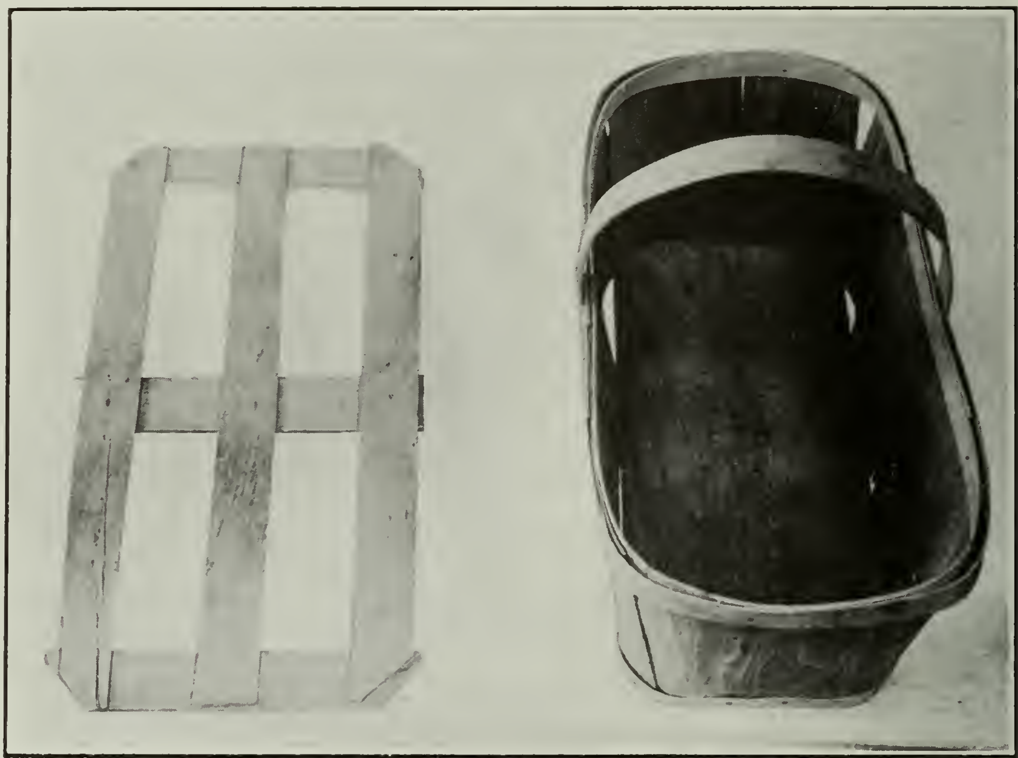


The two grape baskets in common use.

It is in the harvesting operations that the greatest differences are to be noticed between American and Canadian methods. Because of the narrow space between the rows, which will not permit the passage of an ordinary waggon, a specially constructed grape truck is used. This truck, which has the same general appearance as a small-sized lorry is about five feet eight inches wide over all, and so constructed with double reaches that it can be turned around in quite a small area, approximately sixteen feet in diameter. When this truck is turned the hind wheels do not travel in a smaller circle than do the fore wheels, as in the case of an ordinary waggon, but follow in the tracks made by the fore wheels.

The grapes from the time they are cut until they are packed and ready for shipment are treated in many different ways. Some growers pack their grapes in the vineyard, so that the person cutting must also be able to pack efficiently. This practice is followed when harvesting small blocks of early grapes, or when taking the first ripe fruit from the larger plantations for the early market. When the fruit is sold to the grape juice factories or wineries these companies usually furnish flats in which to pack the grapes in the vineyards. Many of the larger growers who have an extensive basket trade also follow this practice of using flats to carry the fruit from the vineyard to their packing houses. These flats vary in size, but the average is thirty inches long, eighteen inches wide and six inches deep. The bunches are placed in these flats by those cutting, and the full flats left on the shady side of the row until they are collected.

Most of the larger growers have specially constructed packing houses where experienced packers, mostly women, grade and pack the grapes in baskets. A typical packing-house or shed is arranged with a sloping table on three sides at a height convenient for the packers who sit on benches while working. One or two men are required to remove the empty flats and supply full ones. There are three sizes of baskets in general use: the "pup" basket, the six-pound basket, and a still larger one holding approximately twenty pounds. The first two are fitted with solid covers while the largest basket has a slatted cover.



This basket is still used to some extent, but not in Ontario. It holds about 20 lbs net.

Until recently most of the grapes shipped from this belt were handled by the Chautauqua and Erie Company, which is a growers' union. Within the last three years two or three other companies have been formed.

An increasing percentage of the grape crop of this district is being used by the grape juice factories and wineries. By requiring that all grapes sold to them be thoroughly ripened, and well colored, these companies have had a great influence on the time of harvesting throughout the belt.

In the Chautauqua district as in the Niagara Peninsula the Concord is pre-eminently the leading market variety. About ninety per cent. of the grapes grown are Concords. The remaining ten per cent. is divided among the following varieties: Niagara, Worden, Moore Early, Catawba, and Delaware.

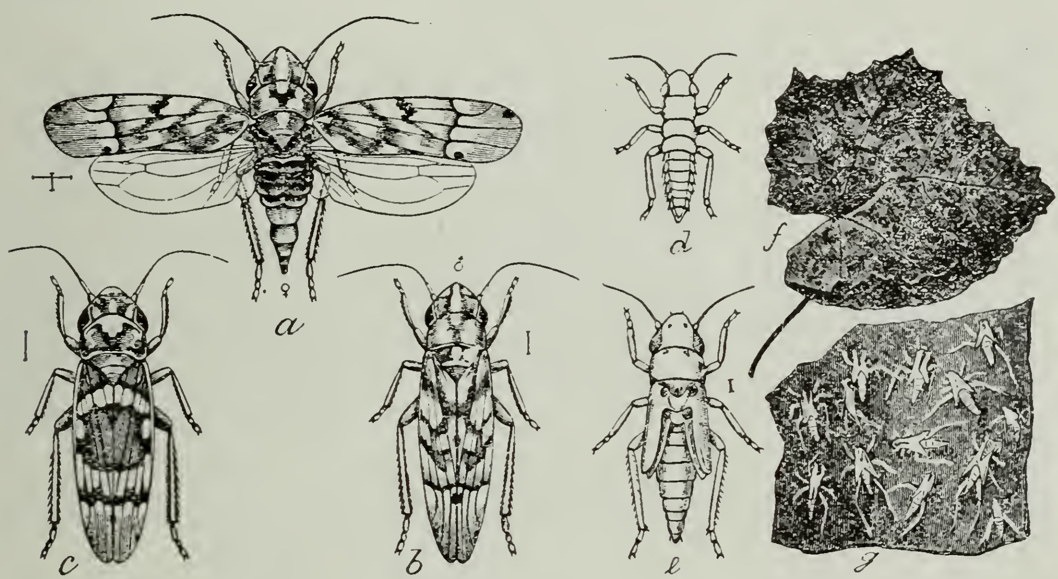
A very large share of all the available land which is suitable for the production of grapes in the Chautauqua belt has already been planted, so that any further development of the industry here must take place at the extremities of the region.

But, since the escarpment becomes quite low at these points the climatic and atmospheric conditions are not as suitable for grape culture, and make grape growing in these localities not a very paying proposition. In the Niagara district on the other hand, although there have been extensive plantings of vines; there still remains for future planting fully as large an acreage of just as good, and as well suited land.

INSECTS ATTACKING GRAPES.

PROF. L. CAESAR, ONTARIO AGRICULTURAL COLLEGE, GUELPH.

The chief insects that attack the grape in Ontario are the Grape leaf-hopper, the Grape-vine Flea-beetle, and the Rose Chafer or Rose Bug as it is often called. No one of these is ever destructive any season in all the vineyards of the province, but all occur more or less locally and often with a considerable interval between severe outbreaks.



Grape leaf-hopper (*Typhlocyba comes*): (*a*) Adult female; (*b*) adult male; (*c*) another form of the species, showing variation in markings; (*d*) newly-hatched nymph; (*e*) last stage nymph; (*f*) appearance of injured leaf; (*g*) cast pupa skins. (*a.e*) Much enlarged; (*g*) less enlarged; (*f*) reduced. (From Marlatt.)

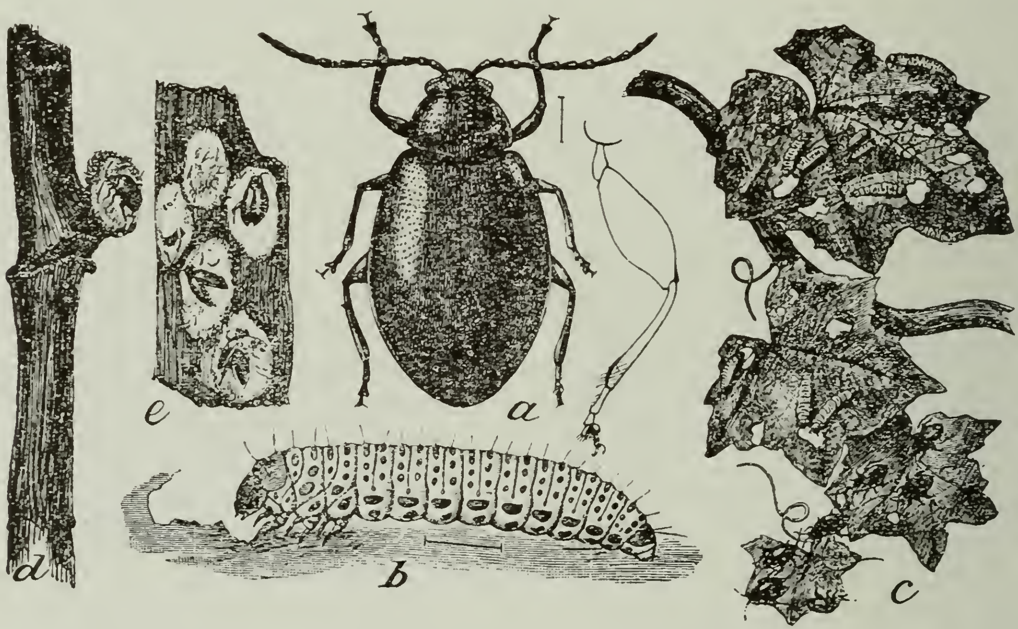
THE GRAPE LEAF-HOPPER.

(*Typhocyba comes.*)

The Grape Leaf-hopper is the most common insect attacking grapes in Ontario. It is usually worst in the neighborhood of woods and waste places where long grass, weeds, and rubbish afford good winter quarters for the adults. It is not however, limited to such places, as vineyards with comparatively clean surroundings are sometimes badly infested.

The adult insect is very small, not more than one-eighth of an inch in length, slender and tapering to one end. The color is pale yellow or whitish with darker markings which are usually reddish. These markings are most conspicuous in spring and fall. Individuals, however, differ so much in the color of the markings that they might easily be mistaken for different species. The adults are very shy and if at all disturbed will leap or fly to another vine. The young leaf-hoppers or nymphs are at first nearly white but as they grow older take on a yellowish tinge. They resemble the adults in shape but have no wings and seldom leap, but instead, if disturbed, run actively away with a sidewise movement. *It is in this nymphal stage when the body is not protected by wings and when they cannot fly that this pest can be best controlled.*

The life-history is briefly as follows: The winter and late autumn are passed in the adult stage under the protection of long, dead grass, weeds or other shelter in fence corners, along old ravines, in waste places and the margins of woods. In the warm days of spring when vegetation begins they emerge and feed on almost any kind of green plant, being specially fond of raspberry and strawberry plants. As soon as the foliage of the grape has got well started, they migrate to vineyards and feed on this. Eggs are laid in the tissues of the leaf during June and the nymphs from these begin hatching towards the end of June and in July. The oldest of these nymphs in an ordinary season becomes full grown by about the middle of July. There is a partial second brood. The winter is passed only in the adult stage, adults seeking winter quarters as soon as severe cold weather comes in autumn.



Grape-vine flea-beetle (*Haltica chalybea*): (*a*) Adult or beetle, with more enlarged leg at right; (*b*) larva, (*c*) larvae and beetles on foliage; (*d*) injury to buds; (*e*) beetles killed by fungus. *a*, *b*, Much enlarged; *c*, *d*, *e*, about natural size. (From Marlatt.)

The injury is caused both by the adults and the nymphs. They feed on the under-side of the leaf and with their sharp needle-like mouth parts pierce through the lower epidermis and suck the sap out of the interior. Wherever the insects are numerous, the leaves at first become mottled on the upper surface above where the sucking was done; later they turn brown and sometimes drop off. The result is that the fruit is smaller than it otherwise would be. The quality is poorer also.

Means of Control.

1. *Clean Culture.*—In the majority of cases no other steps will be found necessary than to take care to see that old fences are removed and no long grass, weeds, bushes or other hiding places allowed to grow up and form winter quarters for the pest. Sometimes the same object can be secured by burning over in early spring grassy or weedy places near the vineyard to destroy the hibernating adults.

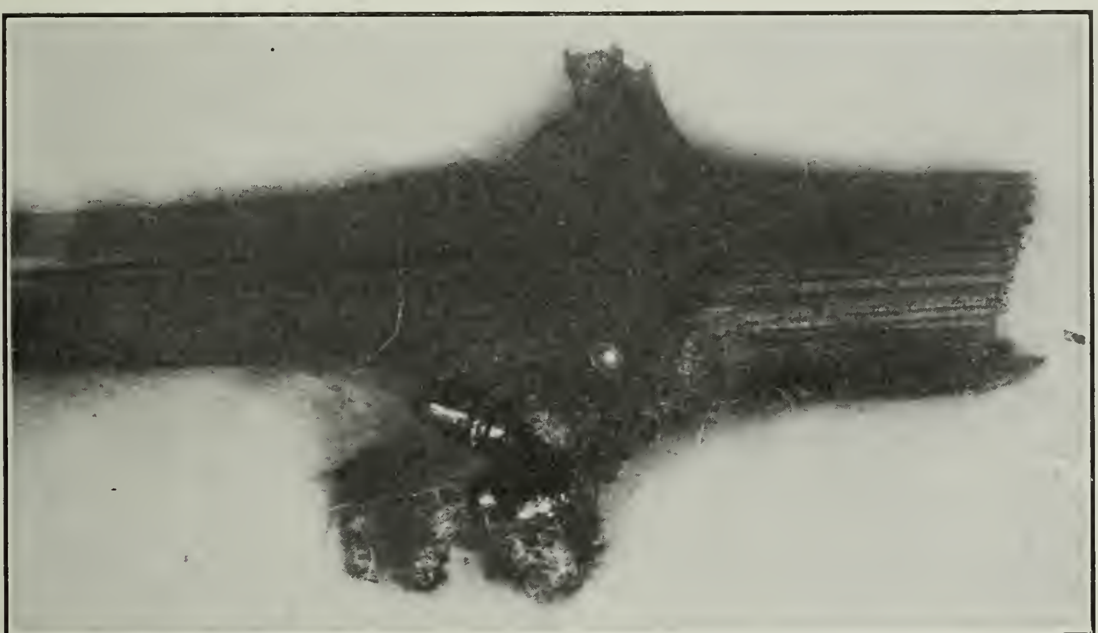
2. *Spraying.*—An examination of the under side of the foliage should be made at the end of June and, if many adults and nymphs are found, the under

surface of the leaves should be thoroughly sprayed with Black-Leaf-40 (40 per cent. nicotine sulphate), 1 part to 1,500 or 1,600 parts of water or of Bordeaux mixture. In most years the best time for this application will be from about the 10th to the 20th of July because at these dates the majority of the nymphs have hatched from the eggs and yet are not old enough to have transformed into adults. The spray does not kill the adults because the wings protect them. Special care must be taken when spraying to use an angle nozzle and fairly high pressure, AND TO COVER THE UNDER SIDE OF EVERY LEAF, IF POSSIBLE. One good spraying is sufficient.

The Grape-vine Flea-Beetle.

(*Haltica chalybea.*)

This is a pretty little beetle nearly one-fifth of an inch in length and varying in color from a greenish-blue to a purplish-blue. Though most of our vineyards are exempt, or practically exempt, from its attack, yet it does a considerable amount of damage almost every year in at least a few localities. The vineyards most likely



Grape-vine flea-beetle (*Haltica chalybea*).

to be attacked are those situated near woods, thickets or waste lands. This is because these places afford ideal hiding places for the beetles in winter. Vineyards may be attacked in spring by the over-wintering adults, or in late June and July by the larvæ, or in late July, August and September by the new brood of beetles from these larvæ. Of these three attacks the one by the adults in spring is far the most destructive and in fact the only one in which any appreciable damage is done. On warm sunny days in May the beetles come out from their winter quarters and attack the swelling buds, eating holes into them and destroying them. The destruction of a bud means the loss of all the fruit that might have been borne on the vine from that bud that season. A single beetle may destroy several buds and thus, if the insects are numerous, great loss may be caused in a few days.

The female beetles soon begin to lay eggs under the bud scales, in crevices in the canes and under the bark. The eggs hatch towards the end of June and during July. The grubs from these are brown, with black heads and legs, and many conspicuous black spots on the back of the body. When full grown they are about one-third of an inch long. They feed on the upper surface of the leaf for about three weeks, eating away the green tissues and causing the injured area to turn brown. There are, however, so many leaves on the vines by this time that the larvæ or grubs are never numerous enough to do much damage. Once they are full grown they drop to the ground, work their way into the soil a couple of inches, and pupate. In about two weeks new adult beetles begin to emerge from these pupæ. These new beetles, like the grubs, feed on the foliage but do very little damage. When cold weather approaches they cease feeding, seek good hiding-places, especially in woods, thickets and waste places, and here hibernate until next spring.

Means of Control.

1. *Clean Culture.* From the above account of the insect's habits it is evident that it will help much to ward off danger if the owners of vineyards try to get as clean surroundings as possible. Old fences around vineyards should be removed, useless thickets cut down, brush heaps burned and a general cleaning up made so far as this is practicable.

2. *The Use of Frames Saturated with Kerosene.* Considerable benefit has been obtained by using frames made of narrow strips of lumber, the frames being about 6 ft. long by 3 ft. wide and covered over with muslin, which must be kept saturated with kerosene. Boys carry these frames along, hold them low beside the vines and gently tap these to cause the beetles to fall into them. This should be done in spring on sunny days as soon as the beetles begin to attack the buds. Care must be taken not to hit too hard or the beetles from the vines ahead will also drop and escape. The kerosene on the muslin kills the beetles that fall on it.

3. *Spraying for Adults in Spring.* To prevent the destruction of the buds in spring by spraying, it is necessary to watch carefully for the first sign that there are sufficient beetles present to justify an application. Then use four or five lbs. of arsenate of lead to 40 gals. of water, and see that every bud is thoroughly covered. It is claimed that the addition of half a gallon of cheap molasses to the above helps to attract the beetles and insures their being more quickly poisoned. If rain comes soon after spraying it will have to be repeated.

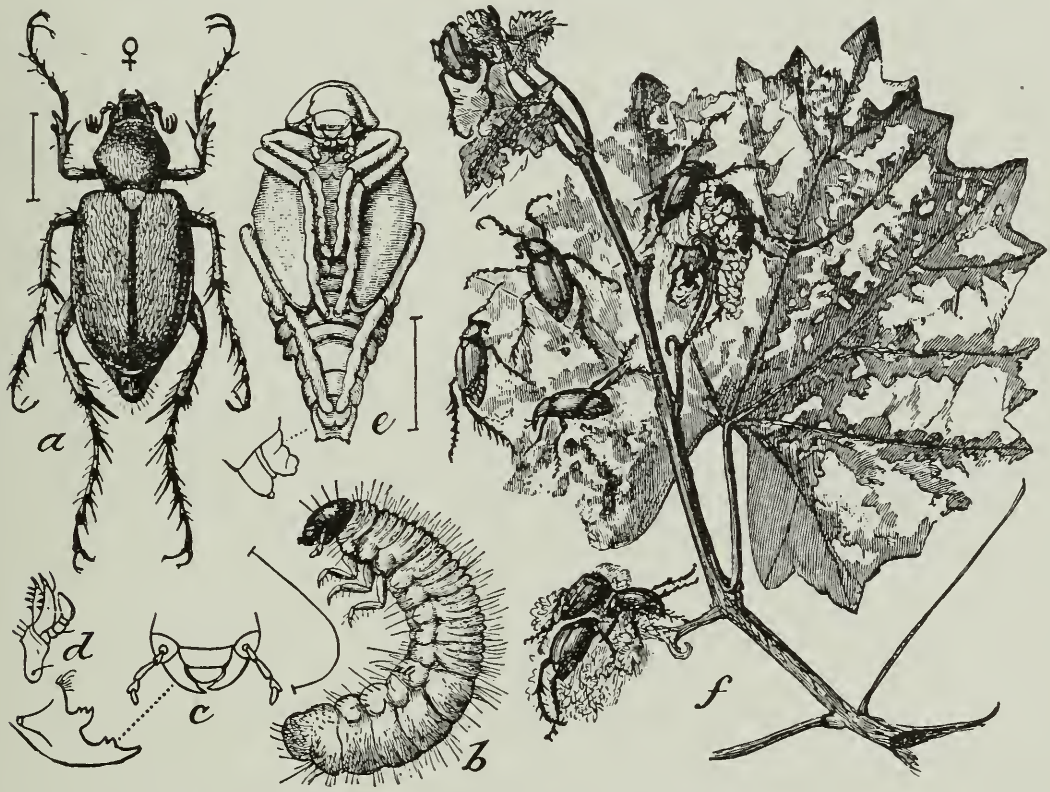
4. *Spraying for Larvae.* By the time the larvæ have appeared it is of course too late to prevent the buds having been destroyed, but by killing the larvæ one will help greatly to make the number of adults so small that injury the next year will be prevented. For the larvæ use about 3 lbs. of arsenate of lead in 40 gallons of water, or better still of Bordeaux mixture, as this will help to control fungous diseases. Apply carefully to the foliage about the end of June or as soon as larvæ are present. One application should be sufficient.

The Rose-Chafer.

(*Macrodactylus subspinosus.*)

The Rose-Chafer is a somewhat slender beetle, nearly half an inch long. It is so densely covered with very fine, short, greenish-yellow hairs on the thorax, and yellowish brown hairs on the wing covers that the whole upper surface has a fawn appearance. The legs are long and slender. The beetle is slow and awkward in its movements and can easily be captured when feeding. Fortunately this pest breeds only in light sandy or gravelly soil, especially in localities where there is much waste land of this character. In such places it is often very abundant and destructive. On several occasions whole vineyards have been noted with almost every grape cluster completely destroyed and many of the leaves badly riddled.

The beetles come suddenly from their breeding grounds when the Concord grapes are just coming into blossom. They alight often in large numbers upon the blossoms, feed on these and the forming berries, and to some extent on the leaves, for about two weeks, then migrate to other plants that are in bloom, such as the sumac, raspberry, blackberry and rose. Often they attack the foliage and young fruit of apples, pears, plums and cherries, and do considerable harm. In about a month from the time they first appear their work is over and the most of the adults have died, though a few linger on for a week or two weeks longer. In the meantime the females have laid their eggs in the light sandy or gravelly soil, especially in the waste places near the vineyard. The larvæ on hatching feed on the roots of weeds and grasses, and become about full grown by November. Full-grown larvæ are about four-fifths of an inch long and resemble white grubs but are smaller and more slender. They then burrow down to a depth of about a foot and remain there over winter. The following spring they come up nearer



Rose-chafer (*Macrodactylus subspinosus*): (*a*) adult or beetle; (*b*) larva; (*c*) (*d*) mouth parts of same; (*e*) pupa; (*f*) injury to leaves and blossoms of grape, with beetles at work. *a*, *b*, *e*, Much enlarged; *c*, *d*. more enlarged; *f*, somewhat reduced. (From Marlatt.)

the surface and about May 24th begin changing into pupæ in little earthen cases from three to six inches below the surface. Adults emerge from these pupæ in from three to four weeks, or, as stated above, about the time Concord grapes are in bloom.

Means of Control.

1. *Cultivation.* Ploughing the breeding places about 6 or 7 inches deep soon after May 24th and discing or harrowing them several times before June 21st will destroy great numbers of the pupæ, and is of great importance.

2. *Spraying.* Several entomologists in the United States have tested a sweetened poison compound of five lbs. arsenate of lead to forty gallons of water containing 1 gallon of cheap molasses, and found that this quickly kills the beetles. It should be carefully applied just as the beetles attack the grapes. Mr. George Brown, of Fonthill, tells me he has used this remedy for several years and finds it

good. I examined some cherry trees near Beamsville that had been sprayed with it for this insect and found dead beetles on the soil below each tree, apparently proving that the mixture worked well. In case of rain it will be necessary to repeat the spraying.

Minor Grape Insects.

There are about a dozen more insects that attack grapes in this province, but only the following three seem worthy of mention:

1. The Grape-Berry Moth (*Polychrosis viteana.*) There are two broods of this insect. The first-brood larvæ injure the blossoms and young fruit by webbing them together and feeding upon them. The second-brood larvæ attack much later in the season and do not web the grapes together, but each larvæ attacks a separate berry, bores into it and feeds upon the pulp and seeds. The larvæ are small, 3-8 inch long and somewhat dark in color. The insect can readily be identified by its habits. It never seems to occur in Ontario in sufficient numbers to justify taking any steps to combat it.

2. The Grape Root-worm (*Fidia viticida.*) This is a small grayish-brown beetle about one-quarter inch long. The beetles themselves do some injury by feeding on the foliage in July and eating out chain-like holes, but the larvæ or grubs do far the most harm, because they live in the soil all the latter part of the summer and all fall and feed upon the roots, thus weakening the vines greatly and in many cases killing them. Although this is a very destructive and common pest in much of the Eastern United States it has, so far as I know, only been found a couple of times in Ontario near the Michigan border and has not done any damage worth mentioning.

3. The Grape Plume Moth (*Oxyptilus persicelidactylus.*) The larvæ of this little plume moth webs together the leaves at the tips of the young shoots, and feeds on them. It is sometimes abundant in a small part of a vineyard but never does sufficient damage to require treatment. It pupates right in the clustered leaves.

GRAPE DISEASES.

J. E. Howitt, Professor of Botany, O.A.C., Guelph.

Nearly all the common diseases of the grape are found in Ontario vineyards, but fortunately it is very seldom that any disease causes serious loss over any large area of the grape growing districts. However, in the past there have been severe epidemics of Black Rot and frequent local outbreaks of Downy and Powdery Mildew. It is, therefore, important that grape growers should become familiar with the appearance of the common diseases and the best methods of combatting them in order that they may recognize them if they appear in their vineyards and apply the measures necessary for their control. Timely and intelligent application of methods of control will almost entirely prevent loss from grape diseases.

Black Rot of the Grape.

(*Guignardia bidwellii* (Ell.) Viala & Ravaz.)

This is generally considered to be the most destructive disease of grapes. In the past it has caused severe losses to the grape growers in some sections of the Niagara District. During recent years it has given very little trouble but has been present to a limited extent every year in some of the vineyards in the neighborhood of St. Catharines and one or two other localities in the Niagara District, and may at any time become epidemic again if climatic conditions become favorable to its development.

Symptoms.—Black Rot affects the leaves, berries, tendrils and canes. It does most damage to the berries on which pale or light spots first appear and gradually enlarge until the whole berry is involved, turns brown and finally shrivels up and becomes hard and black with the surface covered with minute black pimples, the fruiting bodies of the black rot fungus. Such berries are called "mummies" and are frequently seen hanging on the vines. Entire bunches or only a few berries in a bunch may be thus affected. On the leaves the disease produces comparatively small, circular, brown spots with distinct dark margins. On the surface of these spots minute black specks, the fruiting bodies of the fungus, may be seen. Similar but more elongated spots are seen on the shoots.

Life-History.—Numerous spores are produced in the minute fruiting bodies at the surface of the diseased berries, leaves and shoots. These are discharged in enormous numbers whenever the vines are wet by rain, and thus the disease spread during the summer months. It is interesting to note that the disease cannot spread during dry weather as it requires considerable moisture to cause the discharge of the spores from the fruiting bodies. The disease is carried over the winter by the spores in the affected fruits, shoots and tendrils. The mummied fruits hanging on the vines or lying on the ground beneath are the chief source of fresh infection in the spring.

Treatment.—Gather and burn the mummied fruits that may be on the vines. Rake up and burn the trimmings from the vines. Plow as early in the spring as is practicable, taking care to turn under the rotten bunches and leaves as completely as possible. Spray thoroughly with Bordeaux mixture (4-4-40 formula). The time and frequency of spraying will depend upon the weather. Contrary to the usual practice, spraying before rather than after rain is recommended. The general directions for spraying with Bordeaux mixture to prevent Black Rot are as follows: Spray first when the second or third leaf is showing; give a second application just after the fruit is set, and repeat again whenever wet weather threatens during the development and ripening of the fruit. Spraying, in order to be effective, must be very thoroughly done; all the fruit and vines must be covered with the Bordeaux. This can only be accomplished by spraying with a good pressure (not less than 100 lbs.) and having a man follow behind the sprayer with a line of hose in order to cover all the bunches and tips of the shoots that may be missed by the spraying machine if stationary nozzles are used.

Downy Mildew of the Grape.

(*Plasmopara viticola* (B. & C.) Beil & De Tomi.)

This is one of the commonest diseases of grapes in Ontario. It is present to some extent nearly every year and sometimes does serious damage. It seldom becomes troublesome over any great area of vineyards but is frequently found doing considerable damage to vineyards here and there throughout the grape-growing districts of Ontario.

Symptoms.—The Downy Mildew attacks the leaves, berries, young shoots and tendrils. It is usually most noticeable on the leaves, on the upper surface of which it appears first as irregular greenish-yellow blotches which later become brown in color. When the disease is severe the blotches increase in size and run into each other so that the whole leaf becomes brown and withered. On the under surface of these blotches a white downy fungous growth may readily be seen. It is a common thing to see a vine or two in a row of grapes with the leaves completely destroyed by this disease. On diseased shoots whitish patches are seen and, when the disease is bad, the shoots frequently become brown and withered. The berries are often attacked when quite small, become covered with white mildew, and cease to grow. On larger berries a half or more grown the disease causes brown spots which increase in size until the whole fruit becomes brown and rotten. This stage of the disease is spoken of as brown rot.

Life-History. On the under surface of the diseased leaves, and on the surface of affected shoots and berries numerous spores are produced. These are scattered by rain and wind and thus the disease spreads during the summer months. Continued damp weather appears to be necessary for the rapid increase of this disease. In the fall in the tissues of infected leaves and shoots another form of spore is produced. These are thick-walled resting spores which serve to carry the fungus over the winter. They are liberated into the soil by the decay of the leaves and shoots and give rise to the disease again the following summer if the climatic conditions are favorable to its development.

Treatment.—Same as that described for Black Rot.

Powdery Mildew of Grape.

(*Uncinula necator* (Schw.) Burr.)

This disease is common in Ontario vineyards and sometimes causes considerable damage, especially to red-skinned varieties of grapes. Varieties derived from the European grape (*Vitis vinifera*) are said to be most susceptible to this mildew.

Symptoms.—The Powdery Mildew affects the leaves, young shoots, blossoms and fruits. It is first observed on both surfaces of the leaves as circular, whitish spots which have a finely powdered appearance. If the disease is very severe these spots may enlarge until the whole leaf is involved. Such badly attacked leaves are frequently somewhat stunted and distorted. Mildewed blossoms fail to set fruit. Berries that are attacked may cease to grow and drop, or develop irregularly and fail to ripen.

Treatment.—Spray with Bordeaux mixture as recommended for Black Rot and at the first sign of this mildew thoroughly dust the vines with flowers of sulphur and repeat the application as often as may be necessary to keep the disease in check until danger to the fruit is past. Many grape growers claim to control this mildew by the use of flowers of sulphur alone.

Anthracnose, Bird's-eye Rot.

(*Gloeosporium ampelophagum*, Sacc.)

This disease has not proved a serious trouble to grape growers in Ontario. However, it has been observed in various localities in the Niagara District and those who grow grapes to any extent should be on the watch for it as it has been known to cause considerable loss when weather conditions were favorable for its development.

Symptoms.—This is a very striking and easily recognized disease. It attacks the fruits, shoots and leaves, but is usually most noticeable upon the fruit. On affected berries greyish-brown spots appear with well defined purplish-brown margins. Frequently between the dark outer margin and the lighter inner area there is a red circle which gives to the spot the appearance suggestive of a bird's eye. The spots may be numerous and completely cover the berry or there may be but one or two spots on one side; in such cases the unaffected portion of the berry remains green. The spots on diseased shoots are similar to those on the berries but are less highly colored, more elongated and more sunken in the centre. On the leaves spots with pale centres and brown-red borders are produced.

Life-History.—Spores are produced on the surface of the central portions of the diseased spots. These may be scattered by rain or currents of air and thus the disease may be spread during the growing season. It is thought that the disease is carried over the winter by spores adhering to diseased fruits, leaves or shoots.

Remedy.—Spraying with Bordeaux mixture as recommended for Black Rot of Grapes, and the prompt pruning out of diseased canes and bunches of fruit will prevent the disease from doing serious damage.

Chlorosis or Yellow Leaf.

This disease is frequently seen in Ontario vineyards. It is said to be worse on soils rich in lime. The foliage of affected vines first becomes pale, sickly yellow and later brown. In some cases the leaves may turn yellow in the early part of the season but regain their normal healthy green appearance before fall. In other instances the leaves may all yellow, then gradually turn brown and wither. If the foliage is destroyed in this manner for two or three years in succession, the vine is very likely to die. It is a common thing to notice one vine among a number of healthy ones showing symptoms of chlorosis. European investigators state that chlorosis is due to the lack of available iron in the soil. The yellowing of the leaves characteristic of true chlorosis may, however, be caused by other conditions, such as winter injury and "wet feet" (excessive water in the soil).

Remedy.—The results of the experiments conducted by European investigators indicate that true chlorosis may be overcome by applying a liberal dressing of sulphate of iron around the affected vines. Top dressing with nitrate of soda in addition to the sulphate of iron is reported as being beneficial.

Crown Gall.

(*Pseudomonas tumefaciens,* Erw. Smith and Townsend).

This bacterial disease has been observed from time to time on grapes in Ontario, but there are no records of it ever having caused any appreciable damage. It produces swellings or enlargements somewhat similar to those characteristic of the disease when it attacks apples, peaches and raspberries. They are, however, not confined to the crown but are found upon the main arms and larger branches.

Treatment.—Cut out the affected portions of the vine and burn them.

Side Arm or Necrosis.

(*Fusicoccum viticolum,* Reddick.)

This disease has been reported from Ontario but does not appear to be widespread or to have done sufficient injury to attract the attention of grape growers. It has been reported as a serious disease in New York by Prof. Reddick of Cornell University.

*Symptoms.**—"The most prominent indication of the presence of the disease, at most times in the year, is the dead arm which gives the trouble its name; but another striking symptom, visibly only in June and early July is the peculiar yellow coloration of the foliage and the dwarfing, crimping and curling of the leaves that mark affected portions of the vine. The yellowing should attract the attention of every grower during cultivation, and the diseased arm or vine should be removed at once or marked for such treatment at pruning time. There are several other less prominent signs of the disease which enable the expert to distinguish it from other troubles, but which would not be so quickly noticed by the ordinary vineyardist. These are peculiar, longitudinal, ribbed excrescences on the trunk or arm, dry rot in the heart of the trunk and usually extending to the margin, small reddish brown or black spots on the green shoots, petioles, peduncles and leaf veins, and spotting and rotting of the berries very similar to those produced by black rot."

Remedy.—*"The diseased vines should be marked in early summer, when they are easily recognizable from the yellow leaves, and all affected wood removed and burned. By carrying a piece of old cotton or linen cloth when cultivating the vineyard, it is but the work of seconds to attach to the diseased vine a strip of cloth to direct attention to it when trimming. Often the removal of a single arm eradicates the disease, but in other cases the whole trunk will be found affected. If the characteristic discoloration or dry rot of the wood of the main trunk is apparent, the whole vine should be sawed off at a point below the last indications of rot. In many cases it will be best to cut off the vine close to the ground so that renewals will come from below the surface. If all sources of infection are removed, such renewals are sure to be healthy and to develop rapidly into strong vines. In some years it might be safe to leave infected wood to bear fruit while the renewal canes are growing, but when conditions are favorable for infection such a procedure would be very unwise. In any case each renewal should be inspected carefully some time during late summer to see that it has not been infected; for if it has been attacked by the fungus, even slightly, it should be rejected. To insure one healthy renewal it is well to leave two or three suckers at the base of the stump from which to select when tying up. At the regular trimming time precaution should be made not to leave for bearing wood any canes that show lesions of the disease. Detection of these is easy with a little care, as they are usually conspicuous at this time, being reddish in color and slightly elevated."

Conclusion.

Practically all the serious diseases of the grape in Ontario can be prevented from causing loss by spraying with Bordeaux mixture as recommended for Black Rot, with the addition of flowers of sulphur later in the season if Powdery Mildew appears. Except in localities which experience has shown to be practically immune to disease, spraying should be done every year as an insurance against outbreaks.

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*N.Y. Agric. Expt. Station, Bulletin 389, Popular Edition.

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Lime and its Uses in Agriculture

By

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Professor of Chemistry

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Lime and its Uses in Agriculture

By R. HARCOURT

LIME IN AGRICULTURE.

During the last two or three years there has been a great deal of interest taken in the question of applying lime to farm lands. Yet correspondents appear to have no common understanding of soil acidity, its causes, its effects, tests which may be made in the field, what materials may be used to counteract it, and many other points in connection with this question.

It must not be thought that all soils are acid, for some, by reason of their origin, are well supplied with lime. These are almost invariably strong, productive soils, and stock fed on their crops are thrifty, with plenty of bone. On the other hand, large areas of land are just as naturally poor in this constituent from the outset, and under cultivation, the supply is soon so reduced that there is not enough of it to do the work which has apparently been assigned to it in crop production. Stiff clays and wet, low-lying and ill-drained soils are apt to become sour, probably due to the fact that there is little chance for the acid materials found in the soil to drain away. Such soils should be drained first and then limed.

Combined with the fact that some of the soils of this Province are sour and that the natural changes taking place in any soil tend in that direction, we have the other fact that few, if any, of our farm crops can make their best growth in a soil carrying a poor or insufficient supply of lime. In the case of legumes an abundance of lime is essential. In fact it is probable that the frequent failure of clover to come through the first winter is due to lack of lime in the soil.

Lime has three main actions in the soil, it neutralizes the acids formed, it improves the physical condition, and it is apparently essential for the proper development of certain plants and organisms in the soil.

How Soils Become Acid.

The acidity of a soil is due to the presence of acids or acid salts, and they may be either organic or inorganic. We are familiar with the fact that sweet immature corn makes sour silage, sweet cider ferments to vinegar, and that sweet milk will sour. In a similar manner organic matter such as green manures, crop residues, and farm manures undergo fermentation or decomposition in the soil and produce acids. If this acid is to be counteracted or neutralized, there must be some material of an alkali or basic nature present to combine with the acid and form a neutral salt and thus destroy the acids formed. This is one of the functions of lime in a soil. If the soil is naturally poor in lime, or has been depleted of its natural store of lime, the soil will probably be sour.

The natural chemical changes that take place in a cultivated soil tend to bring its soluble plant food constituents into a soluble form. These changes are essential to render the food available to the plant. But, among these food constituents, lime, at least, is rendered soluble faster than is necessary for food purposes. Naturally, unless it is again taken up in an insoluble form, it must gradually be carried downward with the water that sinks into the soil. For this reason the water of wells, of many springs, and of our rivers is hard or limey. For the same reason a subsoil contains more lime than a surface soil, and the latter may become so leached that it does not contain sufficient lime to neutralize the acids formed in the decay of the organic matter when the soil becomes acid or "sour." It is well to remember that the richer the soil is in decaying vegetable matter and the more thorough the cultivation, the faster the lime will be rendered soluble and leached away. For the same reason, the longer the land has been under cultivation, the more likely it is to need lime. Thus it is many years since some of the lands of England and Scotland needed lime. The same is true of much of the land in the States to the south of us, and now our, comparatively speaking, newer lands are reaching the same condition.

During the past season's work on the soil survey, we have had abundance of evidence that these changes have progressed far enough to render the application of lime a necessity in many districts. In the course of the summer's work thousands of borings were made in the soils of the counties studied. In most cases the surface soils were acid to litmus paper, and there was not enough carbonate of lime present to cause any apparent effervescence until a depth of 20 to 24 inches was reached. In some cases there was none even at 40 inches. The only surface soil rich enough in carbonates to give an effervescence with acid was found in Lambton County, and that was of comparatively small area. On such a soil it would naturally be useless to apply lime. In some other places, as in the neighborhood of Guelph, the soil is not yet in need of lime, but the supply is working downward, while in other districts, there is great immediate need. All these data we hope to have clearly mapped, when we get farther on with the work of our soil survey.

Many inorganic fertilizer materials tend to increase soil acidity. Thus sulphate of potash, muriate of potash, and sulphate of calcium, or land plaster, are neutral salts; but the basic part of the salt (potassium and calcium) is taken up by the plants more rapidly than the acid radicle, and the soil becomes sour. Ammonium sulphate has this effect in a double sense, because the nitrogen in the basic part of the compound, ammonium (NH_4), is nitrified in the soil to nitric acid and both parts of the original substance furnish acids.

Lime Improves the Physical Condition of Soils.

But the addition of lime does a great deal more than simply neutralize the acid of a soil. It influences the tilth or texture of a soil. This is most marked and most beneficial in the case of clays and clay loams, rendering them less tenacious when wet, and more friable and mellow when dry. This it does by causing the fine particles of the clay to gather into larger units and makes the soil act more like one made up of larger particles. This flocculation can be readily shown by carrying out the following experiment: Take two glass cylinders or jars, and place in each about a tablespoonful of clay soil, and nearly fill with soft water. To one cylinder, or jar, add about a teaspoonful of slaked lime, then mix thoroughly the contents of each jar by shaking and turning upside down and shaking. Allow to stand and settle. Note the difference in the size of the particles and the rate of settling. The flocculation does away with the stiff, waxy, impervious nature common in clays deficient in lime, and renders them drier, warmer, better aerated, with a larger content of moisture available for plant growth. It also brings about a more favorable condition for root development; improves drainage and permits the farmer to cultivate his clay soil earlier in the spring with all the advantages that naturally follow.

The action of lime on sandy soils is somewhat similar to that on clay, that is, it binds, or cements, the sand particles together; but the effect on the soil is different. It renders the soil closer in texture, and thus, being less open and porous, it does not dry out so readily in seasons of drought.

Lime Liberates Mineral Plant Food.

In addition to neutralizing the acid of soils, and improving their physical condition, lime is also credited with causing certain chemical reactions in the soil whereby the inert potash and phosphoric acid are brought into an available form. In fact, the carbonate of lime appears to be the main-spring of many beneficial reactions occurring in the soil. Most of our soils contain immense quantities of potash in an insoluble form. Through the action of lime compounds these insoluble potash compounds are broken up, the lime taking the place of the potash which is liberated in a form that plants can assimilate. In this way lime compounds may act as an indirect potassic fertilizer, which gives lime a double value at the present time when potash materials are so scarce and expensive. This effect is naturally most noticeable on clays, and more particularly with clover and other leguminous crops which have the greatest difficulty in securing their supply of potash from the soil.

Phosphoric acid is largely held in the soil in combination with iron and aluminum in compounds that are very slowly rendered soluble. The lime reacts with these with the formation of phosphate of lime which is more readily rendered available to the plants. Thus while lime does not directly supply either potash or phosphoric acid, it does help to bring that which is in the soil into an available form. Furthermore, it is generally considered that soils destitute of lime have little power of retaining plant food constituents when applied to the soil as fertilizers in the form of salts of strong acid.

Micro-organisms in Soils Cannot Develop in an Acid Soil.

Thus far we have credited lime with neutralizing the acid of soils, improving the physical condition, and liberating mineral plant food from insoluble forms of combination. But it has still other uses in the soil. A soil worthy of the name must contain a supply of decaying organic matter, humus, or humus-forming material, which is the source and the storehouse of nitrogen, the most important and the most costly element of plant food. In this form, however, the nitrogen is not available as a plant nutrient, the material must undergo further changes with the formation of nitrates. The process by which this is brought about is known as nitrification, and is the life work of certain vegetable micro-organisms or bacteria within the soil. As these nitrifying organisms flourish only in a neutral, or rather slightly alkaline soil, it is essential that some such substance as lime be present to neutralize the acids that are formed in the decay of the organic matter. The nitrate of lime thus formed is the principal direct source of nitrogen to the plant.

Then, there is another class of bacteria whose function is to fix atmosphere nitrogen within the soil. This is one of the micro-organisms which Professor Bottomley claims performs such an important function in his "Humogen," which has recently come into prominence. These organisms known as *Azotobacter,* are, so far as we know, present in all fertile soils. They have, apparently, a very important function to perform in adding to the soil's store of nitrogen, a function they cannot perform in an acid medium. Hence, again we have a reason for the use of lime.

A third class of bacteria important in agriculture is the nitrogen gathering bacteria associated with the legumes. The value of this agent in increasing the productiveness of soils is now well recognized; but it, like the other classes of bacteria mentioned, cannot perform its important function in an acid soil. This is doubtless one of the reasons why an application of lime so beneficially influences the growth of legumes.

Taking into consideration, then, all the important functions which lime has to perform in the soil, and the fact that our soils are steadily losing their lime, it is evident why the application of this material is so important. Fortunately, we have abundance of the lime in our own country, and it is not a costly material.

How to Test for Acid in Soils.

Many methods have been devised for determining the amount of acid in a soil, but none of these are suitable for field use. In most cases, it is sufficient to ascertain the fact that the soil is acid. For this purpose a fairly satisfactory test can be made with blue litmus paper, which can be purchased at almost any drug store. It is sold in sheets or in little "books" which contain about twenty-five or fifty strips of the paper about one-half inch wide and two or three inches long. This is the most convenient form in which to have the test paper. If the sheets are purchased, they may be cut into strips the size of those in the books and placed in a clean, dry, wide-mouthed, well-corked bottle to keep them from acid fumes. When this paper comes in contact with an acid it turns red.

A very simple method and a very satisfactory one in our experience of applying the test is to make a ball of damp soil, break it open and lay the paper on the broken surface, squeeze the parts together again and allow to stand for from five to ten minutes. If on opening the ball, it is found that the blue paper has turned red, the soil is acid and in need of lime. It is apparent that the hands must be free from acid and the soil damp enough to press into shape. Unless the soil is very dry, we have usually found that by getting a sample three or four inches below the surface there was enough moisture to answer the purpose. If the soil is moderately dry the change in color may appear only in spots and greater pressure or longer time may be needed to make a satisfactory test. The rapidity of change and intensity of color developed indicate to some extent the relative degree of acidity. To overcome accidental difference in the soil, the test should be repeated several times with samples taken from different parts of the field. In Bulletin No. 80, Dominion Experimental Farms, Ottawa, Dr. Shutt describes two methods which are not difficult to carry out, and may give more reliable results, especially where the soil is dry. These results are as follows:—

1. "Take up, by means of a spade or trowel, a little of the surface soil from, say, half a dozen places on the area to be examined, and mix well, using the trowel or a clean piece of board. Do not handle the soil. Take a small quantity (a few ounces) of the mixed soil and, putting it in a clean cup or tumbler, pour on a little boiled water, and stir with a clean piece of stick or spoon until the mass is of a consistency of a very thick paste. Into this "mud" press a piece of blue litmus paper by means of a small stick or the back of the knife, inserting the paper until one-half to two-thirds of its length is within the pasty mass. At the end of fifteen minutes, carefully draw out the paper and note if the part that has been in contact with the soil has turned red. If so, the soil is acid."

2. "Place a strip of blue litmus paper in the bottom of a clean, dry glass tumbler (preferably flat-bottomed) and over it place a round "filter paper" (purchaseable at a druggist's), or, if such is not readily obtainable, a piece of clean, white blotting paper cut to fit the bottom of the tumbler. On this put a few ounces of the soil to be tested, collected and mixed, as already described, and pour on sufficient boiled water to moisten or wet the soil thoroughly throughout its mass, but no more, and set aside for half an hour or longer. To examine the litmus paper, the tumbler is inverted; viewed through the bottom of the glass, its color will be well brought out against the white filter paper. As a check and to ensure that any change in color may not be due to acidity of the water or filter paper used, a blank test should be made in the same manner, but using no soil."

Forms of Lime.

In the above discussion we have used the term "*lime*" without designating any particular form. It now remains for us to deal with the various forms of this material on the market.

There are several forms of lime that may be used for agricultural purposes. These are quicklime, air-slaked lime, hydrated lime and ground limestone.

Quicklime must be slaked before it can be evenly distributed over the ground. The best plan is to distribute it over the field in small heaps much as is done with stable manure. Fifty pounds to four square rods will give an application of one ton per acre. If water amounting to one-third the weight of the lime be added and the heap covered with about an inch of soil, the lime will soon slake, when it may be spread with a shovel. This latter operation is not a pleasant one, but if the slaked lime is mixed with earth and a damp day chosen for the work, it may be accomplished without any great inconvenience.

Hydrated lime is simply the quicklime slaked, screened and bagged. It is, consequently, more expensive, but its action in the soil will be the same as the quicklime slaked in the field. Generally speaking it is too expensive a form to use for agricultural purposes. Where a small amount is needed for a garden, it would be a very convenient form to use.

Air slaked lime is quicklime that has been allowed to slake without the direct addition of water. It differs from the freshly slaked lime in that it has taken up some carbon dioxide from the air, and part of the lime has passed back into the carbonate condition. The amount that has been thus changed will depend upon the length of time the lime has been exposed to the air.

Ground limestone is simply the limestone rock, similar to that which is burned in the preparation of quicklime, finely pulverized. Naturally the more finely it is ground the quicker it will react in the soil. The coarser-ground material will remain an active agent for a longer time in the soil. Consequently, it is not essential that the whole of the material be very fine. Generally speaking, if the rock is so pulverized that the larger particles are no bigger than flax seed and all the fine material that would naturally be formed in the process of grinding it remain in it, it will be fine enough. The very finely pulverized material costs more to prepare and is more difficult to handle, and does not serve the purpose any better; for applications of ground limestone only need be made at intervals of four or five years. The finest materials will come into use first and the coarsest later. At the same time, it may prevent a too rapid leaching away of the material.

Gypsum, or sulphate of lime, is found in beds or deposits in various parts of the Dominion. When pulverized, it is very commonly called "land plaster." It is a valuable source of lime, as the compound is more soluble in water than the carbonate of lime, but it does not neutralize the acid of sour soils, and cannot, therefore, take the place of the above mentioned forms of lime for this purpose. In other respects, gypsum, or land plaster, may substitute lime, and being more soluble, may be applied at a much less rate per acre. It also contains some sulphur, which some authorities now think may have a special value in the soil.

Marl is found in beds or as deposits, varying from a few inches to several feet in depth, and it is usually covered with a layer of partially decayed organic matter, commonly called muck. In some cases the deposit is practically pure calcium carbonate; in other cases it will be found mixed with clay, sand or organic matter. Its value for agricultural purposes depends upon the calcium carbonate it contains. It may be drawn directly from beds and applied to the land, or it may be taken out and dried and pulverized, when it may be used in the same way as ground limestone. It is easily reduced to a fine powder, and is a valuable source of carbonate of lime for agricultural purposes.

Lime kiln refuse is a product from the lime kiln and consists of unburnt limestone, quicklime, air-slaked lime and sometimes may contain wood ashes, clay or sand. The ashes are derived from the wood which was used as fuel in burning the lime. This material is somewhat variable in composition, but it is frequently a cheap source of lime, and when wood ashes are mixed with it, there may be considerable potash present.

Gas lime is a by-product in the purification of illuminating gas. It contains certain sulphides of lime which will destroy vegetation, and hence the immediate application to the soil is not advised. But if it is put out in small heaps or spread out in such a way that the air can get through it, these harmful sulphides will in two or three months' time be converted into sulphate of lime. It is then essentially a mixture of carbonate of lime and sulphate of lime or gypsum, both of which have agricultural value and may be used for all the purposes for which ground limestone and gypsum are employed.

Acetylene tank residues are essentially calcium hydroxide or slaked lime. It will probably be partially carbonated, depending on the length of time it has been exposed and may be used for the same purposes and at the same rate per acre as described above for corresponding products.

Equivalent Weights.

In dealing with these various forms of lime, it is well to remember that 56 pounds of quicklime will have the same action, especially in correcting acidity, as 74 pounds of slaked lime and 100 pounds of carbonate of lime, or ground limestone;

or one ton of quicklime will be the equivalent of 2,643 pounds of hydrated lime or 3,571 of carbonate of lime. In general practice, two tons of ground limestone is considered equal to one ton of quicklime. As has been pointed out, air-slaked lime is partly slaked lime and partly carbonate of lime, and is, consequently, a mixture of the hydrate and carbonate of lime. Its value will, therefore, be intermediate between that of freshly slaked lime and the carbonate, that is, 56 pounds of quicklime will be equal to a weight of air-slaked lime between 74 and 100 pounds. From the above data it will be seen that if quicklime is worth $5.00 per ton, ground limestone, equally free from impurities, would be worth $2.80 per ton and slaked lime $3.80 per ton. Furthermore, the cost of transportation of the ground limestone will be approximately double that of the quicklime.

Which Form Should be Used.

The cost of the material, however, is not the only factor to consider in deciding which form of lime shall be applied. The character of the soil and the rapidity of action required must be considered.

Carbonate of lime, that is, ground limestone or marl, is much milder in its action than the freshly slaked lime, and is therefore the better material to apply where rapid action is not an important point, and especially on light sandy and gravelly soils. These soils are usually poor in organic matter, due to the free oxidation induced by their open porous nature. Freshly slaked lime is generally credited with hastening this oxidation, and, on light soils, would thus cause too rapid a dissipation of this valuable material. On heavy clays, freshly slaked lime may be used to advantage. There is not the same fear of unduly hastening the decay of the organic matter and its action in causing flocculation of the clay particles will be more rapid and the improvement in the physical condition of the soil more quickly obtained. On soils between the sands and clays, experiments in other countries indicate that the carbonate of lime will probably give the best results through a term of years, although the returns for the first year or two may be in favor of fresh burned lime.

For mucks and peaty soils that may be decidedly acid, the fresh slaked lime is to be preferred. Quite frequently, it is found that the organic matter in these soils is not sufficiently decayed to give the best results in crop production, consequently, if the lime hastens the decay, an improvement in texture will be effected as well as the acid neutralized.

Amount of Lime to Apply.

The amount of lime that should be applied naturally varies with the nature of the soil, and the degree of acidity. We have generally recommended one ton of fresh lime, or two of ground limestone, per acre. This is probably enough for light soils that are not very acid, but experience is showing us that much heavier applications may be made on clays that show acid with litmus paper. Too heavy dressings with fresh lime tend to sterilize the soil for a time, that is, the lime checks the life process of the organisms within the soil. There is, however, no fear of this with the carbonate of lime. On light soils it is safe to apply from one to two tons of the ground limestone, and on clay the same amount of the fresh lime, or double that amount of limestone dust. But in some cases the clays may be so sour that much heavier applications are required to neutralize the acid present and give the maximum results.

The Time to Apply Lime.

Regarding the time of application, due consideration should be given to other necessary farm work. Lime is not for the sole benefit of any particular crop, but for all the crops in the rotation, although its greatest influence is upon the leguminous crops. A good plan is to apply the limestone dust after plowing and before preparing the seed bed for the legumes. The main essential is to get the limestone on the soil, and convenience or economy in getting the work done is usually the factor which should govern the time of application. There is no reason why limestone dust, and especially limestone screenings, should not be applied in the winter, provided the snow is not too deep, that the material can be evenly distributed, and that the land will not be plowed in the spring.

How to Spread the Limestone.

The main point is to get the material evenly distributed over the ground. It may be spread with a shovel either directly from the wagon or from heaps placed at regular intervals over the ground. Possibly it may be applied by means of a grain drill, or the manure spreader; but undoubtedly the most convenient method is to use the spreaders made for the purpose. *In a recent bulletin Dr. Hopkins of Illinois describes how to make a "home-made" spreader which he considers better than those on the market, especially where heavy applications of the ground limestone have to be made. The instructions are as follows:—

"Make a hopper similar to that of an ordinary grain drill, but measuring 8¼ feet long, with sides at least 20 inches wide and 20 inches apart at the top. The sides may be trussed with ⅜-inch iron rods running from the bottom at the middle to the top at the ends of the hopper. Let the bottom be 5 inches wide in the clear with 2-inch holes 5 inches between centres. Make a second bottom to slide under the first on straps of iron 10 inches apart, which should be carried from one side to the other under the hopper to strengthen it, also with holes to register. Both bottoms may be of sheet steel or the lower one may be of hardwood, reinforced with straps of iron if necessary.

"To the lower and movable bottom attach a V-shaped arm projecting an inch from under the hopper, with a half-inch hole in the point of the V, in which drop the end of a strong lever, bolting the lever loosely but securely to the hopper with a single bolt, and fasten to the top of the hopper a guide of strap iron in which the lever may move to regulate the size of the opening by sliding the lower bottom. Make a strong frame for the hopper, with a strong, well-braced tongue.

"Take a pair of old mowing machine wheels of good size and with strong ratchets in the hubs, and fit these to an axle of suitable length (about 10 feet), and 1⅜ or 1½ inches in diameter. The axle should be fitted with journals bolted to the under side of the frame. Make a reel to work inside the hopper by securing to the axle, 10 inches apart, short arms of ⅜-inch by 1-inch iron and fastening to these arms four slats or beaters of ⅝ by ¾-inch iron about an inch shorter than the inside of the hopper, the reel being so adjusted that the beaters will almost scrape the bottom but will revolve freely between the sides. The diameter of the completed wheel is about 5 inches and it serves as a force feed.

*Farm Truth, No. 1. Ground Limestone for Southern Soils, Southern Settlement and Development Organization, Baltimore, Md.

"Hundreds of these 'home-made' machines are in use, and they are usually more satisfactory and more durable than anything on the market. The cash expense for such a machine has varied from less than $10 to more than $30, depending on how much of the materials and labor must be paid for. Farmers with some mechanical skill may hire only the necessary blacksmithing."

Experiments with Lime.

We have placed very few experiments with lime with the idea of gathering actual weights of increase produce. This was partly because the soil on this farm does not need lime and gives no response to its application, and partly because of the difficulty of carrying out co-operative experiments that extend over a number of years. In 1913 we did get some actual figures from an experiment in which quicklime was applied at the rate of one ton per acre, to a sour loamy soil that was to be planted with corn. The unlimed check plot gave a yield of 690 pounds of crop, the limed plot gave 1,865 pounds.

Last year's experiments on the light sand plots in Norfolk County showed that the limed and manured plots give an average of two tons more potatoes per acre than where manure alone was used. These are very large increased yields, but we must remember that when a soil is sour, it is a waste of time and money to cultivate until this is corrected, for the economic use of every other fertilizing material, including manure, depends upon the lime supply.

There should, however, be little need of demonstrating the fact that lime will improve soils deficient in this constituent. We have, consequently, spent more time in trying out some of the cheaper forms of lime that can now be procured. Two years ago, and again last spring, we had a few carloads of limestone screenings from stone-crushing plants, applied. This is the dust and finely broken stone which is sifted out of the crushed stone before shipping. A part of this is fine enough for agricultural purposes, but a large part is too coarse to effect any immediate results. At one quarry we were able to procure screenings from which two grades of coarser particles had been removed. The remaining material is so fine that 75 per cent. of it will pass a 10-mesh sieve, and 20 to 25 per cent. a 100-mesh sieve, or a sieve with 10,000 openings to the square inch. As this limestone dust can be procured for very little more than cost of loading, we had a few car loads applied experimentally last spring. It was expected that this material would be slower in its action than fresh burned lime or the specially prepared and more finely ground limestone. Many of the experimenters reported that the season was so wet that they had little chance of judging results, and generally speaking it appeared as though where the dust was applied at less than three tons per acre, there was no appreciable result. However, where for any reason it was applied in heavy dressings, good results were plainly visible even the first year, both in the physical state of the soil and in the yield of crop. The effect of this application will probably be more plainly seen next season.

When we commenced experimenting with limestone screenings, there was, so far as we were aware, no home-prepared ground limestone for agricultural purposes on the market. Now there are several firms producing this material in this Province alone. Our experience with the screenings leads us to think that, while they are a cheap material, it will not pay to purchase these, even at the low price, and pay the long freight haul. The finely ground limestone is much quicker in its action, and may be purchased either in bulk or in paper or cotton sacks. When bagged it comes under a higher freight rate than the screenings, which are shipped in bulk in open cars. It is, however, more conveniently handled and it is possible to purchase a few tons, whereas the other must be shipped in carload lots. The bagging must, of course, increase the cost of the material.

As stated earlier in this article, our experience leads us to believe that in some parts of the country the soil is so sour that heavy applications of lime are needed to correct it. This state exists chiefly in clays and muck soils. We have under experiment now some muck soil which is used for producing onions, and on which the growth was not satisfactory. Analysis shows that it carries sufficient acid to require ten tons of freshly burned lime to neutralize the acid in the soil one foot deep over one acre. On this we have applied quicklime on small plots at varying rates up to ten tons per acre and the ground limestone up to twenty tons per acre. A similar experiment has been placed on a heavy clay soil. Another season's observation on the experiments now placed with the screenings, ground limestone, and with quicklime, will be of interest. In the meantime we are of the opinion that it will pay farmers whose lands are sour, and who live close to stone-crushing plants, to haul some of the screenings on to their ground, and give it a trial. Those who have to bring in either the ground limestone or the quicklime by freight, should ascertain the nearest source of supply, as otherwise the cost of hauling may unduly increase the cost of the material.

Ontario Department of Agriculture

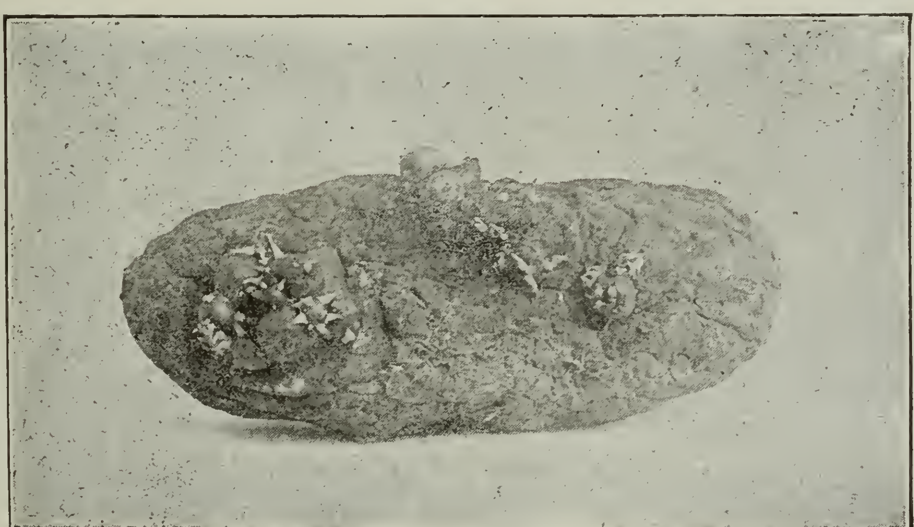
ONTARIO AGRICULTURAL COLLEGE

POTATOES

PROFESSOR C. A. ZAVITZ.

INTRODUCTION.

It is evidently true that potatoes are grown by more people, are used in more homes, and are cooked in a greater variety of ways than any other vegetable produced in Ontario. Fields and patches of potatoes are very common on the farms and in the gardens of the Province. In practically all instances they are



A Study in Potato Growth. A large potato grown in the soil in 1914; small potatoes produced in a dark cellar in 1915; and new sprouts on the small potatoes in preparation for a fresh crop in 1916.

grown for home use, but in many cases they are grown also for supplying the local markets and in some localities they are produced for the larger centres of population.

The potato crop of Ontario could be decidedly and economically improved by a more general use of pure, well bred seed of a few of the best varieties, by the adoption of better methods of culture, and by a more complete control of insects and diseases. It should be the aim of every grower to produce large yields of uniform potatoes free from disease and of high table quality. Varieties of potatoes differ greatly not only in yield per acre, but also in freedom from rot and in cooking qualities. For instance, in the trying season of 1915, the varieties of potatoes grown under uniform conditions at the Ontario Agricultural College varied in yield per acre from 13 to 366 bushels, and in amount of rot from less than one to over seventy-four per cent. Some kinds are found to be very susceptible to rot, and others to be almost immune. The table quality of potatoes varies far more than many people realize when mealiness, flavor, and appearance of different varieties are taken into consideration and are carefully determined.

The chief aim in writing this bulletin is to present the results of experiments and of investigations with potatoes carried out at the Ontario Agricultural College and throughout the Province within the past twenty-six years. The information here given should be of real value to our potato growers in their endeavor to improve both the quantity and the quality of the potato crops of Ontario.

Tops and Potatoes produced from a tuber kept in a warm room.

DESCRIPTION.

The potato (*Solanum tuberosum* L.) belongs to the order solanaceæ and to the genus solanum. This genus embraces about eight hundred and fifty species, many of which are ornamental plants. Only about one-half dozen of these species bear tubers, and of these the potato is decidedly the most important. The potato is a tuber and not a root. The roots of a potato plant are fibrous, branched, and extend in various directions in the soil, but mostly in the upper surface. Some of the stems grow upwards in the air and produce leaves, while others grow horizontally in the soil and produce tubers. The latter are called rhizomes, and if brought above ground many produce leaves instead of tubers. Potatoes are simply the enlarged ends of underground stems, and the eyes are really buds. Tubers of different varieties when grown side by side, or even in the same hills, retain their purity. It is supposed, however, that bud variations may occur in potatoes as in other plants. The flowers, fruits and seeds are produced on the upright stems. New varieties are produced from the potato seeds which are about the size of pin-heads, and these new varieties when established can be grown in their purity from year to year. Tubers used for planting are frequently and conveniently referred to as seed potatoes and are entirely distinct from potato seeds.

HISTORY.

Probably the two greatest gifts of America to the rest of the world are potatoes and corn. The potato is a native of mountainous districts of tropical and sub-tropical America, chiefly from Chili to Mexico, and even as far north as Colorado. The potato was cultivated by the Indians for a long period of time before the discovery of America by Columbus. According to history the potato was taken to Spain, Italy, Ireland and England from South and North America in the Sixteenth Century. It was first regarded as a curiosity, and its growth was exceedingly limited. As late as 1771 only two varieties of potatoes were listed, one white and one red. As the value of the potato as a human food became known its cultivation spread gradually. It is now grown throughout the civilized world. Its ease of propagation, its abundant yield, and its excellent food qualities make the potato one of the most popular vegetables for humanity.

COMPOSITION AND USES.

Potatoes are essentially a starchy food. If used alone, they form an unbalanced ration, but if used in conjunction with foods rich in protein such as meat, fish, eggs and milk they become an important factor in forming a well balanced diet. The average percentage composition of raw and of boiled potatoes and the average percentage of digestible constituents of cooked potatoes may be given as follows:

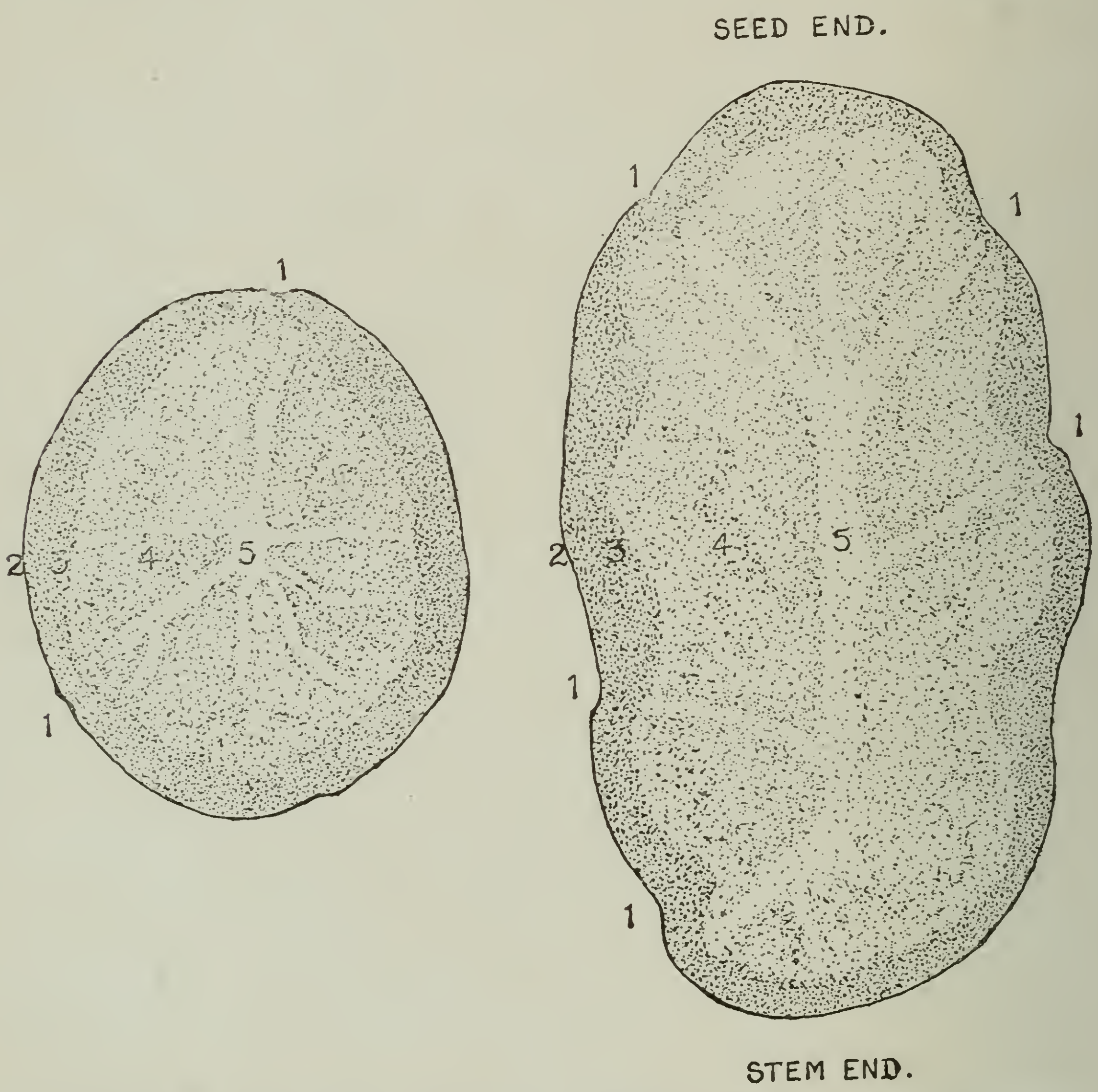
Constituents.	Chemical Composition.			Digestible Nutrients.
	Raw Potatoes.		Cooked Potatoes.	Cooked Potatoes.
	Unpeeled.	Peeled.	Peeled.	Peeled.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Water	78.8	78.3	75.5	....
Protein	2.2	2.2	2.5	1.8
Carbohydrates	17.6	18.4	20.9	19.6
Fat	.1	.1	.1	.1
Ash	1.1	1.0	1.0	....

The carbohydrates are made up of starch, sugar, a small amount of crude fibre, etc. Analyses were made in the Chemical Department of our College of eighty-one lots of potatoes of different varieties and from different soils and localities in Ontario and in New Brunswick. It was found that there was a variation in percentage of dry matter from 16.4 to 26.6, of protein from 1.48 to 2.93 and of starch from 9.57 to 20.74. The average amount of starch from potatoes grown on sandy loams and on light sandy loams was 16.0 per cent. and on heavy clay loams 16.1 per cent. It will be seen, therefore, that the amount of starch was very similar in the potatoes grown on soils of decidedly different character. In a test of thirteen varieties of potatoes, grown under similar conditions of soil and climate, there were wide differences in chemical composition. The table quality of potatoes was influenced more by variety than by all other factors combined such as locality, soil and climate. It is considered that under normal conditions a high percentage of carbohydrates or starch causes potatoes to be dry or mealy, of protein to be waxy, and of water to be wet and soggy.

Four different methods have been used at our College for determining the quality of potatoes. Chemical analysis furnishes information regarding the amounts of the different constituents; the specific gravity test gives approximately the percentage of starch; the physical examination of the cut potatoes shows the appearance of the tubers and indicates roughly the amount of water, etc., and the cooking test gives the mealiness, the flavor and the appearance of the potatoes for domestic use. Of the four methods, the last mentioned is by far the most satisfactory in determining the real value of the potatoes for eating. If unpeeled potatoes are cooked by steam their table qualities are revealed in a manner which is both practical and convincing. Special attention to the table quality of potatoes will be given in this bulletin.

An average crop of potatoes removes less fertilizing constituents from the soil than does either mangels or corn. In the Province of Ontario an average yield of potatoes removes from an acre of land approximately twenty-five pounds of nitrogen, thirty-seven pounds of potash and eight pounds of phosphoric acid.

The chief use of the potatoes grown in the Province of Ontario is for the production of human food. Raw potatoes lose about twenty per cent. of their weight when peeled. The amount which is fed to farm stock in most seasons is confined largely to the peelings, the culls, and the surplus of old potatoes on hand in the summer when the new crop is ready for use. When the yield per acre is large, and the price per bushel is low, a much larger proportion is used for feeding



Transverse and Longitudinal Sections of a Potato: 1, Eye; 2, Skin; 3, Cortical or Cambium Layer; 4, External Medullary Layer; 5, Internal Medullary Layer, pith or water-core.

A good potato has a wide Cortical Layer and a narrow or small Internal Medullary area; and a poor potato has a narrow Cortical Layer and a comparatively large amount of pith.

to farm stock. As the results of experiments in feeding hogs, Fjord of Denmark found that 400 pounds of cooked potatoes equalled 100 pounds of mixed grain; Henry of Wisconsin, that 442 pounds of cooked potatoes equalled 100 pounds of corn meal; and Potter of Oregon, that 360 pounds of steamed or 552 pounds of raw potatoes were equal to 100 pounds of barley. As time advances it is probable that potatoes may be used somewhat more extensively in Ontario than at present for the manufacture of such products as starch, potato flour, commercial glucose, evaporated potatoes, etc. Bulletin No. 47, of the United States Department of Agriculture, printed November, 1913, refers to the potato crop of Germany as follows: "Forty per cent. are fed to stock, twenty-eight per cent. are used for table purposes, twelve per cent. for seed, six per cent. for alcohol, four per cent. for starch and related products, and ten per cent. decay."

DISTRIBUTION.

We have used the statistical reports of the United States Department of Agriculture as the basis for working out the following interesting information. For the five years previous to the war in Europe, from 1909 to 1913 inclusive, the average of the world's annual production of potatoes amounted to practically five and one-half billion (5,500,000,000) bushels. It is interesting to note that this annual production was contributed by the different continents in the following order:

Europe	89.5%	South America	.9%
North America	8.0%	Australasia	.4%
Asia	1.1%	Africa	.1%

Although the potato originated in America nearly ninety per cent. of the world's production is now grown in Europe, and less than nine per cent. in North and South America combined. Of the five years referred to the lowest production was made in 1911, and the highest in 1913, the difference being practically one billion bushels.

For the same five-year period those countries of the world which made the highest average annual production of potatoes were as follows:

Germany	31.3%	Holland	2.1%
Russia	23.9%	Belgium	2.0%
Austria-Hungary	12.3%	Spain	1.7%
France	9.0%	Canada	1.5%
United States	6.6%	Sweden	1.2%
Great Britain and Ireland	4.7%	Italy	1.1%

For the period referred to which closed with the year 1913 practically eighty-six per cent. of the potatoes of the world were produced in those countries which are now at war, the amounts being about equal for the countries of the opposing forces. The average yield of potatoes per annum for the United Kingdom amounted to 254,438,200 bushels, and for Ireland alone 119,874,000 bushels. Ireland, therefore, produced nearly one-half of the potato crop of the United Kingdom, and 2.2 per cent. of the potato crop of the world.

It is interesting to consider the potato production in its relation to the population of the different countries. Determinations have been made showing the number of bushels per capita in some of the principal potato growing countries of the world. For these determinations the average yields of potatoes for the five years, from 1909 to 1913 inclusive, have been used in connection with the populations of the different countries for about the same dates. The following tabulated results show in order the countries, and the average number of bushels produced yearly for each inhabitant:

Ireland	26.0	Canada	10.8
Germany	25.8	Norway	10.4
Holland	18.9	Russia	7.8
Belgium	14.4	Scotland	7.3
Austria-Hungary	12.9	Spain	4.7
France	12.2	United States	3.9
Sweden	11.8	England	2.7
Denmark	11.7	Italy	1.8
Switzerland	11.5	Servia	.5

It will be seen that although Ireland produced only 2.2 per cent. of the potatoes of the world she grew a greater quantity per capita than any of the other countries under consideration. The potatoes of Ireland form an exceedingly important part of the crop production of that country.

For the five-year period closing with 1914 the potato production of the United States was contributed most largely by the States of New York, 10.6 per cent.; Michigan, 10 per cent.; Wisconsin, 9 per cent.; Maine, 7.4 per cent.; Minnesota, 7.2 per cent.; Pennsylvania, 6.9 per cent.; and Ohio, 4 per cent. These seven States furnished more than one-half of the potatoes produced in the American Union. It will be observed that the States here referred to are all in close proximity to Canada, and that six of them are very near neighbors of Ontario. The average yearly production in the United States for the five-year period was practically four hundred and sixty million (460,000,000) bushels.

For the years from 1910 to 1914 inclusive, the average annual potato production of Canada was 75,189,776 bushels according to the Census report of the Dominion. The greatest production was in 1914 with over eighty-five million, and the lowest in 1910 with less than fifty-six million bushels. There was a decided increase in potato production in 1914 over 1910 in each of the Provinces, as well as in the Dominion as a whole. The average potato production in bushels for the five-year period for each of the Provinces of the Dominion was as follows:

Ontario	19,981,074	P. E. Island	5,909,905
Quebec	17,914,134	Saskatchewan	4,840,468
New Brunswick	8,555,054	Manitoba	4,565,968
Nova Scotia	6,240,751	Alberta	4,144,580
British Columbia	3,037,842		

It will, therefore, be seen that over one-quarter of the potatoes of Canada were produced in Ontario. The production of potatoes in Ontario was about equal to the combined production of potatoes in the three Maritime Provinces, and somewhat greater than the combined production of the potatoes in the four Western Provinces.

Potatoes are grown in every county of Ontario. According to the reports of the Ontario Bureau of Industries those counties of the Province which produced an annual average of upwards of one-half million bushels for the period from 1910 to 1914 inclusive, were as follows:

Simcoe	1,133,900	Wellington	684,383
Middlesex	904,283	Huron	620,935
York	860,127	Bruce	570,631
Grey	797,545	Ontario	528,919
Carleton	781,868	Wentworth	514,960
Hastings	696,858	Renfrew	508,869
Dufferin	503,297		

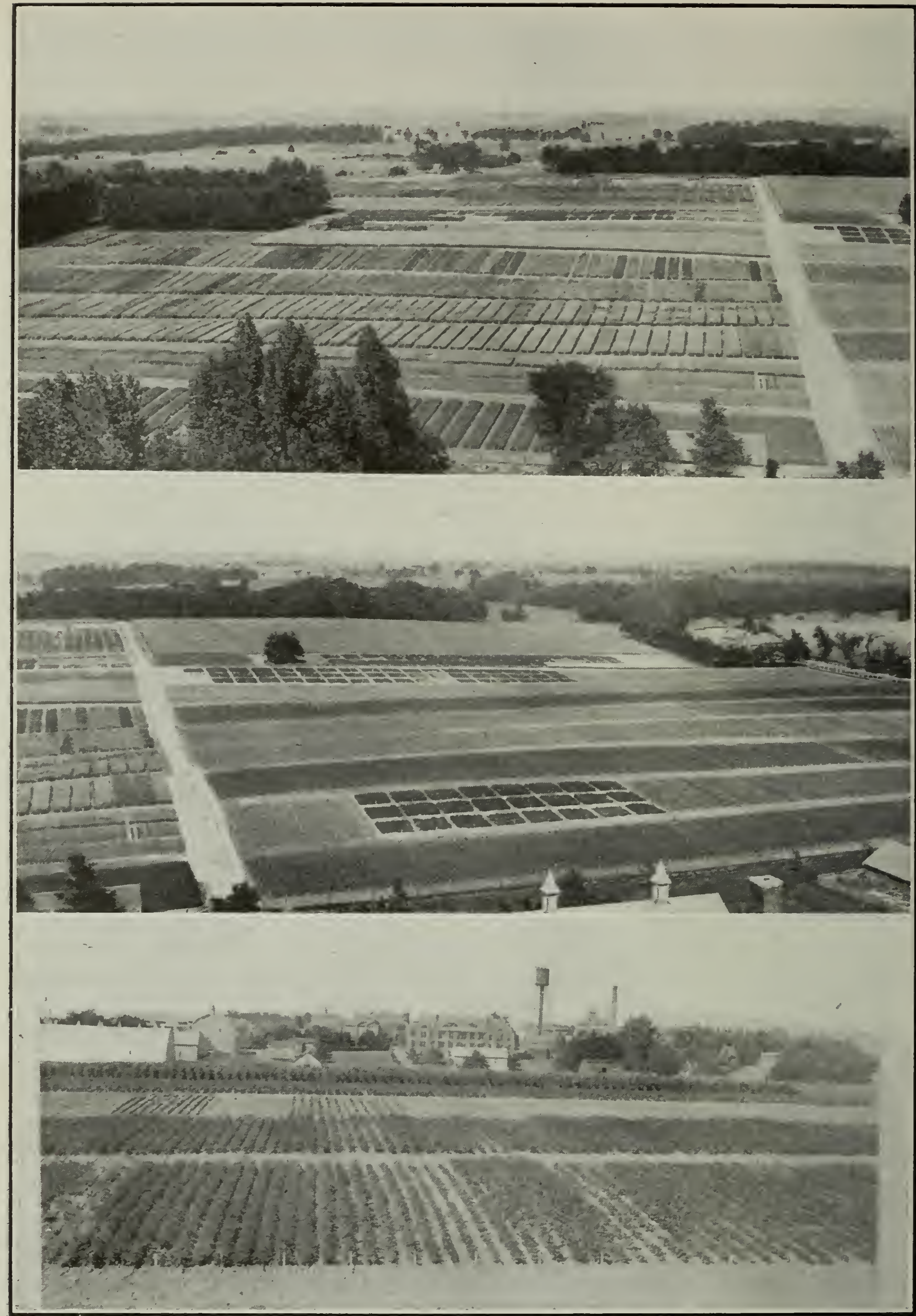
Within the five-year period upwards of one million bushels were produced in three separate years by Simcoe County, and in one year by each of the Counties of Middlesex, York, Grey and Carleton. Those counties of the Province which produced the largest quantities of potatoes represent the western, central and eastern portions of Old Ontario. Many parts of New Ontario, also, are well suited to potato growing but the production is still small in comparison with that of some of the older counties.

According to the census of the Dominion of Canada those townships which were highest in potato production were in the following order: in 1891, Erin, Wellington County; Gloucester, Russell and Osgoode, Russell County; Garafraxa, Wellington County; and Nepean, Carleton County; and in 1911, Gloucester, Russell County; Caradoc, Middlesex County; Vaughan, York County; Caledon, Peel County; Mono, Dufferin County; Erin, Wellington County; and Osgoode, Russell County. Unfortunately, the crop production was not taken by townships in the census of 1901, and consequently, the results for that year cannot be presented.

VALUE OF EXPERIMENTS.

For accurate, specific information of comparative methods of potato growing the growers must depend largely on the experiments and the investigations of the Agricultural Colleges and the Experiment Stations. These institutions are in a position to do work which it would be practically impossible for private farmers to carry out. Comprehensive, systematic experiments in the field and in the laboratory are necessarily expensive and are beyond the means of the individual farmers. In many instances, however, the growers can work in a definite and a systematic way with the Experiment Stations in conducting co-operative tests on individual farms. Such a scheme can be made to furnish important results not only for the experimenters themselves but also for the farmers generally. One of the encouraging features of our day is the knowledge that men are introducing system into their schemes for improvement, and have found that by careful experimenting, in accordance with an orderly plan they can make much more rapid progress, and avoid many disheartening failures.

At the Ontario Agricultural College about forty distinct experiments with potatoes have been conducted in field plots. Each of these experiments has extended over a period varying from five to twenty-six years. As supplementary to the work at the College an average of about 1,600 farmers have conducted annually on their own farms co-operative tests with potatoes. The material and the instructions for this co-operative work have been sent from the College, through the medium of the Ontario Agricultural and Experimental Union. A large number of the farmers of the Province have become very enthusiastic over the co-opera-



Sectional views showing about one-half of the Experimental grounds at the Ontario Agricultural College.

tive experimental work which they have continued from year to year. This experience and this enthusiasm have enabled many to conduct the work with commendable accuracy, and with marked success and to the decided advantage of both themselves and others.

The experimental grounds at the Ontario Agricultural College consist of about seventy-five acres, and are under the control of the Department of Field Husbandry. The grounds are divided into fully two thousand plots, on which experiments are being conducted annually with varieties of potatoes and other farm crops; with artificial, green and barnyard manures; with methods of cultivation, selections of seed and dates of seeding; with treatments for insects and diseases detrimental to the potato; etc.

The plots vary in size according to the requirements of the different experiments, and the yields per acre are determined from the actual yields of the plots in all cases. In the potato tests the general plan is to plant in rows three and one-third links (26⅖ inches) apart with the sets twelve inches apart in the rows. The same distance is allowed between two plots as between two rows of the same plot. In some cases check rows of potatoes are grown between the plots. It will, therefore, be seen that there are no paths left between the plots of potatoes. In most cases a plot consists of three rows each four rods long. Generally the experiments are conducted in two or three places each season. All of the experiments are conducted with the greatest of care and for several years in succession in order to secure results of the highest possible value. An immense amount of thought and care is required in planning, supervising, and examining these plots, and in studying, comparing and summarizing the results for publication.

SOILS.

A portion of the experimental grounds at the College has a gentle slope towards the south, another portion towards the north, and a part of the land is comparatively level. The most of the soil is what might be termed an average clay loam. The bottom lands are tile drained and contain rather more vegetable matter than the higher portions which have a natural drainage. The potato experiments have been rotated over the different sections of the grounds from year to year. Great care has been taken to secure uniformity of soil for all the plots used for each experiment in any season. The grounds are considered to be exceptionally well adapted to experimental work for Ontario.

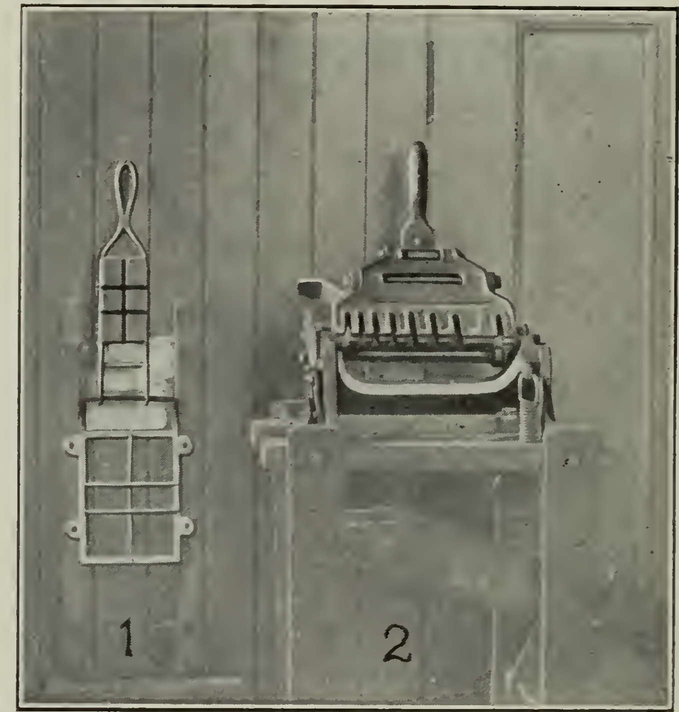
Potatoes can be grown satisfactorily on almost any fertile and friable soil which is either naturally or artificially well underdrained. Good soils, whether loams, sandy loams, or friable clay loams might be mentioned as particularly well suited for the potato crop. Sandy loams are especially favorable for the production of potatoes for early use. On light sands, heavy clays, and black muck soils the growing of potatoes is usually more difficult, although good results are sometimes obtained from even these soils. The most of the soils of Ontario are very well adapted to potato production providing they are properly underdrained either naturally or artificially. Some sections are particularly well suited to potato growing on a large commercial basis.

ROTATIONS.

The usual four years' rotation in the experimental grounds at the College is as follows: potatoes, grain, pasture and grain. Of the land under rotation the grain plots require one-half, the cultivated crops one-quarter, and the pasture one-quarter each year. The four years' rotation in the Farm Department at the College is potatoes, grain, and two years of clover and grass. A favorite three years' rotation in some sections of the country is potatoes, grain and clover.

A large number of Ontario farmers were written to from the College and asked the following question: "After what crops do you prefer to plant potatoes?" Three hundred and seventy-five answers were received. The crops selected were in the following order: clover, grass, oats, peas, other grains and corn. Clover and alfalfa sods form an excellent preparation for potatoes.

The wise man gives proper attention to the rotation of crops for his farm. The kind of farming, character of soil, proximity to market, amount of labor available, and many other features need to be considered in planning a rotation for the best results. As far as practicable it is a good plan to have each crop in the rotation a helpful preparation for the crop which is to follow. A rotation embodying a cleaning crop, a nurse crop, and a leguminous or fertilizing crop contains features of much importance. Potatoes form one of the best cleaning crops which



Machines for Cutting Potatoes for Planting.
(1) Small machine; (2) Large machine.

can be used in a rotation. The thorough cultivation of the potatoes leaves the land in an excellent condition for the crop which is to follow.

CULTIVATION OF SOIL, AND CUTTING AND PLANTING POTATOES.

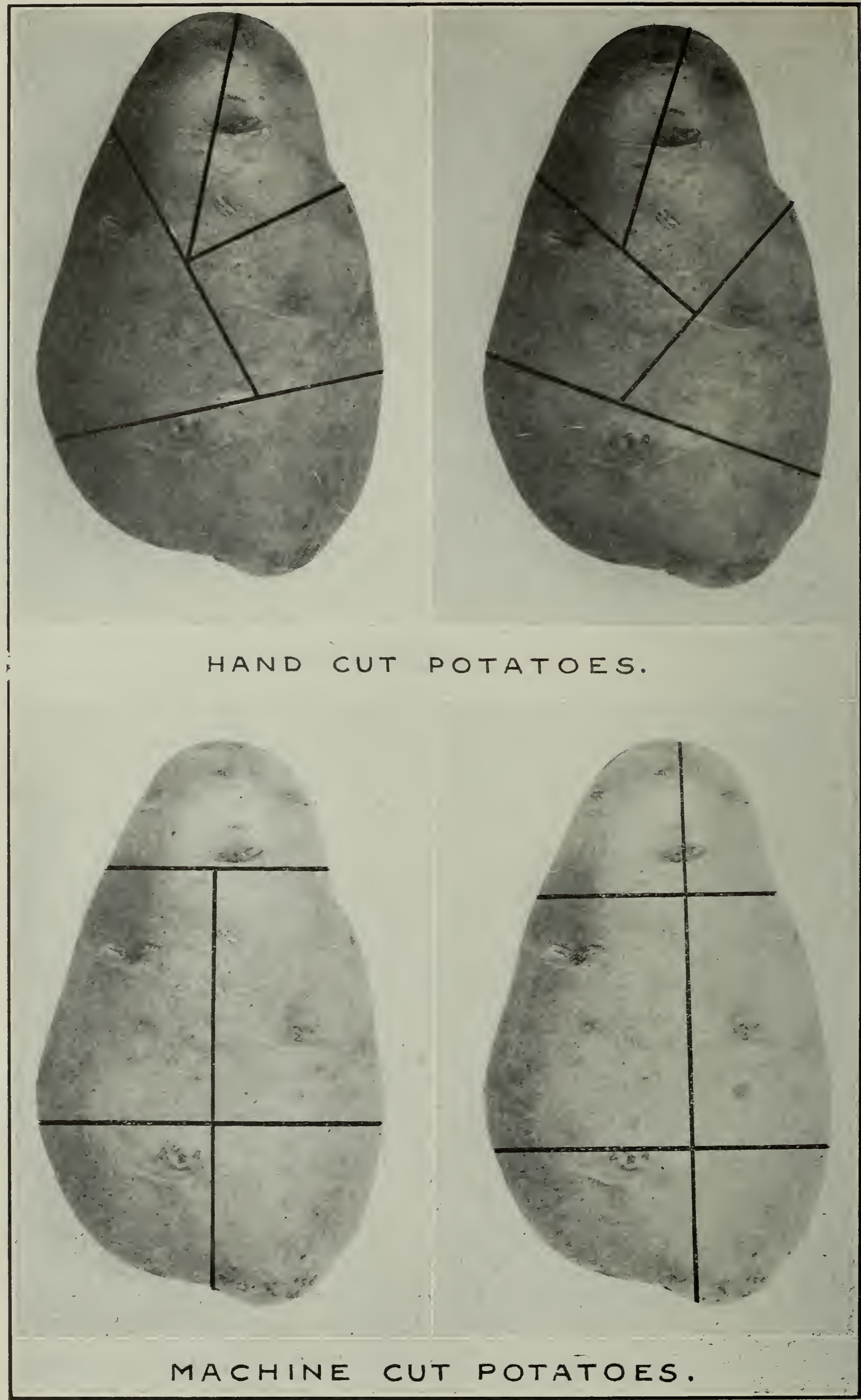
Many of the questions regarding the cultivation of the soil, the preparation of the seed and the planting of the potatoes will be answered through the results of the experiments which are discussed in this bulletin. It seems necessary, however, to make a few additional notes under the foregoing heading.

Preparation of Soil.—Potatoes do exceptionally well after sod, and especially after clover sod. If fresh stable manure is to be used it is a good plan to plow the land deeply in the early part of the autumn, and at a later date to cultivate the soil and give it a dressing of manure, after which it can be put into ridges about thirty inches wide with a double mould-board plow. This protects the manure and the mellow soil in the ridges and enables the air and the frost to come into direct contact with the subsoil in the furrows. It is the practice of some potato growers to place the manure on the sod in the summer, autumn, winter or spring and to plow the sod with its top dressing of manure before planting time. If potatoes follow corn or roots the fresh manure is often used to advantage with the latter instead of the former. When potatoes come after a grain crop the stubble land is frequently worked on the surface as soon as possible after harvest in order to conserve soil moisture and to induce the weed seeds to germinate. With this preparation the land is in excellent condition to be plowed to a good depth in the autumn even though the weather is comparatively dry. If manure is applied to the land in the spring for the potato crop it should be well rotted and mixed throughout the soil instead of being placed with the seed potatoes in the rows as the manure has the tendency of increasing the scab. The cultivation of the soil for potatoes should be deep and thorough. There are but few crops which respond more readily than potatoes to the careful preparation of the seed bed.

Cutting Seed.—Potato sets should be made compact in form and as even in weight as possible. It is a good practice to take the first set from the stem end, to cut slantingly across the potato, and finally to divide the seed end. The number of sets which a single tuber will furnish depends upon the size of the potato as well as upon the size of the individual sets which are to be made. The number of eyes in each piece has some influence but the comparative size of the sets has a greater influence on crop production. For uniformity in results the potato sets should be nearly equal in weight and should contain about the same number of eyes in the different pieces. Potatoes are usually cut by hand, but there are a number of potato-cutting machines on the market of different styles, sizes and prices.

The following table gives the results of cutting three hundred sets of each of two varieties of potatoes, one hundred with each of two machines, and one hundred by hand:

Number of Eyes per Set.	Potato Sets with Different Number of Eyes.					
	Dooley Variety.			Empire State Variety.		
	Small Machine.	Large Machine.	Hand Cutting.	Small Machine.	Large Machine.	Hand Cutting.
0	12	25	..	..	8	..
½	5	5	..	..	8	..
1	28	31	34	18	25	..
1½	12	6	3	8	13	..
2	13	8	29	13	16	33
2½	8	8	8	10	10	7
3	5	4	21	14	7	23
3½	1	3	1	11	4	2
4	4	2	3	6	..	10
4½	1	1	1	3	1	10
5	6	4	..	9	..	7
5½	1	..	..	..	..	3
6	1	1	..	3	4	2
6½	1	1	..	1	..	..
7	1	..	..	1	..	1
7½	..	..	..	..	1	2
8	..	1	..	2	3	..
9	1	..	..	1	..	..
Total Number	100	100	100	100	100	100
Weight of Sets in Ounces. 10 Largest	18.7	14.0	10.1	20.6	12.3	10.5
10 Smallest	2.2	3.0	6.3	2.6	1.3	5.4
1 Largest	2.1	1.8	1.8	2.8	1.4	1.3
1 Smallest	.2	.2	.6	.2	.1	.5



White Elephant variety of potatoes cut in different ways.

The results here presented show that in uniformity in the weights of the sets and in the number of eyes per set the hand cutting gave much better results than the machine work. In three out of the four tests from eight to twenty-five per cent. of the sets cut with the machines contained no eyes whatever. It is good economy to take great pains in preparing seed potatoes for planting. The reader is requested to carefully study the results of experiments along this line as presented in this bulletin.

Planting and Cultivation.—Potatoes should be planted with regularity whether the tubers are dropped by hand or by machinery. If the patches are small it is usual to make the furrows with a single or a double mould-board plow, to drop the potatoes by hand and to cover the seed by splitting the ridges with a plow having either a single or a double mould-board. In the experimental work at our College the double mould-board plow is used extensively. When potatoes are grown in large areas machinery is generally used for planting the crop. There are various makes of these machines now sold by manufacturers. The potato planter opens the furrow, drops the sets, covers the seed, and if desirable applies the commercial fertilizer in the one operation. A machine of the Picker type can be operated by one man. Some growers object to this style of machine as it punctures the potatoes and sometimes causes blanks by missing the sets. The platform type of machine is operated by two men, and a full planting can be obtained if the man who fills the sections in the feeding platform is thorough in his work. A good potato planter gives highly satisfactory results.

Soon after planting the field should be lightly harrowed to smooth the surface, to check the germinating weed seeds, and to conserve soil moisture. This process can be repeated just as the young plants are appearing through the ground. As soon as the plants are up the soil between the rows should be cultivated deeply. Other cultivations should follow every week or ten days according to weather conditions, should become more shallow as the season advances, and should be continued until the tops come together between the rows. Thorough cultivation mellows the soil, conserves the moisture, kills the weeds, and greatly assists in the production of large yields of well formed tubers.

CHANGE OF SEED.

The frequent and the indiscriminate change of seed potatoes from one farm to another has been practised by a large number of people in past years. Any reliable information on the perplexed question of the change of seed should be welcome. If it is necessary to change seed potatoes every few years in order to maintain vigor and vitality the work of trying to improve potatoes by hill selection or from seedlings would be discouraging whether conducted at an experiment station or on the individual farms.

Home-grown Seed Potatoes.—At the Ontario Agricultural College five varieties of potatoes have been grown for twenty-six years in succession without any introduction of tubers from an outside source. Care has been taken each year to select from the crop produced good seed potatoes for planting in the experimental grounds in the following spring. No hill selection has taken place in any year in connection with this experiment. The fertility of the soil has probably remained about uniform as in the four years' rotation in which the potatoes were grown, three farm crops were removed from the land, barnyard manure was used once, and no commercial fertilizers were applied.

The results of the experiments are both interesting and suggestive. Starting with 1890, the first year of the experiment, the average yields per acre per annum for the five varieties for the five-year periods were as follows:

1890–1894	133.0	bushels.
1895–1899	212.0	"
1900–1904	237.2	"
1905–1909	208.7	"
1910–1914	211.1	"

The average yield for the whole period of twenty-five years was 200.4 and for the last five years 211.1 bushels per acre. The average yields for the second, fourth and fifth periods were comparatively close, the yield for the first period was low, and that for the third was high. In the first period three out of the five seasons were somewhat unfavorable for potato production, and in the third period only in one year was the yield below normal. The average annual yield per acre for the last period was 23 bushels greater than the average of the other four periods. According to the reports of the Ontario Bureau of Industries the average yield of potatoes for the Province for the five-year period, from 1910 to 1914, inclusive, was 125.6 bushels or an annual yield per acre of 85.5 bushels less than that produced from the five varieties grown at the College for the same period, and after having been grown for twenty years previously on the same farm without change of seed. The ten highest average annual yields were produced after the first five-year period of the experiment. The average results of the five varieties show a higher annual yield per acre for the latter as compared with the former thirteen years of the experiment. It is interesting to note that the average yield per acre of the five varieties in 1915 was exactly thirty bushels per acre greater than that of 1890. This increase was made in spite of the fact that the year 1915 was an exceptionally severe one for potato growing in Ontario.

In each of three different years previous to 1900 the five varieties of potatoes were carefully tested for table quality, including mealiness, flavor and appearance. On scoring the table quality of the same varieties and in the same way in the years 1913 and 1914 it was found that the average quality was practically the same, being slightly in favor of the potatoes produced in the later years.

These results show that potatoes have been grown on average clay loam on the one farm for at least twenty-six years without any perceptible decrease in either productiveness or table quality. In fact the tendency seems to have been towards a slight increase rather than towards a decrease in both yield and quality.

Sources of Seed Potatoes.—In each of four years an experiment has been conducted at the College in testing under uniform conditions potatoes obtained from different sources. For instance, eighteen lots of Empire State potatoes were secured from eight different sources, five being in the Province of New Brunswick, and three in Ontario. Seed potatoes grown about one hundred and forty miles north of Guelph in Muskoka district, near the Muskoka Lakes, have given a higher yield per acre than those obtained from any other source in each of the four years of this experiment. Somewhat similar results to those obtained at Guelph have been secured by other experimenters. Seed potatoes grown in Scotland gave excellent results in the experiments conducted on the Experimental Farm of Cambridge University in England. W. T. Macoun of the Central Experimental Farm at Ottawa, has obtained high records from seed potatoes produced at Indian Head, Sask. It is a common practice of some of the potato growers of the warmer climates to purchase their seed potatoes occasionally from a northern district possessing a cooler climate. Some light may be thrown on this subject by the results which are presented under the heading which follows.

Immature Seed Potatoes.—An experiment has been conducted at the College in each of four years in testing the value of immature potatoes for seed purposes. Six varieties of potatoes comprising two each of the early, the medium and the late kinds were planted at intervals of two weeks, from May 31st until July 12th, and tubers of each variety were obtained from each of the four crops and all were planted about the first of June in the following year. The average of the **four years'** results in bushels per acre per annum from seed potatoes obtained from each of four dates of planting two early, two medium, and two late varieties are as follows:

RESULTS FROM PLANTING MATURE AND IMMATURE SEED POTATOES.

Seed Potatoes obtained from the crops produced from the plantings of the following dates of previous year	Average Percentage Maturity, Sept. 11th.	Early 2 Varieties (8 tests).	Medium 2 Varieties (8 tests).	Late 2 Varieties (8 tests).	Average 6 Varieties (24 tests)
May 31st	57	192.01	191.67	193.44	**192.37**
June 14th	56	201.36	185.94	197.09	**194.80**
June 28th............	55	211.39	184.33	209.80	**201.84**
July 12th............	53	221.36	209.20	227.82	**219.46**

Potatoes produced from immature seed were slightly later in maturing than those produced from seed which was ripe.

Immature potatoes have a special value for seed purposes according to the results of the experiments which we have conducted. The superior value of northern grown potatoes is probably due to the fact that they are produced in a cool, short season and are harvested at an early date and before they are fully matured. The special value of seed potatoes grown at a high elevation could probably be explained in the same way. Somewhat similar results might be obtained in a warmer climate by using the second crop or immature potatoes for seed or by growing the seed potatoes on heavy damp land, in the shade of trees or under a mulch of from four to six inches of straw or of coarse manure. The results* of experiments conducted in Nebraska have shown that seed potatoes grown under a mulch have compared favorably with seed potatoes obtained from a more northerly district. It should be remembered that a potato is an underground stem and not a seed. The study of immature potatoes for crop production has an important bearing on potato growing and particularly so in the warmer climates.

Small potatoes can be divided into the following three classes: (1) the best tubers from choice seed planted late; (2) the late-formed tubers from strong, robust plants; and (3) the tubers produced from weak, inferior plants. The tubers from either class one or class two would be likely to produce good yields and those from class three unsatisfactory results. In using small seed tubers taken from potatoes of the general crop there is danger of securing those belonging to the third class.

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*Mulched potatoes for seed purposes in Eastern Nebraska. Bulletin No. 146, University of Nebraska, 1915.

VARIETIES, AND VARIETY TESTS.

There are far too many varieties of potatoes grown on the farms of Ontario. This is one of the greatest weaknesses in the potato industry of the Province. It is a defect which should be remedied as soon as possible. If Ontario would confine herself to a few of the best varieties of potatoes the annual crop would be increased in yield, in quality, and in commercial value. Owing to the comparative ease with which new varieties are originated from potato seed the number of named sorts has become very large. Seed agents, seedsmen, and growers are constantly introducing new kinds before their relative worth for the Province has been properly determined by comparative experiments. Many of the new kinds are introduced by advertising literature and by travelling salesmen repre-

Potatoes of the Empire State variety

senting American seed firms. Agents go from house to house and sell small quantities of potatoes at high prices. These are usually grown locally to a limited extent. There is scarcely a locality that does not grow several varieties which makes it very difficult to furnish car lots of uniform potatoes.

In 1914, thirty-five Agricultural Societies, in eighteen counties and districts of Ontario, used potatoes for the Field Crop Competitions. The number of fields of potatoes entered in the separate Societies varied from ten to twenty-five. There were in all four hundred and fifty-four (454) entries, or an average of thirteen for each Society. No restriction was placed on the number of varieties entered. The reports show that there were over one hundred named varieties of potatoes entered in the Field Crop Competitions in the one season. Of this number sixty-eight varieties received prizes, fifty-two varieties were entered only once, nine varieties ten or more times, and three varieties over thirty times. The number of varieties in the separate competitions varied from three to thirteen. The societies which had less than five varieties in the competition were Caradoc and Strathroy, Middlesex County, each 3; Rainy River Valley, Rainy River district, 3; Verner, Nipissing district, 3; Trafalgar, Halton County, 4; and Rocklyn, Grey County, 4. Those societies which entered the greatest number of varieties were Oliver, Thunder Bay district, 13; South Muskoka, Muskoka district, 11, Stephenson and Watt, Muskoka district, 11; Parry Sound, Parry Sound district, 10, and Armour, Ryerson and Burk's Falls, Parry Sound district, 10.

Potatoes of the Davies' Warrior variety. This lot of potatoes took the Championship Prize in a competition of all the different lots of potatoes shown in the regular classes at the Provincial Winter Fair held in Guelph in December, 1915.

Potatoes of the Early Rose variety.

These facts show the real necessity of testing a large number of the different varieties of potatoes under uniform conditions in order to compare the relative merits of the various kinds. This has been done with great care at the Ontario

Agricultural College. The results are of high value as a general guide and should result in the elimination of many of the varieties now grown in Ontario.

Over four hundred named varieties of potatoes have been under experiment at the College. Nearly all of these have been grown for at least five, and some for fifteen, twenty, or even twenty-six years. After five years' trial the poorer varieties are dropped and the better ones are continued in the experiment. New varieties are added from year to year. In the variety tests good seed potatoes are used for planting each year, but there is no hill selection. A four years' rotation consisting of potatoes, grain, pasture and grain is used. The land for the potatoes is plowed in the autumn. No commercial fertilizers are applied in the variety tests but the land is given a dressing of twenty tons (about twelve loads) of farmyard manure per acre each four years. When practicable the manure is spread on the plowed land in the autumn and the soil is placed into thirty-inch ridges with a double mould-board plow. The land is cultivated in the spring and the manure thoroughly mixed with the soil, and the varieties of potatoes are planted the latter part of May in rows three and one-third links (26⅖ inches) apart. Fifteen pounds of each variety of potatoes are cut into one hundred and ninety-eight (198) pieces which are planted one foot apart in three rows each four rods long. After planting is done the surface soil is kept stirred with a harrow or a weeder until the potatoes are nicely up. A scuffler is used between the rows and level cultivation is followed. Paris green or commercial lead arsenate and Bordeaux mixture are used for spraying the vines three or four times each year. Careful notes are kept of the varieties when growing and when ripening. The potatoes after being harvested are sorted, weighed and carefully examined.

The table quality of the varieties under test is determined in the autumn, the winter, or in the early spring, and usually every second year. This feature of the work has received the special attention we believe its importance demands. For information regarding the method adopted in determining the table quality of the varieties of potatoes the reader is referred to the special section of this bulletin under the title "Table Quality of Potatoes."

Both the yields of the total crop and of the marketable potatoes are determined each season. Those are classed as marketable which are at least one and one-half inches in diameter as determined by a machine for sorting potatoes.

The table here presented gives the average results for **five successive years** of each of one hundred and sixty-four varieties of potatoes grown in the experimental grounds at the College.

CHARACTERISTICS, YIELDS AND TABLE QUALITIES OF 164 VARIETIES OF POTATOES GROWN FOR FIVE YEARS IN SUCCESSION.

Varieties.	Maturity.	Color.	Table Quality (Average 2 Years.)				Bushels per Acre. (Aver'ge 5 yrs.) Bushel, 60 lbs.	
			Mealiness 40 points.	Flavor 40 points.	Appearance 20 points.	Total 100 points.	Marketable.	Total.
1. Empire State	Late	White	34.0	33.5	15.5	83.0	201.7	**224.2**
2. Rose's New Invincible	Late	Dull white	30.5	25.5	14.0	70.0	196.2	**219.2**
3. American Wonder	Late	White	33.0	29.5	14.5	77.0	190.3	**217.4**
4. Rural New Yorker No. 2	Late	White	29.5	28.0	15.0	72.5	200.4	**216.6**
5. Pearl of Savoy	Late	Dull white	34.5	31.0	15.5	81.0	189.1	**214.1**
6. Morning Star	Late	White	31.0	31.4	14.5	76.5	181.9	**213.8**
7. Governor Foraker	Late	White	32.0	30.0	15.0	77.0	154.0	**211.3**
8. Silver King	Medium	White	29.5	30.0	15.0	74.5	167.3	**210.7**
9. Early Rose	Medium	Rose	33.0	30.0	14.0	77.0	179.5	**209.6**
10. Green Mountain	Late	White	27.0	27.0	15.5	69.5	189.6	**208.9**
11. Irish Daisy	Late	White	29.5	31.0	14.5	75.0	165.6	**208.7**
12. Dempsey's Seedling	Late	Dull white	35.0	33.5	16.5	85.0	171.3	**208.3**
13. White Elephant	Late	White and rose	32.0	30.0	14.5	76.5	184.1	**208.3**
14. Early May Flower	Medium	White	30.0	28.5	14.5	73.0	171.6	**207.3**
15. Dakota Red	Late	Red	26.0	27.5	14.5	68.0	184.8	**205.8**
16. Late Rose	Medium	Rose	31.5	33.5	14.5	79.5	165.7	**205.6**
17. Alexander's Prolific	Late	White	29.0	28.0	15.5	72.5	183.7	**205.1**
18. Woodbury White	Late	White	31.5	30.0	14.0	75.5	175.1	**205.1**
19. Burnaby Mammoth	Late	White and rose	33.5	31.0	15.5	80.0	170.3	**204.0**
20. Burpee's Superior	Late	White	30.5	29.0	14.0	73.5	172.2	**204.0**
21. Columbus	Late	White and rose	32.0	27.5	15.5	75.0	176.5	**203.6**
22. Sweet St. Vernal	Late	White	30.0	28.5	15.0	73.5	169.2	**203.3**
23. Island McDonald	Medium	White	26.0	27.0	14.0	67.0	166.0	**202.7**
24. Great Divide	Late	White	32.0	31.5	15.5	79.0	152.7	**202.3**
25. Wilson's First Choice	Late	White	29.5	29.0	15.5	74.4	170.5	**202.2**
26. The Ideal	Early	White and rose	28.5	28.5	13.5	70.5	160.6	**201.7**
27. Farmers' Alliance	Medium	Dull white	31.0	31.0	14.5	76.5	158.5	**201.6**
28. Bill Nye	Late	White	31.0	26.0	15.5	72.5	167.8	**201.2**
29. State of Maine	Late	White	29.0	27.5	14.0	70.5	182.4	**200.5**
30. New Queen	Very late	Nearly white	33.0	31.0	15.5	79.5	174.9	**200.3**
31. The Daisy	Medium	White and rose	34.0	34.0	15.0	83.0	167.3	**200.3**
32. Thunderbolt	Medium	White	29.0	26.5	15.5	71.0	179.7	**200.3**
33. Halo of Dakota	Medium	Nearly white	32.0	32.0	15.0	79.0	160.0	**200.0**
34. Hotel Favorite	Medium	White	30.5	35.5	16.0	82.0	164.5	**199.9**
35. St. Patrick	Medium	White	32.5	30.5	14.5	77.0	166.7	**199.5**
36. Troy Seedling	Very late	White	27.0	25.0	13.0	65.0	149.0	**198.8**
37. Early Oxford	Medium	Rose	31.5	28.5	14.0	74.0	159.7	**198.4**
38. Pride of the West	Late	White and rose	28.5	27.0	14.5	70.0	165.1	**197.9**
39. Delaware	Late	White	29.0	28.5	15.0	72.5	178.0	**197.7**
40. Watson's Seedling	Medium	Rose	31.5	29.5	13.0	74.0	160.6	**197.4**
41. Garnets	Medium	Rose	31.0	30.0	14.5	75.5	160.3	**197.2**
42. Rural Blush	Very late	Rose	32.5	34.5	14.5	81.5	170.7	**197.1**
43. Badger State	Medium	White	24.5	29.5	15.0	69.0	165.3	**196.6**
44. Early Yorker	Late	Dull white	34.0	33.0	15.5	82.5	167.8	**196.2**
45. Early Harvest	Early	White	30.5	32.5	13.5	76.5	145.6	**196.1**
46. Burbank's Seedling	Medium	White	30.0	34.0	17.5	81.5	164.0	**195.6**
47. Fillbasket	Late	Dull white	32.0	29.5	15.0	76.5	165.8	**195.5**
48. June Eating	Late	White	31.5	29.0	14.0	74.5	170.7	**195.3**
49. Crown Jewel	Early	White	31.0	30.5	14.5	76.0	156.2	**194.9**
50. Clark's Nonsuch	Medium	Dull white	31.5	31.0	14.5	77.0	170.0	**194.4**
51. Bruce's White Beauty	Medium	White	31.0	31.5	14.5	77.0	157.1	**193.7**
52. Adirondack	Late	White	30.5	31.0	15.0	76.5	174.9	**193.3**
53. Ohio Junior	Early	Rose	26.5	28.0	13.5	68.0	177.3	**192.6**
54. Scotch Regent	Late	White	29.5	25.5	13.5	68.5	158.0	**192.6**
55. Rochester Rose	Late	Rose	27.5	27.0	13.5	68.0	156.1	**192.0**
56. Advance	Medium	White and rose	29.5	28.5	12.5	70.5	154.3	**191.7**

CHARACTERISTICS, YIELDS, TABLE QUALITIES, ETC.—*Continued.*

Varieties.	Maturity.	Color.	Table Quality (Average 2 Years.) Mealiness 40 points.	Flavor 40 points.	Appearance 20 points.	Total 100 points.	Bushels per Acre. (Aver'ge 5 yrs.) Bushel, 60 lbs. Marketable.	Total.
57. Summit	Medium	Rose	29.0	29.0	13.5	71.5	157.6	**191.4**
58. The Dandy	Medium	White	30.5	29.0	14.5	74.0	149.4	**190.4**
59. Montana Wonder	Late	White	30.0	27.5	15.5	73.0	153.0	**190.3**
60. Vick's Perfection	Early	White	30.5	28.0	14.0	72.5	150.9	**189.8**
61. Manitoba Rose	Late	Rose	28.0	27.5	14.5	70.0	163.1	**189.2**
62. Hoffman	Medium	Rose	32.5	30.5	14.0	77.0	151.5	**188.8**
63. Early Puritan	Medium	White	30.5	32.5	14.5	77.5	161.8	**188.7**
64. Red Australian	Medium	Rose	26.5	28.5	14.5	69.5	158.0	**188.6**
65. Extra Early Vermont	Medium	Rose	33.5	32.5	15.0	81.0	142.1	**188.5**
66. Munroe Co. Prize	Medium	White	28.0	27.0	14.5	69.5	154.2	**188.5**
67. Halton's Seedling	Early	Rose	29.5	28.5	13.5	71.5	150.0	**188.3**
68. Timpe's No. 4	Late	White	27.5	29.5	15.0	72.0	154.8	**188.0**
69. Hartzell's Seedling	Late	White	30.5	29.5	15.0	75.0	165.3	**187.6**
70. Everitt's Seedling	Medium	Rose	30.0	29.0	14.0	73.0	146.9	**187.3**
71. Tonhocks	Early	Dull white	31.0	29.0	15.0	75.0	154.3	**187.3**
72. Early Everitt	Medium	Rose	30.0	29.0	14.0	73.0	154.6	**186.8**
73. Granger	Medium	White	27.5	28.0	14.0	69.5	153.8	**186.6**
74. Russel's Seedling	Late	Dull white	29.0	27.5	14.0	70.5	160.0	**186.3**
75. Burpee's Extra Early	Early	White and rose	31.5	29.5	14.5	75.5	141.7	**185.9**
76. Kaiser	Late	White	23.5	26.0	13.5	63.0	169.9	**185.8**
77. Restaurant	Late	Dull white	26.5	25.0	14.5	66.0	160.3	**185.5**
78. White Lily	Late	White	30.0	28.0	15.0	73.0	155.9	**185.3**
79. Reed's Eighty-Six	Medium	Rose	31.0	30.5	13.5	75.0	140.9	**185.2**
80. Snowdrop	Late	Dull white	32.0	32.0	15.0	79.0	151.5	**184.8**
81. Grand Mogul	Very late	White	25.0	26.5	14.0	65.5	163.5	**184.7**
82. May's Imperial	Early	Dull white	31.0	27.0	13.5	71.5	159.8	**184.7**
83. Nebula	Medium	Rose	31.5	28.5	14.0	74.0	133.9	**184.7**
84. Molly Stark	Medium	Dull white	35.0	32.5	14.5	82.0	153.8	**184.2**
85. Paris Rose	Early	Rose	31.0	29.5	14.0	78.5	136.1	**183.3**
86. Polaris	Early	Dull white	31.5	31.0	14.0	76.5	148.3	**183.3**
87. Vick's Champion	Medium	White	26.0	26.5	14.0	66.5	161.0	**183.3**
88. Thorburn's Extra Early	Early	Rose	34.5	32.5	14.5	81.5	138.7	**181.8**
89. Arizona	Medium	Rose	30.0	26.0	13.0	69.0	147.9	**181.3**
90. Hopeful	Medium	White	31.5	30.5	16.5	78.5	161.4	**180.8**
91. Early Pride	Early	Rose	30.5	30.5	14.5	75.5	123.8	**180.8**
92. Mount Carbon	Medium	White	26.5	26.0	14.5	67.0	159.3	**180.8**
93. The Freeman	Medium	White	30.5	31.0	15.5	77.0	125.7	**179.0**
94. King of the Roses	Early	Rose	28.5	29.0	13.5	71.0	142.1	**178.9**
95. Snow Queen	Medium	White	29.0	28.0	14.5	71.5	139.7	**178.9**
96. Early Sunrise	Early	White and rose	32.5	30.5	14.5	77.5	142.1	**178.8**
97. Rosy Morn	Early	Rose	33.0	32.0	14.5	79.5	152.6	**178.2**
98. Early Maine	Medium	Rose	31.5	30.0	14.0	75.5	139.2	**178.1**
99. Steele's Earliest	Early	Nearly white	30.0	29.0	13.0	72.0	123.7	**178.1**
100. Pootaluck	Medium	Rose	29.5	30.5	12.5	72.5	138.6	**178.0**
101. Early White Prize	Early	Dull white	32.5	30.5	15.0	78.0	134.0	**177.8**
102. Putnam	Late	White	25.5	22.0	13.0	60.5	148.3	**177.8**
103. Great West	Late	White	30.0	29.0	15.5	74.5	153.7	**177.2**
104. Mammoth Pearl	Late	White	27.0	26.0	14.0	67.0	157.3	**176.8**
105. Sunlit Star	Early	Rose	32.5	31.5	16.0	80.0	144.8	**176.8**
106. Stray Beauty	Very early	Red	19.5	19.0	13.0	51.5	147.9	**176.5**
107. Pride of the Table	Late	Rose	30.0	28.0	15.0	73.0	147.7	**176.0**
108. Early Dominion	Very early	Dull white	31.5	29.0	14.5	75.0	159.3	**175.9**
109. McIntyre	Late	Nearly white	32.0	31.5	15.0	78.5	143.8	**175.6**
110. Minister	Very late	White	28.5	27.5	15.0	71.0	158.5	**174.6**
111. Kosh Konong	Medium	White	24.0	22.0	13.0	59.5	153.7	**174.3**
112. Vaughan	Early	White and rose	32.5	30.5	15.0	78.0	137.0	**174.2**
113. Parson's Prolific	Late	White	26.5	27.0	15.0	68.5	152.3	**174.2**
114. General Gordon	Late	Rose	28.5	29.5	16.0	74.0	151.0	**174.1**

CHARACTERISTICS, YIELDS, TABLE QUALITIES, ETC.—*Continued.*

Varieties.	Maturity.	Color.	Table Quality (Average 2 Years.) Mealiness 40 points.	Flavor 40 points.	Appearance 20 points.	Total 100 points.	Bushels per Acre. (Aver'ge 5 yrs.) Bushel, 60 lbs. Marketable.	Total.
115. Van Orman's Earliest	Early	White	26.0	23.5	15.0	64.5	137.1	**173.8**
116. Golden Harvest	Medium	Rose	32.0	29.5	15.0	76.5	127.3	**172.6**
117. Early Pontiac	Early	White	28.5	28.0	13.0	69.5	128.4	**172.5**
118. Clay Rose	Late	Rose	28.5	29.0	15.0	67.5	140.5	**171.4**
119. Pride of the Market	Late	White	28.5	28.5	15.0	72.0	139.7	**171.1**
120. Boley's Northern Spy	Early	Rose	30.5	28.5	14.0	73.0	155.4	**170.8**
121. Chas. Downing	Very early	White	30.0	32.0	15.0	77.0	101.4	**168.6**
122. Improved Rose	Late	Rose	34.0	31.5	15.0	80.5	139.0	**168.3**
123. Salzer's Prize Taker	Medium	Rose	29.0	28.0	13.5	70.5	131.6	**168.1**
124. Ontario	Late	Dull white	30.0	29.5	14.5	74.0	137.4	**167.8**
125. Howe's Premium	Very early	White and rose	22.0	25.5	13.5	61.0	143.1	**166.3**
126. The Rosedale	Medium	Rose	31.0	30.0	15.0	76.0	130.1	**166.1**
127. Six Weeks	Very early	Rose	30.5	28.5	14.5	73.5	146.5	**165.3**
128. Chicago Market	Medium	Rose	29.5	29.0	14.5	73.0	132.5	**164.5**
129. White Star	Late	White	32.5	30.5	15.5	78.5	144.6	**164.4**
130. Early Northern	Medium	Nearly white	31.0	29.5	14.0	74.5	123.2	**164.2**
131. Rot Proof	Late	Rose	29.0	26.5	13.0	68.5	104.8	**163.7**
132. Vick's White Gem	Medium	White	30.5	30.5	14.5	75.5	118.5	**163.0**
133. Early Essex	Medium	Rose	31.0	29.5	13.5	74.0	123.8	**162.9**
134. Pride of Ireland	Medium	White	25.5	25.0	13.5	64.0	143.9	**162.5**
135. Victor Rose	Late	Rose	32.0	31.0	14.0	77.0	137.9	**162.1**
136. Beauty of Beauties	Medium	White	24.0	24.0	14.0	62.0	141.5	**161.3**
137. The People's	Late	White	23.0	22.0	13.5	58.5	141.7	**161.2**
138. Early Market	Early	White and rose	27.5	27.0	13.0	67.5	139.1	**160.9**
139. Lee's Favorite	Early	Rose	30.5	29.5	13.5	73.5	115.4	**160.8**
140. New Satisfaction	Medium	Dull white	30.5	30.5	15.5	76.5	119.6	**160.1**
141. Snowflake	Very early	White	29.5	30.5	14.5	74.5	92.3	**159.2**
142. Early Advancer	Early	Dull white	29.0	28.0	13.5	70.5	111.3	**158.0**
143. North Pole	Very early	Dull white	30.5	28.0	14.5	73.0	110.8	**157.9**
144. Harbinger	Medium	White and rose	30.0	27.5	15.5	73.0	97.3	**155.8**
145. Governor Rusk	Very late	Rose	31.0	31.0	15.0	77.0	112.8	**155.3**
146. Rose of Erin	Late	Rose	26.0	24.5	14.5	65.0	131.6	**154.6**
147. Rose Seedling	Medium	Rose	25.5	26.5	16.0	68.0	135.7	**154.0**
148. Negro	Very early	Purple	25.5	22.0	12.5	60.0	68.3	**153.5**
149. Seneca Beauty	Late	Rose	27.5	27.0	15.5	70.0	136.4	**153.3**
150. Chatauqua	Late	Rose	29.0	26.0	13.0	68.0	118.4	**152.8**
151. Landreth's Garfield	Medium	White	28.0	28.0	14.0	70.0	102.5	**152.6**
152. Vanguard	Medium	Rose	29.0	30.0	13.0	72.0	108.3	**152.1**
153. World's Fair	Medium	White	32.0	30.5	15.0	77.5	114.5	**151.4**
154. Royal Adelaide	Late	Dull White	26.5	26.0	12.0	64.5	124.9	**150.6**
155. Dreer's Standard	Late	White	30.0	30.5	14.5	75.0	116.3	**147.5**
156. Maggie Murphy	Late	Rose	32.0	33.0	15.5	80.5	125.8	**145.5**
157. Michigan Blues	Late	Purple	25.5	24.5	14.5	64.5	122.4	**141.5**
158. Lady Finger	Medium	White	29.0	37.0	11.5	77.5	42.6	**139.8**
159. Potentate	Early	White	29.5	29.5	14.5	73.5	125.8	**139.5**
160. Silver Dollar	Early	White	25.5	16.0	12.5	54.0	104.0	**138.3**
161. Browell's Seedling	Medium	Rose	27.5	26.5	15.5	69.5	104.0	**135.8**
162. Prince Albert	Medium	White and rose	27.5	30.0	14.0	71.5	100.8	**134.1**
163. Columbia Peachblow	Late	White and rose	29.0	32.0	14.5	75.5	83.3	**115.7**
164. Eyeless	Early	White and rose	27.0	33.0	13.0	73.0	43.9	**93.0**

The average annual yield of potatoes per acre for the thirty-four years, from 1882 to 1915 inclusive, has been 116 bushels in Ontario, and 85 bushels in the United States; and for the twenty-six years, from 1890 to 1915, practically 200 bushels at the Ontario Agricultural College. In each of the thirty-four years the Ontario yield was greater than the yield of the United States with the exceptions of 1902 and 1915. On the average for the whole period the yield of potatoes in Ontario was greater than that of the United States by fully 36 per cent. The highest annual average yields per acre made in Ontario were 163 bushels in 1884 and 159 bushels in 1895 and in 1914; and in the United States 113 bushels in 1912, and 110 bushels in 1904. The lowest annual average yields per acre made in Ontario were 76 bushels in 1915, and 76.1 bushels in 1887; and in the United States 56 bushels in 1890, and 57 bushels in 1887.

According to the census reports of Canada the average yield of potatoes per annum for the five years, from 1910 to 1914 inclusive, was 158 bushels for the Dominion and 129 bushels for Ontario.

A study of the reports of the Bureau of Industries for Ontario shows that usually the highest yields of potatoes in the Province are produced in the northern and north-eastern sections, and the lowest average yields in the southern portions.

The results in the United States and in Canada here referred to show that the potatoes which were grown in the north gave larger yields per acre than those which were grown farther to the south.

As the average yield of potatoes per acre in Wellington County, in which the Agricultural College is located, has been about equal to the average yield throughout Ontario for the past quarter of a century, the results of the potato experiments conducted at Guelph should form a good general guide for the Province.

The results of the one hundred and sixty-four varieties of potatoes grown in the experimental grounds for a period of five years show an average of 181 bushels per acre per annum. The ten highest yielding varieties gave an average of 215 bushels, and the ten lowest yielding varieties an average of 130 bushels per acre. The two varieties in this extensive test which gave an average yield of over 200 bushels of marketable potatoes per acre were the Empire State and the Rural New Yorker No. 2.

It will be seen that as a general rule somewhat larger yields per acre were produced from the late as compared with the early, and from the white as compared with the colored varieties. Apparently the productiveness was influenced but little owing to the shapes of the potatoes of the different varieties. A popular potato is one of about the following dimensions: Length 3½ inches, width 3 inches, and depth 1½ to 1¾ inches.

There is a decided difference in the table quality of the potatoes of various kinds. Variety is a most important factor in determining the quality of cooked potatoes. The figures given in the tabulated results regarding the table quality of the separate varieties are exceedingly interesting and worthy of careful study. It will be seen that in mealiness there is a variation of from 19.5 to 35 points, in flavor from 19 to 35.5 points, and in appearance from 11.5 to 17.5 points. In table quality the Dempsey's Seedling, the Empire State and the Daisy made the highest scores. The Stray Beauty or Bliss Triumph came comparatively low in table quality. This variety, however, is particularly useful for very early market when it is dug before maturity, at which time it compares more favorably in quality with the other varieties.

The comparative order of merit of the highest ten varieties of potatoes obtained by combining the table quality with the yield of marketable tubers is as follows: Empire State 100.0, Pearl of Savoy 91.4, American Wonder 87.5, Dempsey's Seedling 87.0, Rural New Yorker No. 2, 86.8, White Elephant 84.1, Morning Star 83.2, Rural Blush 83.2, The Daisy 83.0, and New Queen 83.0. In comparison with these the lowest varieties in order of merit were the Negro 24.5, the Lady Finger 19.7, and the Eyeless 19.1.

The potatoes representing all the varieties given in the tabulated list have been carefully examined. Some of them are very similar in growth and in appearance. In each of the following nine groups the varieties were found to correspond closely with one another: Grand Mogul, Sir Walter Raleigh, Carman No. 3, and Minister; Delaware, Green Mountain, and Alexander's Prolific; Carman, Pearl of Savoy, Early Yorker, and Brown's Elephant; Early Everitt and Everitt's Seedling; Pride of Ireland, Kosh Konong, and Beauty of Beauties; Improved Rose and Sunlit Star; Reed's Eighty-Six, Early Maine, and Nebula; Early Puritan and Bruce's White Beauty; Vick's Champion, Mount Carbon and Mammoth Pearl. Although there is a similarity in these varieties it is possible that the history of the various kinds is different.

The following table gives the average results of each of five varieties of potatoes for table quality for **eight years,** and in yield per acre for the last quarter of a century:—

Varieties.	Table Quality Average 8 years. (Maximum 100.)	Bushels per Acre per annum. Average 25 years.
Empire State	83	220
Rose's New Invincible	74	216
Rural New Yorker No. 2	69	204
White Elephant	76	199
Stray Beauty	50	159

The first, third and fourth are late varieties of white potatoes well known in Ontario. The Stray Beauty is also called the Bliss Triumph and Earliest of All, and is a round, red potato which matures early and is used largely for early market.

In an experiment extending over a period of ten years, twenty-eight varieties of potatoes were grown under uniform conditions. Some of these are included in the table already presented. A number of other varieties, however, not included with the former results are here mentioned in addition to two kinds which are again named as a basis of comparison. The average yield of each variety for the ten-year period in bushels of potatoes per acre per annum was as follows: Empire State 242, Holborn Abundance 230, Rural New Yorker No. 2, 225, Beauty of Hebron 216, Rose of the North 209, Sir Walter Raleigh 195, Carman No. 1, 193, Early Fortune 183, and New White Beauty 180.

In another competition of each of twenty-four varieties for eight years the following average yields in bushels per acre per annum are interesting: Davies' Warrior 252.2, Extra Early Eureka 218.0, Empire State 193.0, Early Ohio 182.0, and Early Pinkeye 151.0.

In each of the past two years eighty-eight varieties of potatoes have been grown in our experimental grounds. Some of these were grown in 1914 for the first time. It will be remembered that the season of 1914 was particularly good and that for 1915 was unfavorable for potato growing. We do not put much stress on two years' results, but as some of the varieties have been grown for only that length of time we believe the results will be interesting. Those kinds which gave the highest average yield in bushels per acre per annum for the two-year period are as follows: The Hustler 287.8, Pan American 261.3, Statesman 260.8, Late Faction 260.2, Irish Cobbler 260.0, Sir Walter Raleigh 256.5, and Dooley 254.6. In yield of potatoes per acre the Dooley occupied ninth place in 1914 and eighth place in 1915.

The results of experiments at the College for the past year are of peculiar interest owing to the abnormal weather conditions. One variety, viz., the Snowball, gave a yield of only 13 bushels per acre, and another variety, viz., the Hustler, under similar conditions, gave a yield of 366 bushels per acre. The Extra Early Eureka came third in 1915 with 326 bushels per acre, and second with an average of 232 bushels per acre for the past five years. It has already been shown that in the past eight years the Davies' Warrior stands first with 252, and the Extra Early Eureka second with 218 bushels per acre per annum. In comparing the varieties tested for a longer period of time the Empire State occupies highest place in productiveness. These three varieties, viz., the Empire State, the Davies' Warrior and the Extra Early Eureka have all given high yields per acre in the comparative tests at the College.

At the Provincial Winter Fair, held at Guelph, in each of the past eight years those varieties of potatoes which have been most prominent are the Empire State, in the Late Long White class, and the Rural New Yorker No. 2, the Green Mountain and the Gold Coin in the Late Round White class. In December, 1915, potatoes were entered under three separate organizations at the Provincial Winter Fair at Guelph. Of the Late Round White varieties the Davies' Warrior took first prize in the open class and also first prize in the Canadian Seed Growers' Association class. The Davies' Warrior variety also took first and second prizes for potatoes of any type from the Standing Field Crop Competitions in the Province, and it received the Championship for the best lot of potatoes in any section in any class at the Winter Fair. The following varieties received one first prize each: Empire State, Delaware, Beauty of Hebron, Burpee's Extra Early and Early Rose. The Dooley potatoes had more entries than any other variety and received sixth prize in the open class and fifth prize in the class from the Field Crop Competition. The potatoes were judged by T. G. Raynor, of the Dominion Department of Agriculture.

DESCRIPTION OF EACH OF TEN VARIETIES OF POTATOES.

Although upwards of four hundred varieties of potatoes have been under experiment at the College only a few of these are outstanding in certain important characteristics. Ten varieties which have become prominent in Ontario, or which have made high records in our experimental work have been selected for a somewhat detailed description. It is difficult to describe in words the comparative shapes of the potatoes of the different varieties. In order to get some definite basis of comparison one hundred tubers grown at the College in 1915 of each of ten varieties of potatoes were carefully measured. It should be remembered that these measurements were made for one year only, and of potatoes which were grown in a season which was somewhat abnormal. It is the object in presenting the average results to give the comparative thickness, width and length of potatoes of the different varieties without regard to the comparative size of the tubers. In order to make the results as comparable as possible the thickness of the potato is taken as the unit and is represented in every instance by 1. By taking 1 as the basis of thickness, the width and the length form interesting comparisons.

The following table gives the comparative thickness, width and length of the tubers of each of ten varieties grown in the experimental plots in 1915, the varieties being arranged in order of the comparative length of tubers:—

Varieties.	Thickness.	Width.	Length.
Empire State	1	1.28	2.09
White Elephant	1	1.24	1.81
Green Mountain	1	1.26	1.71
Davies' Warrior	1	1.37	1.62
Rural New Yorker No. 2	1	1.34	1.60
Dooley	1	1.32	1.55
Carman No. 1	1	1.30	1.51
Early Ohio	1	1.20	1.51
Extra Early Eureka	1	1.26	1.37
Stray Beauty	1	1.23	1.30

In addition to the measurements given in the preceding table describing the shape of the tubers of each of ten different varieties, the following information furnishes further particulars:

Empire State.—Originated in 1881 by E. L. Coy, Hebron, N.Y., from seed of White Elephant, and introduced by W. A. Burpee in 1885; variety late in maturing, popular and extensively grown in Ontario; skin, white and smooth; eyes, medium depth; rot resistance, medium; yield, excellent; table quality, superior.

White Elephant.—Originated by E. L. Coy, Hebron, N.Y., and is supposed to be a seedling of Garnet Chili, crossed with White Peach Blow; introduced by J. M. Thorburn & Company in 1881; variety late in maturing, not as popular or as much grown in Ontario now as twenty years ago; skin, nearly white with rose tint; eyes, medium depth; rot resistance, medium; yield, good; table quality, good; said to be closely related to the Beauty of Hebron, which it resembles in appearance.

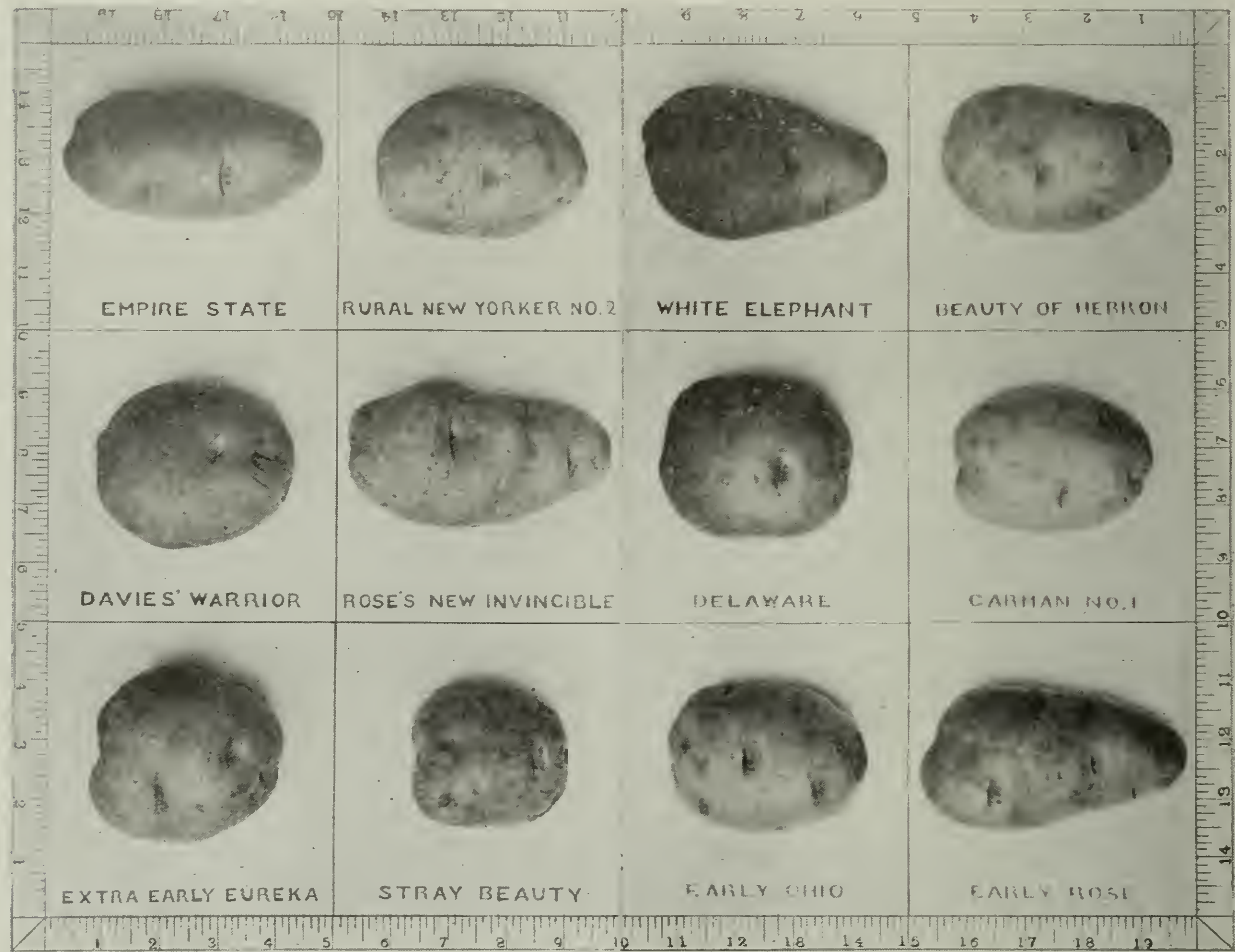
Green Mountain.—Originated in 1878 by O. H. Alexander, Charlotte, Vermont; said to be a seedling from a cross between Excelsior and Dunmore; sold by J. A. Everett & Company in 1885; variety late in maturing, fairly popular and grown extensively in the Maritime Provinces; skin, dull white; eyes, fairly shallow; rot resistance, medium; yield, good; table quality, fair; similar in appearance to Delaware, which is sometimes sold for the Green Mountain.

Davies' Warrior.—Originated in Scotland, and introduced by Wm. Davie & Company about 1899; imported by the Ontario Agricultural College in spring of 1904; increasing in Ontario as its qualities become known; maturity, very late; skin, white; eyes, shallow; rot resistance, best of all the varieties tested at the Ontario Agricultural College in each of five years in which rot was more or less prevalent; yield, one of the highest; table quality, good.

Rural New Yorker No. 2.—Originated from seed selected by Elbert S. Carman, Editor of "The Rural New Yorker," and introduced by the Rural New Yorker Publishing Company in 1888, and by J. M. Thorburn & Company in the year following; late in maturing; popular, and most extensively grown variety in Ontario; skin, white and smooth; eyes, medium shallow; rot resistance, medium; yield, good; table quality, good; tubers large and sometimes hollow.

Dooley.—Originated from one hill of potatoes selected in the field in Waupaca County, Wisconsin, in 1896; introduced by Gunson, Brown & Company in 1900; grown in parts of Middlesex and Wentworth counties, Ontario; medium to late in maturing; skin, white; eyes, fairly shallow; rot resistance, good; yield, good; quality, fair.

Carman No. 1.—Originated in 1889 by Elbert S. Carman as a seedling from a seedling, and sold by J. M. Thorburn & Company in 1894; late in maturing; fairly popular, grown considerably in the Western Provinces; skin, white; eyes, fairly shallow; rot resistance, poor; yield, fair; table quality, fair; tubers sometimes hollow.



Twelve Prominent Varieties of Potatoes grown from eight to twenty-six years in connection with the experiments at Guelph

Early Ohio.—Originated in 1871 by Alfred Reese, and is said to be a seedling of the Early Rose; introduced in 1875 by J. J. H. Gregory; popular as an early variety in Ontario for home and market; skin, rose or flesh color; eyes, comparatively shallow; rot resistance, poor; yield, fair; table quality, good.

Extra Early Eureka.—Originated from one hill of potatoes selected in a field of the Early Morn variety by Geo. R. Pedrick, of New Jersey, in 1895; increasing in Ontario as its qualities become known; maturity, early; skin, white; eyes, medium depth; rot resistance, one of the best; yield, good to excellent; table quality, good in all seasons. In appearance the Extra Early Eureka closely resembles the Irish

Cobbler, but in the tests at the Ontario Agricultural College it has been superior to that variety both in table quality and in rot resistance.

Two Early Varieties of Potatoes grown under uniform conditions. The Extra Early Eureka variety at the right shows strong, vigorous plants, and the Early Ohio variety at the left a more delicate growth.

Stray Beauty, or Bliss Triumph.—Originated in Connecticut, and said to be a seedling of Peerless crossed with a seedling of Early Rose; introduced by B. K. Bliss & Sons in 1878; grown for home use and early market in Ontario to a limited extent, but more extensively in the Eastern States; popular with market gardeners for very early digging; one of the earliest of the four hundred varieties of potatoes tested at the Ontario Agricultural College; skin, red; eyes, rather deep; rot resistance, one of the best; table quality, comparatively good early in the season, but poor in the winter.

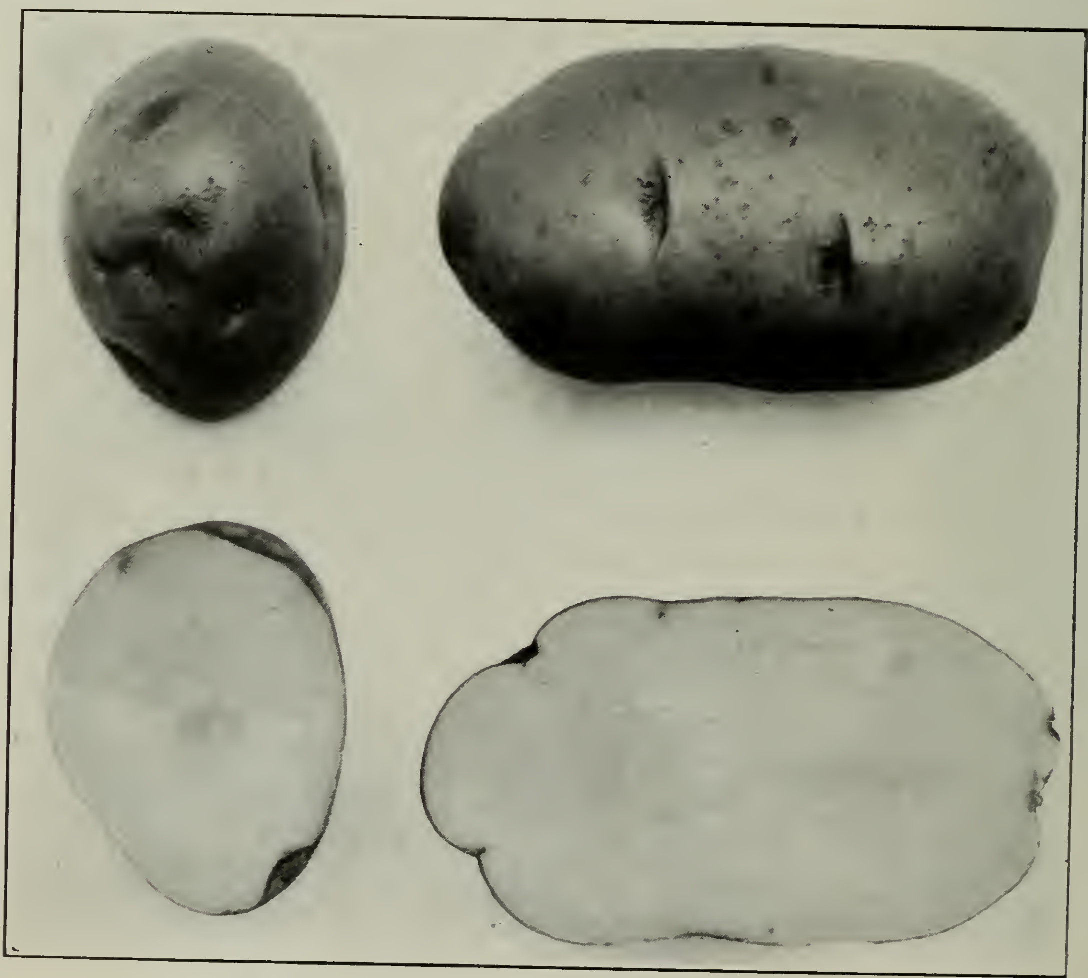
EARLY VARIETIES FOR EARLY USE.

There is much interest taken in early varieties of potatoes whether grown for home use or for early market. Experiments in which all potatoes are allowed to mature before they are harvested do not furnish the best information in regard to comparative value of the different varieties for very early digging. From the general experiments with varieties of potatoes some of the earliest kinds were selected for special tests in regard to their productiveness before being matured. An experiment with this special object in view was conducted for five years in succession by planting six rows of each variety in the spring and digging two rows of each at the end of nine weeks, two rows of each at the end of twelve weeks, and the remaining two rows of each at the end of fifteen weeks after the seed was planted in order to ascertain which varieties of potatoes would give the best returns in the shortest time after planting.

The following table gives the average results for **five years** in yield of potatoes per acre, and in percentage of potatoes over one inch in diameter for each of the three dates of digging:

Varieties of Early Potatoes.	Percentage of Potatoes over one inch in diameter. Average five years.			Yield of Potatoes per acre. Average five years. (bushels).		
	9 weeks.	12 weeks.	15 weeks.	9 weeks.	12 weeks.	15 weeks.
Stray Beauty	78.2	90.4	93.1	112.5	164.0	184.6
Howe's Premium	81.1	92.8	94.5	103.1	151.4	185.4
Early Ohio	85.2	95.3	95.1	99.8	160.8	173.3
Early Dominion	84.1	95.3	96.5	88.6	159.5	196.6
Burpee's Extra Early	72.9	91.2	94.1	86.2	158.8	175.4
Steele's Earliest of All	68.4	89.9	94.5	85.0	151.6	188.4
Tonhocks	73.3	91.8	95.6	81.2	164.6	216.9
Snowflake	56.6	87.3	92.3	78.1	143.2	172.6
Chas. Downing	57.4	86.7	92.2	77.1	148.1	188.0
Early Rose	64.4	91.7	96.0	75.9	155.1	223.9
Early Sunrise	62.3	89.0	95.1	59.0	137.4	177.5

In the table here presented the varieties are arranged in order of yield per acre at the first digging. It will be noticed that the greatest yield per acre was produced by the Stray Beauty at the first, by the Tonhocks at the second, and by the Early Rose at the third digging. The comparative ratio between



Empire State Potatoes.

the first and the third digging is quite marked in the different varieties, as for instance, in yield per acre the first crop as compared with the third was 61 per cent. in the Stray Beauty, and 56 per cent. in the Howe's Premium; and only 34 per cent. in the Early Rose and 33 per cent. in the Early Sunrise. The Early Ohio which stands third in average yield per acre comes highest in percentage of large potatoes as represented in the results of the first digging.

Another experiment with early varieties was conducted in a similar manner as the one already described and was repeated for six years. The second experiment included five varieties not mentioned in the first test. These varieties gave the following number of bushels of marketable potatoes per acre at nine weeks after planting: Early Andes, 160; Six Weeks, 157; Early Fortune, 154; Early Dawn, 152; and Early Pinkeye, 146. In comparison with these the Early Ohio gave 143 bushels per acre.

Four varieties of early potatoes have been under test for early production in each of eleven years. The average yield of potatoes per acre per annum for the

Davies' Warrior Potatoes.

whole eleven-year period when harvested at the end of nine weeks was as follows: Early Dominion 126.6; Early Ohio, 126.4; Stray Beauty, 115.7, and Burpee's Extra Early 100.1. When these experiments were started we did not have the Extra Early Eureka or the Irish Cobbler varieties under test, therefore, these varieties were not included in the special experiment with early potatoes.

Taking into consideration the different experiments we have conducted those varieties which are among the most productive for early use are the Stray Beauty or Bliss Triumph, the Early Andes, the Early Dominion, the Howe's Premium and the Early Ohio

CO-OPERATIVE EXPERIMENTS WITH VARIETIES OF POTATOES.

Some of the varieties of potatoes which are now the most extensively grown throughout Ontario were first tested at the College and were afterwards used in the co-operative experiments on different farms over the Province. The Rural New Yorker No. 2, the Empire State, the Davies' Warrior, the American Wonder and the Green Mountain of the late varieties, and the Early Ohio, the Stray Beauty and the Extra Early Eureka of the early varieties have been used in this way. Co-operative experiments with a few of the leading varieties of potatoes have been conducted throughout Ontario annually since 1894. As the Davies' Warrior had made the highest record of the late potatoes and the Extra Early Eureka of the early potatoes previous to 1913 it was decided to confine the co-operative experiments entirely to these two kinds. Full reports of carefully conducted

Extra Early Eureka Potatoes.

experiments of these two varieties were received from 310 Ontario farmers in 1913, and from 293 farmers in 1914. The average results for the past four years show that the Davies' Warrior gave an increase over the Extra Early Eureka in average yield of potatoes per annum of 25.6 bushels. In the average of the co-operative experiments for 1909, 1911 and 1912 the Extra Early Eureka surpassed the Early Ohio by 41 bushels per acre per annum. In the co-operative experiments conducted in 1911 and in 1912, the Davies' Warrior surpassed the Empire State in yield of potatoes per acre per annum by an average of 36.3 bushels. In the average of experiments successfully conducted in 1908, the Empire State surpassed the Green Mountain variety by an average of 38.7 bushels per acre. During the six years in which the Empire State and the American Wonder were tested throughout Ontario the former surpassed the latter in yield of potatoes per acre in each of six out of eight years.

The three varieties of potatoes which have made particularly good records in the co-operative experiments throughout Ontario in yield per acre, table quality, and popularity with the experimenters are the Davies' Warrior and the Empire State of the late varieties, and the Extra Early Eureka of the early kinds. The Davies Warrior does particularly well in some localities and not quite so well in others. As for instance, it did splendidly near Mount Brydges, in Middlesex County, on three different farms on which it was grown for four years, and it did poorly near Strathroy, only five or six miles distant, and where it was tested for a year or two on a couple of farms. In the Acre Profit Competition conducted in 1915 in different counties and with different varieties the Davies' Warrior gave a yield per acre on one farm of five hundred and fourteen bushels, which was the highest in the Province. The Empire State is a fine quality of potato but seems to require more favorable growing conditions than some of the other varieties. The Extra Early Eureka has been popular as a fairly early potato under a variety of conditions. For fuller information regarding the results of the co-operative experiments the reader is referred to the annual reports of the Experimental Union which can be secured from the Department of Agriculture, Parliament Buildings, Toronto.

TABLE QUALITY OF POTATOES.

The table quality of potatoes has been already referred to in connection with results presented in the large table of varieties. As the subject is of so much importance, however, and has been so frequently neglected in comparing different varieties of potatoes it is thought advisable to give particular attention to the question at this time. The table quality of potatoes is influenced to a certain extent by soil, maturity, age of the tubers, varieties, etc. There is a greater variation in table quality of potatoes of different varieties than many people realize. The information presented in this bulletin is most convincing in this respect.

The process of testing the table quality of all the varieties of potatoes at the College in any one year requires from one week to ten days. A potato steamer for cooking fifteen varieties at a time has been specially constructed for the purpose. The potatoes are cooked by steam and without being peeled. By this method there is practically no loss of the constituents of the potatoes. The scale of points used for scoring the cooked potatoes is as follows:

Mealiness	40 points
Flavor	40 points
Appearance	20 points
Total	100 points

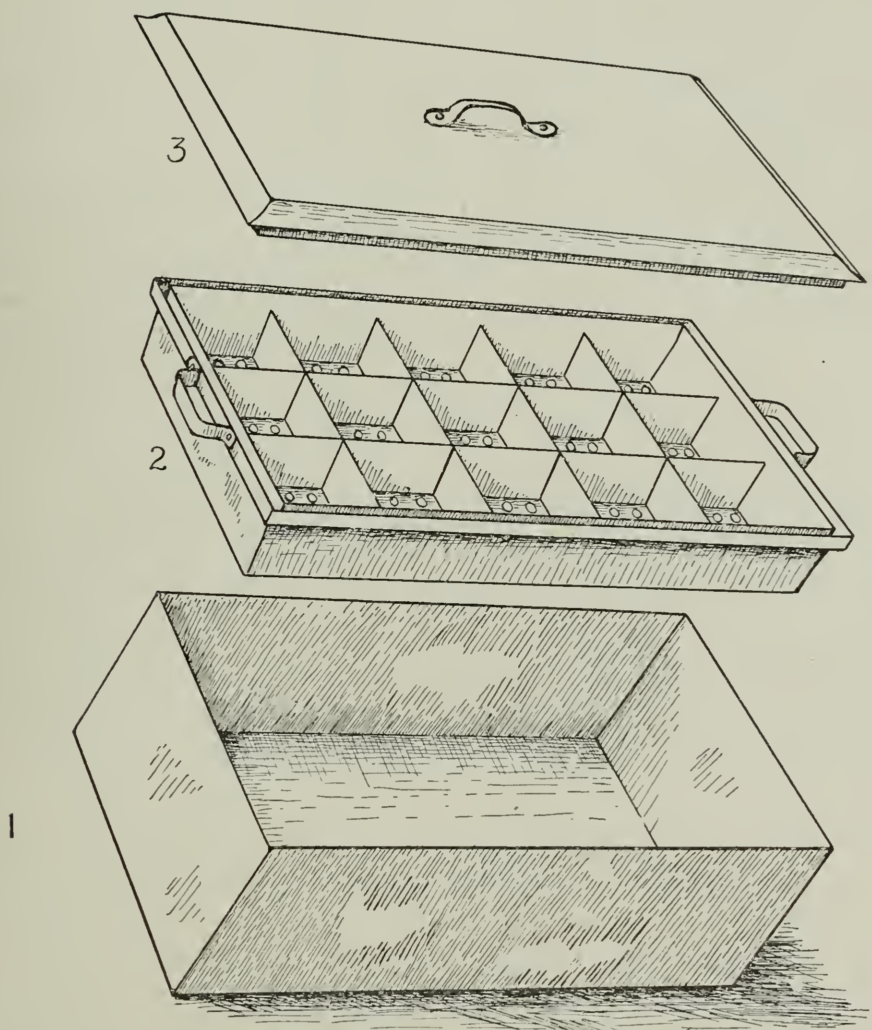
The same system has been used throughout the experiments for testing the table quality of the potatoes. Those who have cooked and examined the potatoes are members of the staff of the Department of Field Husbandry, and they have made a special study of the work. The results are presented with much confidence. The demand in Ontario is for a white, mealy, flaky potato of good flavor and of good appearance.

The following list gives the table quality of each of eighty-two varieties of potatoes from **two to eight years:**

Varieties.	Table Quality. Average Percentage. Perfection—100. 8 yrs.	6 yrs.	4 yrs.	3 yrs.	2 yrs.
Empire State	83	83	83	83	84
Pearl of Savoy	79	78	79	77	79
White Elephant	76	75	76	75	76
American Wonder	75	75	71	71	76
Burpee's Extra Early	75	74	74	73	69
Rose's New Invincible	74	75	76	76	80
Early Rose	74	73	72	72	71
Rural New Yorker, No. 2	69	68	65	68	70
Six Weeks	68	66	65	66	63
Irish Cups	64	59	53	51	49
Stray Beauty	50	50	47	46	43
Beauty of Hebron	....	79	80	81	83
Davies' Warrior	....	74	72	73	77
The Howard	....	74	72	75	73
Early Ohio	....	71	67	67	63
Rose of the North	....	71	71	74	69
Lightning Express	....	71	68	70	77
Extra Early Eureka	....	69	68	69	61
Early Fortune	....	66	63	65	60
Carman No. 1	....	65	65	68	70
New White Beauty	....	64	63	59	62
The Hustler	...	61	61	60	54
Sir Walter Raleigh	....	61	59	54	58
Early Pinkeye	....	52	50	47	48
Queen of the Hebrons	....	....	79	79	81
Windsor Castle	....	....	78	79	80
Westcott	....	....	78	77	73
Verifest	....	....	76	77	78
Laurentina	....	....	76	83	81
Silver King	....	....	75	77	75
King Seedling	....	....	75	72	71
Adams	....	....	75	74	83
The Queen	....	....	74	74	69
Moreton	....	....	73	77	75
Ninety Fold	....	....	73	76	79
Brown's Prolific	....	....	72	79	81
Late Faction	....	....	72	75	80
Findlay's Star	....	....	71	70	71
Irish Date	....	....	71	70	68
Cora	....	....	71	76	75
Dalhousie	....	....	71	75	78
Eldorado	....	....	70	71	73
Early Puritan	....	....	69	69	70
Satisfaction	....	....	69	68	66
Early Lima	....	....	68	68	64
Monarch	....	....	68	68	74
Up-to-date	....	....	67	63	60
Delaware	....	....	66	64	70
First Choice	....	....	65	61	58
Dalmeny Acme	....	....	64	63	64
Isle of Jersey	....	....	64	62	58
Noxall	....	....	61	57	54
The Pingree	....	....	61	57	62
Millionaris	....	....	61	58	62
Pan-American	....	....	60	59	58
Irish Cobbler	....	....	58	57	55
Canadian Standard	....	....	58	56	50
Solanium Commersoni Violet	....	....	57	55	58
King Edward	....	....	53	59	63
Derby's Early	....	....	49	50	48
Solanium Commersoni White	....	....	48	46	45
New Golden Gem	....	....	47	51	55
President	....	....	43	44	54
Midlothian	....	....	41	43	46
Read's Golden Gem	....	....	40	31	31
British Queen	....	....	....	73	70
Empire State No. 5	....	....	....	69	63
Ringleader	....	....	....	64	69
Wonderful	....	....	....	59	57
Bermuda	....	....	....	56	51
Golden Nugget	....	....	....	53	50
New Found	....	....	....	50	48
Red Fir	....	....	....	49	43
Ashleaf	....	....	....	48	51
White Fir	....	....	....	45	44
Statesman	....	....	....	....	75
Snowball	....	....	....	....	64
Dooley	....	....	....	....	64
Wee McGregor	....	....	....	....	62
Pride of Kerns	....	....	....	....	62
Manitoba Wonder	....	....	....	....	61

The table quality of the potatoes grown in 1915 was tested from the eleventh to the twentieth of November, and that of 1914 from the fifteenth to the twentieth of June. In other years the cooking has been done in January, April, May and June, so that it will be seen that the potatoes have been tested at various times after harvest.

The results in the table here given represent a large amount of work which has been brought together in the best way for comparison. All varieties named have been tested for the two years, 1914 and 1915. A smaller number of varieties have been tested for three years, and ten varieties for as many as eight years. The only varieties included in this list which were also included in the large table are the ten varieties which have now been tested for table quality for eight years. The varieties are placed on the list in the order of their table quality for the largest number of years in which they have been tested. It will be seen that the Empire State heads the list in table quality of the varieties tested for eight years, the Beauty of Hebron for those tested only six years, the Queen of the Hebrons for those tested only four years, the British Queen for those tested only three years, and the Statesman for those tested only two years. This arrangement will enable the reader to compare the table quality of any variety of potatoes on the list with that of any other variety which has been grown for as many



A Potato Steamer for Cooking fifteen Varieties of Potatoes at one time: (1) Boiler, (2) Receptacle with Fifteen Perforated Compartments, and (3) Cover.

years. For instance, the table quality of the Early Rose can be compared with nine varieties for eight years or with eighty-one varieties for two years, and the Statesman can be compared with all the varieties on the list but only for a period of two years owing to the fact that it has been under experiment for only that length of time.

It should be remembered that some of the early varieties such as the Six Weeks, the Stray Beauty and the Early Pinkeye which show comparatively low results in table quality when tested in the winter are usually grown for very early use and are frequently dug before they reach maturity, at which time they would probably surpass in table quality the late varieties. The Early Ohio and the Extra Early Eureka are early potatoes of fairly good quality even in the winter season. For general use it is very difficult to find potatoes which are superior in table quality to the Empire State or to the Beauty of Hebron.

POTATO IMPROVEMENT, INCLUDING SELECTION AND HYBRIDIZATION.

It is believed that the potato has been cultivated in Peru for over two thousand years. In the sixteenth century when the potato was introduced into Europe the plants evidently yielded large numbers of small, irregular tubers, and an abundance of seed. The improvement of the potato through cultivation, selection and hybridization has apparently increased the uniformity and the size and has improved the table quality of the tubers, and has decreased the number of potatoes per hill and the seed producing power of the plants.

There are over one thousand named varieties of potatoes in North America and fully four hundred have been grown under experiment at the Ontario Agricultural College. Many of these are inferior even though they have been extravagantly advertised, some are old varieties under new names, and comparatively few are of sufficient merit to receive high recommendation for general cultivation by the farmers of Ontario. If these few were grown to the exclusion of fully eighty per cent. of the kinds now under cultivation better results would be obtained. Even the few best varieties are not ideal and there is still much important work to be done by improving the best kinds through selection, and by originating new varieties through hybridization with the object of combining the good qualities and of eliminating the undesirable characteristics of the parent varieties.

Selection work with potatoes can be accomplished with good results either by private growers on their own farms or by scientific investigators at the Experiment Stations. The work can be carried out by either individual or mass selections of tubers or of hills.

Mass Selection of Tubers.—In this method selections are made from the general crop of potatoes by carefully picking out for planting for seed production those tubers which are of the desired form and quality, and which are apparently sound and free from disease. Some growers take for seed the average run of the crop which often includes very uneven tubers and sometimes a mixture of different varieties. Possibly some other growers use for seed the culls which have been discarded by the family cook.

An experiment was started in 1896 and was conducted in duplicate in each of twelve years in continuous selection of tubers of different sizes. From each variety, large, medium, small marketable, and small unmarketable potatoes were selected for planting. From the crop produced from these different selections tubers of similar sizes were again selected for planting and this process was continued each season for twelve years. Exactly the same number of tubers of each selection and of each variety were planted on plots which were uniform in size. The plots, however, varied in size in different years, the smallest being one row and the largest three rows each four rods in length. It will, therefore, be seen that the continuous selections were made within comparatively narrow limits. As there were some rotten potatoes in 1903, the weights of which were not ascertained, the results for that year could not be included.

The following table gives the average results of duplicate experiments conducted in each of **eleven years** in the continuous selection and planting of whole potatoes of different sizes:

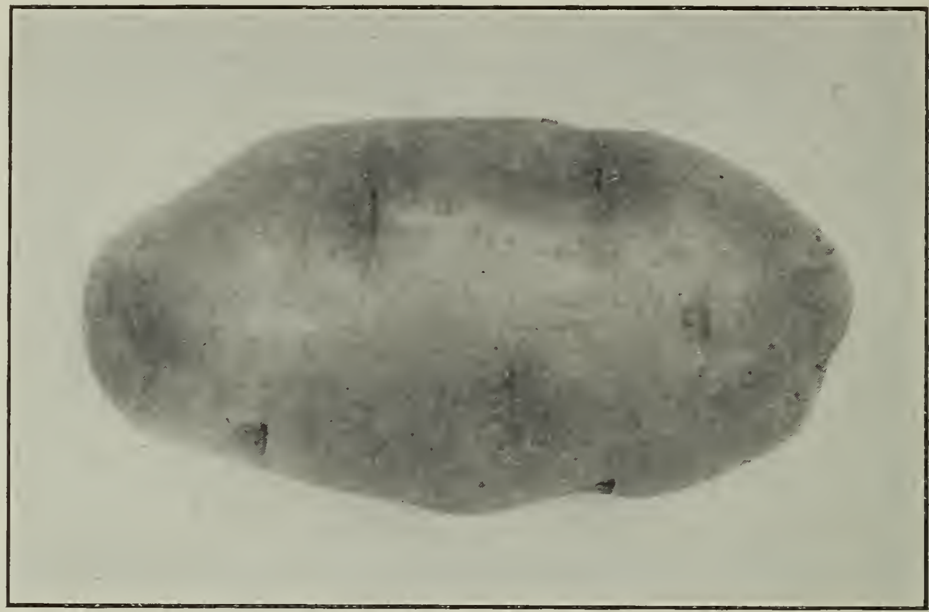
Years.	Yields per Acre from planting whole Potatoes of different sizes. Continuous selection.			
	Small Unmarketable. (Bushels.)	Small Marketable. (Bushels.)	Medium Marketable. (Bushels.)	Large Marketable. (Bushels.)
1896	65.0	105.6	143.8	168.8
1897	190.8	215.6	257.5	283.4
1898	98.8	156.3	196.3	222.5
1899	90.0	169.4	183.1	196.9
1900	48.5	95.2	123.3	137.1
1901	120.8	207.5	292.9	337.9
1902	99.4	116.3	173.1	199.4
1904	96.9	104.1	130.9	128.8
1905	178.8	204.4	220.6	238.8
1906	76.9	105.9	129.1	146.3
1907	93.4	118.8	142.5	174.4
Average yield, 11 years	105.4	145.4	181.2	203.1

It will be seen that in every instance, except one, as the size of the seed potatoes increased there was also an increase in the yield of potatoes per acre. The relative difference in the production of tubers of different sizes is probably more marked in unfavorable than in favorable seasons. It is difficult to ascertain from these results just what influence continuous selection had on crop production, as the size of tuber which is planted exerts a marked influence on the yield of potatoes. For further information on this question the reader is referred to the results of other experiments presented in this bulletin. It is interesting to note that the small, unmarketable potatoes came lowest, and the small marketable potatoes second lowest not only in yield of potatoes per acre but also in the percentage of marketable potatoes produced.

Mass Selection of Hills.—In this method, the selections are made in the field by digging separately the potatoes produced by different plants and by collecting together for seed purposes only those tubers which come from the best hills.

Individual Tuber Selection.—From a bulk lot of potatoes of a suitable variety selections are made of the most desirable tubers regarding colour, smoothness, shape, size, quality, and freedom from disease. These selected tubers are planted whole or in the form of a certain number of sets, and the progeny from each tuber is kept separate from that of every other tuber. By careful testing under uniform conditions these different lots of the one variety the grower aims to secure a superior strain of potatoes.

In the spring of 1909 two hundred and forty-one tubers of the Empire State variety of potatoes were carefully selected from a bulk lot of this variety grown at the College in the year previous. These potatoes were weighed separately and classified into groups of from twelve to twenty-eight tubers each. The individual potatoes comprising any one group did not vary in weight more than one-sixteenth of an ounce. The potatoes were all planted whole and the crop produced from each of the two hundred and forty-one tubers was harvested by itself and the potatoes were counted and weighed. The best hills in each group were carefully noted. In the spring of 1910 one pound from each of forty-three of the most promising hills of the previous year was used for seed. This amount was cut into thirty-three pieces which were planted in one row four rods in length by placing the sets two feet apart. In 1911 and 1912 the selections were reduced to fourteen, in 1913 to eight, and in 1914 and 1915 to three.



A Potato of the Empire State variety.

The following average yields of potatoes per acre per annum for the past two years show the comparison of the selections with one another and with the Empire State variety, which has not been submitted to the individual tuber selection process:—

Selection No. 1	181.4 bushels.
Selection No. 2	177.3 "
Selection No. 3	175.9 "
Variety	162.5 "

It should be remembered that none but well formed tubers of good size of the Empire State potatoes had been planted at the College for nineteen years before the individual tuber selection work was started. Even from this stock of material the individual tuber selections appeared to have an influence in increasing production.

Individual Hill and Tuber Selection.—This method can be carried out in the large field, the market garden, the family patch, or the nursery plot where potatoes are grown. In ordinary culture, however, the potato sets usually vary in size, and consequently the hills vary in productiveness. In order to select most readily those hills possessing the power of reproducing desirable characteristics care should be taken to plant tubers or sets which are uniform in size. In commencing the work, therefore, it is not only important to use the best variety obtainable for the purpose, but also to give the potatoes in the individual hills an even chance for development. When the crop is beginning to ripen there is frequently a noticeable variation in the appearance of the plants. This permits of a selection of the hills having vigorous plants with the best foliage and the least amount of late blight and of other diseases. The hills can be marked by driving stakes or laths beside those selected. Another examination of the crop can be made in a week or ten days, and still another at a little later date, and, if necessary, some of the stakes changed according to the appearance of the plants. A few days after the tops die the selected hills can be carefully dug with a potato fork and examined individually. The product of each hill showing a good yield of uniform tubers of desirable appearance and free from scab, rot or other diseases can be placed in a separate bag and numbered. The selected potatoes should be kept in a cool, dry, dark cellar during the winter and early spring. At planting time a uniform number of the best potatoes from each bag can be selected and each tuber cut once lengthwise and once crosswise, thus making four sets comparatively even in weight. Two feet could be allowed between the sets and three feet between the tubers in every row. Each tuber of four sets would require 9 feet of the row. The length of the rows, therefore, would be 45 feet if five tubers, 54 feet if six tubers, and 63 feet if seven tubers were used from each bag. Three feet is a good distance to allow between the separate rows. Comparative examinations can be made of the tops in the growing season and of the potatoes in the autumn which have been produced from the individual sets, from the individual tubers, and from the individual hills. This gives an exceptionally fine opportunity for determining the comparative results of the different selections regarding vigor of growth, freedom from disease, and type, uniformity, production and quality of potatoes. Tubers can be taken from the best hills, or from the best groups of four hills, or from the best rows for further selection, for comparative tests, or for both. The writer recommends this individual hill and tuber selection method as one of the best and most interesting which can be followed in obtaining an improved strain of potatoes either for home use or for commercial purposes.

In developing the foregoing system some interesting work has been done at our College. For instance, individual hill selections were made from the Davies' Warrior potatoes in 1910 and again in 1911. Eleven of the best strains resulting from the selections have been tested in duplicate in each of the past **three years** and the following table gives the average results of each of four of these strains as tested in each of the years 1913, 1914 and 1915:—

Selections.	Percentage Table Quality 1915.	Yields of Potatoes per Acre (bushels).			
		1913. 2 tests.	1914. 2 tests.	1915. 2 tests.	Average 3 years. 6 tests.
Selection No. 5	74	210.0	321.0	199.2	**243.4**
" " 2	72	197.5	285.7	166.3	**216.3**
" " 1	71	191.3	253.6	127.5	**190.8**
" " 8	71	145.0	177.1	86.5	**136.2**

These strains were all started from carefully selected hills of promising characteristics, and yet the results show most decided differences in productiveness. The Davies' Warrior potatoes in the variety tests, where no hill selection was used, gave an average of 136.6 bushels per acre per annum for the same period. This work has been valuable in furnishing a strain of Davies' Warrior potatoes which has given an average annual yield of fully one hundred bushels per acre over the ordinary variety. It has also emphasized the value of the application of a good system of selection in the improvement of the potato crop.

Originating New Varieties from Potato Seed.—The potato blossoms are produced on the upper parts of the stems and vary in color. The flower is complete, comprising calyx, corolla, stamens and pistil. The construction of the flower favors self-fertilization. It is very rare to find insects visiting the blossoms. The amount of cross-fertilization through the agency of the wind is uncertain. Early writers inform us that the potatoes of two and three centuries ago produced an abundance of seed. Potato seed in the commercial varieties of the present day, however, is very scarce. The improvement of the potato has developed large yields of tubers which make heavy demands upon the food manufactured by the leaves. It is probably due to this demand that the transfer from seed to tuber production has taken place. The cause of the lack of fertilization of the flowers seems to be due to the sterility* of the pollen, and in the majority of cases the unfertilized flowers drop to the ground. In a few instances, however, fertilization takes place and seed is produced. It is stated that seed production is increased by removing the early formed tubers of the potato plant. The potato "apple" or fruit is globular in form, about three-quarters of an inch in diameter, and contains many seeds which are about the size of pin-heads.

It is a comparatively easy matter to produce new varieties of potatoes from the seed. It is an exceedingly difficult process, however, to produce a new variety of potatoes which is superior to the best kinds already in existence. That scientific workers will eventually produce potatoes of high merit by means of artificial cross-fertilization of varieties, possessing the most desirable characteristics, is fully expected. It is probably safe to say that this line of work will be confined largely to the Agricultural Experiment Stations. Much may be done, however, by private citizens who revel in scientific work and who have time and money at their disposal and a wholesome desire to be of real service to humanity.

PLANTING POTATOES AT DIFFERENT DATES.

In four separate experiments potatoes were planted at different dates. In one experiment the planting on May 14th surpassed that of the planting of May 28th. In another experiment, which was only conducted for one year, potatoes which were planted on May 4th gave the highest, on May 23rd the second highest, and on June 13th the third highest yield per acre. In still another experiment potatoes were planted on May 31st, June 14th, June 28th and July 12th, thus allowing two weeks between each two dates of planting. This experiment was conducted in duplicate by using two early, two medium, and two late varieties of potatoes in each of the six years. It will, therefore, be seen that there were thirty-six separate tests in this experiment. Exactly the same weight of seed and the same number of sets were used throughout. All other details in reference to cultural methods were the same for all of the plots in each of the years.

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*Wm. Stuart, U.S. Department of Agriculture, Bulletin 195, on "Potato Breeding and Selection," 1915.

The following table gives the results of thirty-six tests conducted over a period of **six years** in planting early, medium and late varieties of potatoes at four different dates :—

Dates of Planting	Average Percentage Maturity. Sept. 10th.	Bushels per Acre of Marketable Potatoes. 36 tests.	Total Yield of Potatoes per Acre (bushels). Average six years.			
			EARLY Varieties. 12 tests.	MEDIUM Varieties. 12 tests.	LATE Varieties. 12 tests.	Average of three classes of Varieties. 36 tests.
May 31	91	164.5	163.8	201.9	203.5	**189.7**
June 14	78	146.6	152.0	183.9	191.9	**175.9**
June 28	44	101.8	104.7	149.1	147.5	**133.8**
July 12	10	46.6	67.6	76.4	75.4	**73.1**

The results show that in all of the average results, whether of marketable potatoes or of total yield of early, medium or late varieties, the yield was the highest from the earliest planting. As the different dates of planting advanced the yield per acre decreased to a marked degree. In every instance the yield per acre from the planting of May 31st was more than double that from the planting of July 12th. It should be considered that these experiments were conducted at Guelph on an ordinary clay loam.

The experiment last described was concluded in 1914. In the following year a somewhat more extensive experiment was started by planting potatoes at six different dates. In all six varieties of potatoes were used, two early, two medium, and two late. The conditions of culture were the same throughout as near as it was possible to have them.

The following table gives the average results in percentage of table quality and yield per acre of six varieties of potatoes grown from each of six different dates of planting in 1915 :—

Dates of Planting.	Average Table Quality. 1915. Percentage.	Average Yield per Acre. 1915. (Bushels.)
May 3	**71**	**201.3**
May 17	**71**	**169.6**
May 31	**68**	**123.1**
June 14	**64**	**72.1**
June 28	**52**	**31.9**
July 12	**39**	**5.8**

It will be seen that the results of each of the four experiments conducted at the College all favor comparatively early planting, and that as the dates of planting increase the yields per acre decrease. According to the results of experiments conducted at our College immature potatoes are of inferior quality for eating in the winter, but are of superior value for planting in the spring.

DIFFERENT EXPOSURES OF SEED POTATOES FOR THREE WEEKS BEFORE PLANTING.

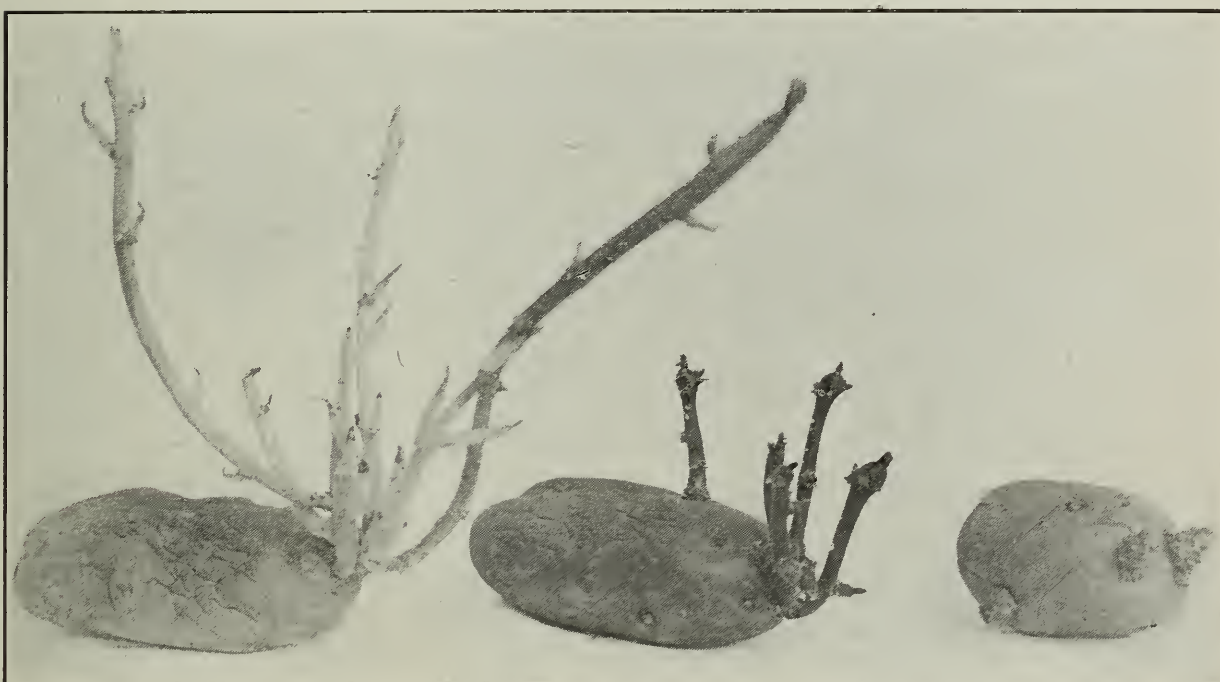
For five years in succession an experiment was conducted in which potatoes were carefully and evenly divided into different lots and placed in varying degrees of light and heat for three weeks before they were planted. Some were placed in the dark cellar, others in the cellar in front of a window, others on the barn floor, others in the greenhouse immediately below the glass, and others in the open air. Two varieties were used each year. The different lots of each variety were made up of the same weight and of the same number of tubers. The potatoes were weighed and distributed each year in the latter part of May and the planting took place three weeks later. The potatoes placed in the dark cellar grew long, tender, light colored sprouts, while those placed in the warmer temperature and in the light produced short, green-colored sprouts. One-half of the potatoes kept in the dark cellar were planted with the sprouts removed, and the other half with the sprouts still attached to the tubers. The following table gives the average percentage marketable, the yield marketable and the total yield per acre for the ten tests in the **five years** for each of the six treatments:

Places where Potatoes were kept for twenty-one days before planting.	Average Percentage Marketable.	Average Bushels per Acre per Annum.	
		Marketable.	Total Yield.
1. In barn in light (sprouts on)	77.9	187.1	221.1
2. In root cellar in light (sprouts on)	74.4	173.8	210.6
3. In root cellar in dark (sprouts on)	74.1	169.4	206.0
4. In greenhouse in light (sprouts on)	59.8	134.6	189.3
5. In root cellar in dark (sprouts off)	63.1	130.5	177.3
6. In open air (sprouts on)	58.2	62.9	107.3

Potatoes which were placed on the barn floor in the latter part of May and allowed to remain there for three weeks, after which they were planted whole with the short sprouts attached, gave better results than tubers submitted to any other exposure in total yield and in yield of marketable potatoes per acre. The potatoes which were kept for three weeks in a dark root cellar and which were carefully planted with the slender sprouts attached gave an average yield of 28.7 bushels per acre more than similar potatoes from which the sprouts had been removed. These results go to show that seed potatoes from which sprouts have been removed in the spring before planting are considerably weakened for crop production. The results also show that if seed potatoes are allowed to sprout in the spring their value depends largely upon the conditions under which the sprouts are allowed to develop before the time of planting. The tubers which were exposed to the open air were injured considerably by the changes in temperature. The results seem to favor the practice of allowing potatoes to sprout under proper conditions in the spring not only to hasten the crop for early market but also to furnish good yields of tubers. Unfortunately, no potatoes were kept sufficiently cool to prevent any sprouting so as to furnish unsprouted seed as a basis of comparison.

In another experiment conducted in duplicate, but for only one season, potatoes which had been kept in a dark, moderately cool root cellar produced long slender sprouts in the spring. These potatoes were separated with great care and part of them were planted with the sprouts attached, and an equal number after the sprouts had been removed. The potatoes were planted whole, and the cultural methods were the same for the different plots. The average yield of potatoes produced was 26.3 bushels per acre less from the tubers from which the sprouts had been removed than from those on which the sprouts were attached. These results confirm those of the former experiment and show that if potatoes are allowed to sprout in the spring of the year and the sprouts are removed the value of the tubers for crop production is apparently decreased.

When a whole potato is exposed to the light a very few of the eyes start to grow, and these are generally situated at or near the seed end. The accumulated resources of the potato are largely devoted to the development of the few sprouts which start first and many of the eyes remain in a dormant condition. In the



Three Sprouted Potatoes: (1) Placed in the dark, (2) Placed in the dark for a time and later in the light, and (3) Placed in a subdued light.
Potatoes placed in the light until short, thick, green sprouts are grown to an inch or so in length make excellent seed, especially for producing a crop for early market.

earliest stages of growth the food material of the young sprouts appears to be drawn from that portion of the tuber which is at the greatest distance away from the new growth.

Seed potatoes placed in shallow trays and stored for a short time before planting in a moderately warm, well ventilated and lighted room are likely to give excellent returns. By this process the sprouts will be short, dense, full of color and strong enough to withstand ordinary handling. The young sprouts will develop buds near the potatoes which probably accounts for the increase in productiveness. The sprouted tubers hasten the season of growth and produce fine, healthy plants which are more likely to escape blight. This method is particularly advantageous if the grower is desirous of having his crop ready for market very early in the season.

PLANTING WHOLE AND CUT POTATOES.

Various experiments have been conducted in different countries and at different times to glean information regarding the best way to prepare potatoes for planting. In order to glean data along this line which might be of particular value to the potato growers of Ontario an experiment was conducted for six years in succession. In this experiment potatoes of different sizes were planted whole at different distances apart, and in comparison with these cut pieces of different sizes were planted from uniform tubers. The experiment was conducted in duplicate in each of the first two years, and in triplicate in each of the last four years. It will, therefore, be seen that we conducted sixteen complete and separate tests in the six-year period. The varieties of potatoes principally used were the Empire State, the Pearl of Savoy, and the Rural New Yorker No. 2. The quantity of seed per acre varied according to the manner of preparing the seed. The potatoes were planted in rows 3 1-3 links apart, and the planting took place from the fourteenth of May to the fifth of June, according to season. The treatment of the land was the same as has been described for the experiment with different varieties. The following table gives the average results in percentage of crop marketable, in total yield per acre, and in yield per acre less seed used, in the experiment comprising sixteen tests conducted over a period of **six years:**

Preparations.	Percentage of Crop Marketable. Average 6 years.	Yield per Acre. Average 6 years (bushels).	Yield per Acre less seed used. Average 6 years (bushels).
Large whole, one foot apart	79.25	338.03	110.98
Large whole, two feet apart	84.00	247.75	133.00
Large whole, three feet apart	85.83	200.26	125.49
Medium whole, one foot apart	82.07	274.01	179.81
Medium whole, two feet apart	87.37	210.36	163.39
Small whole, marketable, one foot apart	87.83	201.03	176.54
Medium cut in two, one foot apart	83.95	211.32	163.45
Medium, two eyes in a piece, without seed ends, one foot apart	90.57	153.21	135.45
Medium, one eye in a piece, without seed ends, one foot apart	91.39	106.46	96.38
Medium, seed ends, one foot apart	85.57	104.24	98.22

It will be seen that the largest yield of potatoes and the lowest percentage of marketable tubers were produced from the large whole potatoes planted one foot apart in the rows. This required the largest amount of seed of any of the ten plots comprising this experiment. The yield per acre decreased as the distance between the potatoes in the rows increased or the size of the potatoes decreased. The highest perecntage of marketable potatoes was produced from the cuttings having only one eye in each piece. The results show that the amount of seed used has a marked influence on the yield of potatoes per acre. The heaviest planting, however, has two serious drawbacks, viz., the large amount of potatoes required to plant an acre and the large percentage of unmarketable potatoes in the crop produced. The last column to the right gives the yield per acre remaining after subtracting the amount of seed planted from the total crop produced. It will, therefore, be seen that the most economical results were not obtained either from the largest or the smallest amount of seed used. This experiment has some important lessons in itself, but it is particularly valuable in suggesting other lines of investigation, and we would advise the reader to examine the results of the experiments given under the headings which follow before drawing conclusions from the results presented in connection with this experiment.

An interesting little experiment was conducted in planting very small whole potatoes of about one-quarter of an ounce in size in comparison with small whole potatoes weighing about one ounce each. The number of potatoes was uniform throughout. The results showed that the very small potatoes gave slightly less than one-half the yield per acre as compared with the one ounce tubers.

PLANTING SETS OF DIFFERENT SIZES WITH ONE EYE IN EACH SET.

Suggested by the results of the foregoing experiment a test was arranged with the object of securing more definite information regarding the exact influence of the size of the cut potato on the resulting crop. This experiment consisted of six separate plots in which potato sets 1-16, ⅛, ¼, ½, 1 ounce and 2 ounces in weight were planted under similar conditions. No piece contained more than one eye. The pieces were planted one foot apart in the rows, there being exactly the same number of sets used in each of the plots. The experiment was conducted in duplicate in each of five years by using two varieties each season. There were, therefore, in all ten tests conducted during the five-year period. The potato sets were planted to a depth of about four inches, and flat cultivation was used each year. The following table gives the average of **five years'** results in testing potato sets of each of six different sizes:

Size of Sets Planted	Eyes per Set.	Amount of Seed used per Acre (bushels).	Average results for five years (10 tests).			
			Percentage of Crop marketable.	Yield per Acre (bushels).		
				Marketable.	Total.	Total less Seed used.
One-sixteenth oz........	1	1.3	61.0	36.8	47.5	46.2
One-eighth oz...........	1	2.6	88.6	78.8	89.7	87.1
One-quarter oz..........	1	5.2	89.7	98.4	111.1	105.9
One-half oz	1	10.3	88.7	109.4	129.0	118.7
One oz.	1	20.6	89.5	129.9	148.4	127.8
Two ozs.................	1	41.2	87.6	149.7	173.9	132.7

The results here presented are certainly interesting. They show that the size of the piece of potato planted has a very marked influence on the yield produced. Under exactly similar condtions there was a variation of from 47.5 to 173.9 bushels of potatoes per acre per annum owing to the difference in the size of the potato sets which were planted. There was an increase in the yield of potatoes per acre as the size of the potato sets increased in weight. Planting two-ounce in comparison with one-ounce pieces an additional 20.6 bushels of seed potatoes were required, and an additional yield of 25.5 bushels of potatoes were harvested. Of this quantity, however, only 19.5 bushels per acre were of marketable size, therefore, on the average the one-ounce pieces proved more economical than the two-ounce sets.

An experiment was conducted for only one year in testing single eyes with large and small amounts of tuber material attached. In this experiment large potatoes of uniform size were selected and all the eyes were removed and thrown away excepting two of the strongest appearing ones on each potato. One of these eyes on each tuber was then removed with a small piece of potato attached. approximately one-sixteenth of an ounce in weight, and the remaining part of the potato, about eight ounces in weight, was left attached to the other eye. It will be observed that the eyes of these two sets were similar in every respect except in the one particular, viz., that there was only a small amount of the fleshy part of the potato attached in one case, while in the other there was a large amount of the fleshy part of the potato attached to the eye. An equal number of sets of each selection were planted. The experiment was conducted in duplicate, there being four plots in all. The soil and methods of cultivation were similar. The large potato sets with single eyes gave an average yield per acre of 340, and the small sets with single eyes of 48.1 bushels per acre. This is an extreme test and shows the very great difference which it is possible to obtain from potato eyes of uniform strength. but which are furnished with different amounts of nourishment for the young plants.

PLANTING SETS OF DIFFERENT SIZES AND AT DIFFERENT DISTANCES APART.

Based on the results presented in connection with the last experiment another test was started by planting potato sets of 1 ounce, 1½ ounces and 2 ounces in size at distances of 12, 18 and 24 inches apart in the rows. The experiment, therefore, consisted of nine separate plots and it was conducted in duplicate each season, and for a period of five years. Each piece contained only one eye. The potato sets were planted to a depth of about four inches and flat cultivation was used each year. The rows were 26⅖ inches apart in every instance. The following table gives the average of the ten tests conducted in **five years** in planting different sized sets at different distances apart:

Size of Sets Planted	Distance between Sets in rows (inches).	Amount of Seed used per Acre (bushels).	Average results for five years (10 tests).			
			Percentage of Crop marketable.	Yield per Acre (bushels).		
				Marketable.	Total.	Total less Seed used.
One oz.	12	20.6	86.8	125.8	144.9	124.3
	18	15.5	88.1	116.7	132.5	117.0
	24	10.3	89.5	102.1	114.1	103.8
One and one-half ozs.	12	30.9	84.0	140.2	166.9	136.0
	18	23.2	87.0	125.9	144.7	121.5
	24	15.5	87.7	103.3	117.8	102.3
Two ozs.	12	41.2	84.1	150.8	179.3	138.1
	18	30.9	86.7	125.0	151.2	120.3
	24	20.6	88.3	118.4	134.1	113.5

It will be seen that the total yield of potatoes increased as the size of the cut tubers increased in weight and as the space between the tubers decreased in distance. The highest yield per acre was produced from the two ounce sets placed one foot apart, and the lowest yield per acre from the one ounce sets placed twenty-four inches apart in the rows. The extremes in the yields per acre corresponded with the extremes in the amount of seed used and in the distance between the sets. The percentage of marketable potatoes was highest where the smallest potato sets were planted at the greatest distances apart. The highest yield per acre, less the amount of seed used, was produced from the two ounce pieces one foot apart in the rows. This, however, required a large amount of seed. Under average conditions seed potatoes in the spring are more valuable than an equal quantity of potatoes in the autumn, therefore, the heaviest seeding in this experiment, although the most productive in total yield and in total yield less the amount of seed used, was not the most economical. The results here presented in tabulated form are very suggestive and are worthy of careful study. If seed potatoes are plentiful and cheap it might be wise to use some of the larger amounts of seed per acre. If, however, the potatoes are scarce and expensive some of the smaller amounts of seed per acre would probably prove the most satisfactory.

PLANTING SETS OF EQUAL SIZE WITH A VARYING NUMBER OF EYES.

The proper number of eyes to leave in each potato set has been discussed on many occasions. As the size of the set itself has a marked influence on the yield of potatoes it is important to use sets of uniform size if definite results from a

Planting Experimental Potatoes under uniform conditions.

different number of eyes are to be obtained. An experiment has been conducted in our experimental plots in which every set was cut so as to weigh one ounce, but in which the number of eyes in the different sets varied from one to five. Great pains were taken to have all the pieces of exactly the same size—in fact every piece was weighed by itself on a fine balance and was trimmed as required. For No. 1 plot each set contained one eye, for No. 2 plot two eyes, for No. 3 plot three eyes, for No. 4 plot four eyes, and for No. 5 plot five eyes. The experiment was conducted in duplicate each year by using two varieties of potatoes and it was continued for five years in succession. The potato sets were taken from uniform tubers and some of the eyes were removed in accordance with the requirements of the experiment. The conditions of planting were the same as those given in the variety experiment.

The following table gives the average results of **five years'** experiments in planting one ounce potato sets containing from one to five eyes each:

Number of Eyes in ounce Sets.	Average results for five years.		
	Weight of 30 largest Potatoes per plot (lbs.)	Percentage of Crop Marketable.	Yield of Potatoes per Acre per annum (bushels).
Each Set containing 1 oz. and 1 Eye .	9.8	86.2	139.8
" " 1 " 2 Eyes.	9.2	84.6	151.3
" " 1 " 3 "	9.0	82.6	153.9
" " 1 " 4 "	8.6	81.2	161.3
" " 1 " 5 "	8.5	83.3	165.1

The potato sets of one ounce in size and containing one eye each produced the largest potatoes, and the highest percentage of marketable tubers, but the lowest yield per acre. With one slight exception as the number of eyes increased from one to five in the potato sets of one ounce each there was a decrease in the size of the largest potatoes, a decrease in the percentage of crop marketable, and an increase in the average yield of potatoes per acre per annum. The sets containing five eyes each produced twenty-five bushels per acre more than those containing one eye each in the average annual yield for the five-year period. This would be an increase of practically six bushels per acre for each additional eye in the potato sets which were planted. The highest average yield of marketable potatoes per acre was produced from the sets containing five eyes, and the lowest average yield of marketable potatoes from the sets containing one eye each. From observations made of the vines growing above ground it was found that on the average there were three stems from the one-eyed sets and four and one-half stems from the five-eyed sets.

It is the opinion of some people that potato sets should always be planted with the eyes facing upwards. An experiment was conducted in one year in which potatoes were cut into flattened sets. In one plot every set was placed with the eyes downwards, and in another with the eyes upwards. The experiment was conducted in duplicate. The average yields per acre from the two methods were practically identical. In dropping potato sets it is not now considered important to have the eyes pointed in any one specific direction.

PLANTING SINGLE EYES FROM DIFFERENT PARTS OF THE SEED TUBERS.

In each of five years, an experiment was conducted by planting single eyes of potatoes taken from different parts of the tubers. As the yield of potatoes per acre varies with the size of the sets planted, great care was taken to have the pieces planted of exactly the same weight by actually weighing all the pieces separately. The experiment was, therefore, a test of the comparative value of the eyes and was not influenced by the difference in the size of the pieces planted. Uniform potatoes of the same varieties were used for supplying the sets. Where necessary to meet the requirements of this experiment, the surplus eyes were removed from the sets leaving only one eye in each piece. The experiment was conducted with at least two varieties of potatoes each year, so that the results represent the average of at least ten separate tests. The cultural methods were the same as those described under the variety experiment. The following table gives the average results for **five years** from testing single-eyed sets taken from different parts of the tubers:

Potato Sets of uniform weight, and containing single Eyes taken from different parts of the tubers.	Average results for five years.		
	Weight of 30 largest Potatoes per plot (lbs.)	Percentage of Crop marketable (4 years).	Yield per Acre (bushels).
Middle portion	12.4	85.3	174.8
Stem end	11.5	82.1	167.7
Seed end	11.9	84.2	162.0

In four out of the five years, the eyes taken from the central portions of the potatoes produced the highest yields per acre and, in one year, the eyes taken from the seed ends of the potatoes were the most productive. In the average results for the five-year period, the eyes taken from the seed ends produced potatoes which came second in percentage of marketable tubers and lowest in total yield of potatoes per acre. In yield of marketable potatoes, there was only a difference of 1.3 bushels per acre between the results from the eyes taken from the stem end and from the seed end of the tubers. The results from the eyes taken from the central part of the potatoes gave the best returns in every respect.

In comparing these results with those of somewhat similar experiments conducted elsewhere it should be remembered that in the experiment here reported all of the potato sets weighed exactly the same amount and the individual pieces contained precisely one eye each. If the sets taken from the different parts of the potato were of uneven weights and contained a varying number of eyes there would be a combination of three determining factors, and the results would be difficult of interpretation. The force of this statement will be understood if the reader will make a study of the results already presented in this bulletin in reference to planting one-eyed sets of different sizes and one-ounce sets with a varying number of eyes.

PLANTING ONE, TWO AND FOUR POTATO SETS PER HILL.

An experiment was conducted in each of seven years by planting one, two and four potato sets per hill. The hills were the same distance apart in both cases and the amount of seed used per acre was uniform throughout. In each test, Plot No. 1 contained one whole potato of two ounces in weight per hill, Plot No. 2, two half potatoes of one ounce each per hill, and Plot No. 3, four quarter potatoes of one-half ounce each per hill. The experiment was conducted in duplicate each year, in some seasons the same variety of potatoes being used in both tests, and in other seasons different varieties of potatoes being used in the two tests. In the seven-year period there were fourteen distinct tests conducted. The treatment of the soil and the method of planting were similar to those described for the variety experiment. The following table gives the average of **seven years'** results in growing potatoes with one set, with two sets, and with four sets per hill:

Number of Sets Planted per Hill.	Weight of Sets Planted per Hill (ozs.).	Average Results for Seven Years.			
		Weight of 30 Largest Potatoes per Plot (lbs.).	Percentage of Crop Marketable.	Bushels per Acre.	
				Marketable.	Total.
One Whole Potato	2	10.9	81	154.9	187.7
Two Half Potatoes	2	10.4	77	145.8	183.1
Four Quarter Potatoes	2	8.9	72	124.6	165.4

The results of this experiment were very decided throughout. In each of the seven years the two-ounce whole potatoes gave the highest percentage, and the four half-ounce sets per hill gave the lowest percentage of marketable potatoes. The four sets of potatoes per hill gave the lowest yield of marketable potatoes, and with only one exception the lowest total yield of potatoes per acre in each of the seven years during which the experiment was conducted. The average results for the whole period show that two-ounce potatoes when planted separately gave an annual average yield of fully 30 bushels per acre of marketable potatoes more than the same amount of seed planted in the form of four one-half ounce pieces per hill. When a whole potato is planted a comparatively small number of the eyes start to grow and the nourishment in the potato goes to produce a few strong vigorous stems. By cutting the potato into small pieces practically all of the eyes are forced into growth. The cutting of the potato, therefore, tends to increase the number of stems produced, and when from two to four potato sets are planted in one place there is a greater number of stems produced than when one larger piece of the same total weight is used. The more pieces there are per hill the greater is the tendency to produce numerous stems which are weak, small and slender and which produce a large number of small potatoes, and a comparatively light yield per acre.

INFLUENCE OF PLASTER AND LIME WHEN SPRINKLED ON FRESHLY CUT SEED POTATOES.

The practice of sprinkling freshly cut seed potatoes with plaster (gypsum), lime or some other material is not entirely new. The use, however, of these materials is confined chiefly to a few potato growers and to seedsmen who sometimes forward potato eyes by mail. In order to obtain data which would form a serviceable guide in regard to the treatment of freshly cut seed tubers an experiment was conducted for five years in succession in which freshly cut seed potatoes were sprinkled with plaster or with lime, or were left untreated before planting. In order to secure as accurate results as possible six separate tests were made in one year, and four separate tests in each of the other four years. In the five-year period, therefore, no less than twenty-two tests were conducted. Finely ground land plaster and slaked lime were used. The planting took place in the latter part of May or in the first week of June each year, and equal amounts of seed were used on the different plots. The cultural methods were practically the same as those given in the variety tests.

The following table gives the average of twenty-two tests conducted for **five years** in treating freshly cut seed potatoes in different ways before planting.

Treatment of Freshly Cut Seed Potatoes.	Weight of 30 Largest Potatoes per plot (lbs.). Average 5 years.	Percentage of Crop Marketable. Average 4 years.	Yield per Acre (bushels). Average 5 years.
Coated with Ground Plaster.............	13.9	81.1	214.4
Coated with Slaked Lime	13.6	78.9	200.6
Not Treated	12.8	78.8	190.8

The average results show that freshly cut potatoes which were coated with land plaster gave 23.6 bushels per acre per annum over those which were left untreated. The results from the sets treated with lime occupied an intermediate position between those from the sets treated with land plaster and those left untreated. In each of four out of the five separate years the plaster coated sets produced the highest total yield per acre, and also the highest percentage of marketable potatoes. The average weight of the largest potatoes produced from the coated seed was higher than that of those produced from the untreated sets.

Another experiment was conducted for seven years in succession in which finely ground brick and road dust were each used for coating freshly cut seed potatoes in comparison with land plaster. The average results of fourteen tests made in seven years show the following yields of potatoes in bushels per acre per annum: untreated, 179.4, road dust, 186.0, ground brick, 189.5, and land plaster 191.1.

In the average results for twelve years untreated seed gave an average of 184.1, lime coated seed, 199.3, and plaster coated seed, 200.8 bushels per acre per annum. The results varied somewhat in different years but in the majority of the tests the land plaster or gypsum gave better returns than slaked lime for coating the freshly cut seed tubers.

Based on experiments which were conducted at the College a co-operative test was arranged through the medium of the Experimental Union. This was repeated in each of five separate years during which time there were 97 good reports of successfully conducted experiments received, or an average of about twenty per year. The experiment consisted of one plot of freshly cut potatoes which had been untreated, in comparison with another plot of exactly the same size and containing an equal number of sets which had been coated with land plaster as soon as cut. The same amount of seed was used in the two plots. Definite quantities of both the seed and the land plaster were forwarded from the College to the experimenters. The average results for the five years show that the coated seed gave a yield of 187.7 and the untreated seed of 177.6 bushels, or a difference of 10.1 bushels per acre per annum in favor of the use of the land plaster on the freshly cut sets. The coated sets gave the largest average yield per acre in each of four years, and in the other year the results were about equal. The experimenters were quite generally in favor of the use of land plaster for coating freshly cut seed potatoes as the result of their experimental work.

From the results of the various tests which were conducted both at the College and throughout Ontario it will be seen that there has been a decided advantage from coating freshly cut seed potatoes with some powdered material. Of the different materials used the finely ground land plaster or gypsum has proved the most satisfactory in increasing the yields of potatoes per acre. The land plaster or gypsum is secured from mines at Caledonia, at Cayuga, and at other places in Ontario. It is obtainable at a comparatively low cost.

PLANTING POTATO SETS AT DIFFERENT TIMES AFTER CUTTING.

It has been the opinion of some potato growers that it was an advantage to cut seed potatoes three or four or five days before they were planted. Possibly potatoes have been cut on a rainy day or on a Saturday when the children were not at school and the cut pieces were planted a few days later and fairly good yields were obtained. If such a method could be followed satisfactorily, it would often prove a convenience especially for the older people if not for the children. An experiment was conducted at the College for eight years with the object of securing definite information regarding the best time for planting potatoes after being cut for seed. At least two varieties of potatoes were used each year. Two lots of potatoes, each containing the same number and the same weight of tubers of each variety, were used. One lot of each variety of potatoes was cut from four to five days before the time of planting and the other lot of each variety was cut and planted on the same day. The cultural methods were uniform throughout and, as all the potatoes belonging to this experiment were planted at the same time, it will be seen that the one point of comparison was the difference in the time of planting the seed potatoes after they were cut. The following table gives the average of sixteen separate tests conducted in **eight years** from planting potatoes at different times after cutting:

Time of Cutting and of Planting Seed Potatoes.	Percentage of Crop Marketable. Average 8 years.	Yield of Potatoes per Acre (bushels). Average 8 years.
Potatoes cut and planted on the same day...............	77.4	170.1
Potatoes cut four or five days before planting............	76.3	162.3

It was, at first, the intention to cut a part of the potatoes four days before planting. On a few occasions, however, it was not possible to plant the potatoes satisfactorily until five days after they were cut. In the average results of the experiment which was conducted in each of eight years, the potatoes which were cut and planted on the same day gave an annual yield of 7.8 bushels per acre per annum more than those which were cut from four to five days before they were planted. Not only was there a larger yield per acre but there was also a larger percentage of marketable potatoes produced from the seed tubers which were cut and planted immediately. The best results were obtained from cutting and planting the potatoes immediately whether or not they were sprinkled with any material, such as: land plaster, slaked lime, road dust or ground brick.

Thinking that the different kinds of soil might have some influence in the results from growing potatoes from seed cut at different times, a co-operative experiment was conducted through the medium of the Experimental Union in order to glean further information and to enable the farmers to secure definite knowledge along this line of investigation. Seed of the same variety was carefully weighed into two lots and was sent from the College to each experimenter who applied for the experimental material in each of five years. Each experimenter was asked to cut one lot of potatoes five days before planting and to cut the other lot into an equal number of pieces five days later. All the potatoes were to be planted on the same day. It was evidently difficult for all the experimenters to plant on the fifth day, as for instance, in one year there were 218 good reports of successfully conducted experiments throughout Ontario. Of this number, 17 were planted four days, 192 five days, and 9 six days after the first lot of potatoes had been cut. The results of the co-operative experiments show that the potatoes which were planted immediately after they were cut surpassed in yield per acre those which were cut four, five and six days before planting in each year of the test. The average of over three hundred tests throughout Ontario in the five-year period show a yield of potatoes per acre per annum of 16.6 bushels in favor of cutting and planting immediately.

It will be seen that the results of experiments conducted at the Ontario Agricultural College and also throughout Ontario are decidedly in favor of planting potatoes immediately, rather than four, five, or six days after being cut.

PLANTING SEED POTATOES AT DIFFERENT DEPTHS.

The most suitable depth for planting seed potatoes depends somewhat upon the character of the soil and upon the method of cultivation. It should be remembered that the soil on which the experiments are conducted at the College is what might be termed an average clay loam, and the results in depth of planting would probably be somewhat different than those obtained from either a light, dry, sandy or a heavy, damp, clay soil.

Potatoes were planted in the experimental grounds at the College to a depth of one inch, three inches, five inches and seven inches in each of seven years. From two to four varieties were used each season. In the experiment extending over a period of seven years there were twenty-two separate tests conducted. All details in connection with the methods of culture were identical throughout the test as near as it was possible to have them, with the one exception of the variation in the depth of planting. The potatoes were planted in the latter half of May or in the first week of June according to the season. Level cultivation was practised throughout.

The following table gives the average results of twenty-two tests conducted in seven years in planting potatoes at four different depths:

Depth of Planting.	Depth of new Potatoes below surface. Average 3 years (inches).	Yields per Acre (bushels).	
		Marketable Potatoes. Average 5 years.	Total crop. Average 7 years.
One inch	1.7	177.4	192.4
Three inches	3.0	188.9	202.8
Five inches	4.0	188.6	206.2
Seven inches	4.9	164.1	189.6

In the individual years there was a considerable difference in the results from the different depths of planting. The largest yield per acre was obtained from planting at a depth of seven inches in one year, and of one inch in another year. The deep planting gave the highest returns in a dry season and the shallow planting in a season when there were frequent rains. The planting at a depth of five inches gave the highest yields in the greatest number of years, and stood the highest in annual yield per acre per annum for the whole period of seven years. When we take into consideration the yield of marketable potatoes we see there is practically no difference in the results from the plantings of three and five inches in depth. On examining the depth of the new crop of potatoes it was found that those which were produced from the three-inch planting were three inches deep, from the one-inch planting nearly two inches deep, and from the seven-inch planting nearly five inches deep. The potatoes in any one plot were not at a uniform depth, but the figures here presented in tabulated form are about the average. Some of the potatoes from the shallower plantings came so close to the surface that they were more or less sunburnt. On an examination of the potatoes produced from the different depths of planting, it was found that the percentage of sunburnt potatoes amounted to practically 33 from the one-inch planting, 4 from the three-inch planting, and nothing from the five and the seven-inch plantings. In regard to quantity and quality of potatoes the best results were obtained from planting at a depth of from three to five inches. Another interesting experiment would be to carefully test the comparative results of planting at the depths of three, four and five inches.

METHODS OF CULTIVATION.

A number of experiments have been conducted in the Field Husbandry Department at the Ontario Agricultural College in the use of different methods of cultivating potatoes. Attention is again drawn to the fact that the soil in which these experiments were conducted was what is usually termed an average clay loam and was fairly well under-drained.

In each of nine years, a combined experiment was conducted to determine the

The appearance in the spring of land which in the previous autumn had been placed into ridges thirty inches apart by means of a double mould-board plow.

influence of planting in rows and in squares, and in comparing hills or ridges with level cultivation. Each test consisted of three plots, the first being planted in rows twenty-six and two-fifth inches apart with the potatoes one foot apart in the rows, and the second and third each being planted with the potatoes thirty-three inches apart each way. Plots number one and two received level cultivation, and plot number three was hilled. The experiment was conducted in duplicate in each of nine years. In eight out of the nine years, two varieties of potatoes were planted, and the other year the one variety of potatoes was used in the duplicate test. The three plot experiment was, therefore, conducted eighteen times. The potatoes were planted at exactly the same rate of seed per acre in the different plots of the experiment. The individual sets planted in the rows would, therefore, be smaller than those planted in the squares, as the former constituted the larger number. The following table gives the average results of eighteen tests conducted in **nine years** with potatoes planted in rows and in squares and cultivated in hills and on the level:—

Method.	Cultivation.	Average Annual Results for nine years.		
		Weight of 30 largest potatoes per plot (lbs.)	Yield of marketable potatoes per acre (bush.)	Total yield per acre (bush.)
Rows 27 inches apart......	Level	11.0	162.9	**193.8**
Squares 33 inches apart....	Hills or ridges ..	12.1	143.0	**161.6**
Squares 33 inches apart ...	Level	12.6	129.9	**154.0**

In eight out of the nine years, the rows which were cultivated on the level and which were represented by plot number one gave a higher yield per acre than the squares which were also cultivated on the level and which were represented by plot number two. In the average results for the nine years the level rows gave a total yield of 39.8 bushels and a yield of marketable potatoes of 33.0 bushels per acre per annum more than the level squares.

The squares which were hilled gave an average increase in annual yield per acre over the squares which were cultivated on the level of 7.6 bushels of total crop and of 13.1 bushels of marketable potatoes. The highest average yields per acre were produced from hills in six, and from level cultivation in three of the years of this experiment. Speaking in a general way, it might be mentioned that the seasons in which the level cultivation gave the highest results were comparatively dry.

As an outgrowth of the experiment at the College in growing potatoes in hills and on the level, a co-operative experiment was planned for the farmers of Ontario. For five years in succession potatoes were distributed from the College to those farmers who applied for the material, and instructions were given for carrying on the test in comparing the practice of hilling up potatoes as against growing them on the level. The results in each of three years were in favor of the hilled potatoes, probably due to the cool damp season, and, in each of the other two years they were in favor of level cultivation. In taking the average of the five years, during which time 170 successfully conducted experiments were reported, we find that the potatoes which were hilled gave 210 bushels, and those which were grown on the level 206.2 bushels, or about 4 bushels per acre in favor of those grown in hills.

A few years ago, high yields of potatoes per acre were claimed from what was known as the "Rural Trench System." In this method, trenches about one foot deep were made in which the potatoes were planted in loosened soil. In order to glean some information regarding the value of such a system in Ontario, an experiment was conducted for three years in succession, and an average of three tests were made in each year, or a total of nine tests. Immediately before time for planting the potatoes trenches were dug to a depth of one foot and to a width of ten inches. The trenches were made four rods in length and three feet apart from centre to centre. Each test consisted of three plots. The soil removed from the trenches in number one plot was mixed with farmyard manure at the rate of twenty tons per acre, and that of number two plot was left unfertilized. Number three plot consisted of rows twenty-six and two-fifth inches apart, and was the same as our ordinary method of cultivation previously described. After the soil was returned to the trenches, the potatoes were planted in each of the plots of the experiment to a depth of about five inches below the surface. The average results for the nine tests in three years showed the following yields of potatoes per acre per annum: Trenches with farmyard manure, 290.8 bushels; trenches without manure, 245.6 bushels; and ordinary method, 283.6 bushels. It will be understood that in the ordinary method the rows were not so wide apart as were the trenches. Had the trenches for this experiment been dug in the autumn of the year so that the frost could have acted on the soil the results might have been somewhat different. From the results which have been obtained, there appears to be but little advantage from the loosening of the soil immediately before the potatoes are planted, as described in this experiment.

When potatoes are planted after sod, it is a frequent practice to plow the land in the latter part of May to a depth of about four inches. The potato sets are dropped from twelve to eighteen inches apart in every third furrow. The land is harrowed a few times before the potato plants reach the surface. The young growth of the grass and the roots of the plants keep the soil in a friable condition and, if the soil is properly handled excellent returns are sometimes obtained from this method. The soil between the rows of potatoes should be carefully scuffled as required throughout the season to clear the land of weeds, to prevent the soil from baking, and to conserve the moisture.

EXPOSURE IN THE SUN OF SEED POTATOES AND OF FURROWS AT TIME OF PLANTING.

Many farmers will realize that it is sometimes a difficult matter to prepare the land either with a single or a double mould-board plow, and to drop the potatoes in the furrows without an exposure of both the seed and the furrows to the air and the sun before the potatoes are covered. If the seed potatoes have been taken from a comparatively dark root cellar and exposed on the ground for a time before being covered it is interesting to know just whether or not the heat and the wind will exert an injurious influence on the vitality of the seed. For the purpose of gleaning some information on this question two sets of experiments were conducted at the College in each of five years. In one experiment there was an exposure of simply the drills, and in the other there was an exposure of both the drills and the potatoes. The second experiment referred to was made up of four separate plots. The drills were made and the potatoes dropped for all the plots of the experiment, and the drills for No. 1 were closed immediately, for No. 2 in twenty minutes, for No. 3 in one hour, and for No. 4 in five hours. Each of the experiments was conducted in duplicate each year, and, therefore, comprised ten different tests. The results of these experiments showed a small amount of injury from the exposure of the drills and the tubers in the field immediately before they were covered. The average yield per acre per annum for the five years was 147.9 bushels from the drills which were covered immediately, and 146.2 bushels from the drills which were not closed until five hours after they were made and after the cut potatoes had been dropped into them.

APPLICATION OF MANURES AND FERTILIZERS.

It is practically impossible to conduct experiments with fertilizers and potatoes on any one soil which will be a definite and complete guide for farmers who wish to grow potatoes under different conditions and on varying soils. The results from fertilizer experiments are influenced by the character of the soil, the fertility of the soil, the weather conditions, the date of planting, the method of cultivation, the kind of potatoes grown, etc. Realizing the difficulties in securing all the information desirable from fertilizer experiments, work has been conducted not only at the College but on various farms throughout the Province of Ontario. The work at the College has been carried on in certain sections of the experimental grounds and over Ontario through the medium of the Ontario Agricultural and Experimental Union. We believe that this system gives the farmers decidedly better information than if the work were confined entirely to the College. Through our assistance the potato growers are thus enabled to ascertain for themselves the influence of certain fertilizers upon the potato crops grown on their own particular soils. The plan adopted furnishes a means by which the farmers may know how to use the fertilizers economically and thus receive good returns and prevent unnecessary losses. The chief value of the co-operative work is for the farmers themselves, and yet the average results give important information in supplying suggestions and in forming a general guide for the Province.

Within the past twenty-four years a large amount of experimental work with fertilizers and potatoes has been conducted at the Ontario Agricultural College. In all experiments with potatoes and fertilizers duplicate tests were carried on each year generally by using a late variety of potatoes for one set and an early variety for another set. The fertilizers were sown broadcast and mixed through the surface soil. The potatoes were planted in rows 26 2-5 inches apart, and level cultivation was practised. The potato sets were planted one foot apart in the drills. All experiments were conducted on what might be termed an average clay loam.

For five years in succession an experiment was conducted by using thirteen different fertilizers with the potato crop. In each of three years the experiment was conducted on land which was somewhat elevated, and in the other two years on rather low lying land. The test was not conducted on the same land for more than one season. Besides the separate single fertilizers such as Nitrate of Soda, Muriate of Potash, and Superphosphate, a number of brands of commercial fertilizers were used. The Nitrate of Soda and Muriate of Potash were used at the rate of 160 pounds per acre, Unleached Ashes at the rate of 800 pounds per acre, and all other fertilizers at the rate of 320 pounds per acre.

The following table gives the average results of the experiment with fertilizers and potatoes for a period of **five years**:

Fertilizers.	Percentage of Crop marketable. Average 5 years.	Bushels of total Crop per Acre. Average 5 years.
Royal Canadian	90.3	162.4
Potato Manure	88.9	149.5
Bone and Potash	89.4	146.3
Sure Growth	86.6	146.1
Superphosphate (Animal)	88.0	143.6
Reliance	88.4	142.9
Superphosphate (Mineral)	87.6	141.6
Muriate of Potash	89.3	140.5
Victor	87.7	136.7
Pure Bone Meal	86.1	132.4
Capelton	86.8	130.4
Unleached Wood Ashes	87.9	130.3
No Fertilizer	86.3	121.7
Nitrate of Soda	80.1	117.1

The Royal Canadian, Reliance, Victor and Capelton fertilizers were obtained from the Capelton Chemical and Fertilizer Company, and the Potato Manure, Bone and Potash, Sure Growth and Pure Bone Meal from the W. A. Freeman Fertilizer Company. The Unleached Ashes was a mixed product obtained at the College. According to analyses made by the Chemical Department at the College the following average composition of the fertilizers was determined: Royal Canadian, 3.83 per cent. nitrogen, 10.15 per cent. available phosphoric acid, and 5.38 per cent. potash; and Potato Fertilizer, 3.19 per cent. nitrogen, 9.25 per cent. available phosphoric acid, and 6.30 per cent. potash. The single fertilizers had the following average composition: Nitrate of soda, 15.7 per cent. nitrogen; Superphosphate, 15.4 per cent. available phosphoric acid; and Muriate of Potash, 50.9 per cent. potash. The Royal Canadian Fertilizer usually sells for $38, the Potato Fertilizer for $34.50, and the Bone and Potash and Sure Growth Fertilizers each for $32.50 per ton. In recent years the average prices for the single fertilizers per ton have been approximately $60 for Nitrate of Soda, $24.50 for Superphosphate, and $50 for Muriate of Potash. The prices paid per ton for each of the single fertilizers in the spring of 1914 were as follows: Nitrate of soda $57, Superphosphate $20, and Muriate of Potash, $43. In the autumn of 1914, however, after the European war had started the Muriate of Potash advanced to $100 per ton.

It will be seen that the Royal Canadian Fertilizer when applied at the rate of 320 pounds increased the yield slightly over 40 bushels per acre. Leaving out of consideration the cost of transportation and of application and the influence of the fertilizer on the soil for future crops, it will be seen that the increase in yield of potatoes per acre was produced at a cost of fifteen cents per bushel for the Royal Canadian, and of twenty-two cents per bushel for the Potato Fertilizer. Of the separate fertilizers it will be seen that the Animal Superphosphate gave a higher yield than the Mineral Superphosphate, the Muriate of Potash and the Nitrate of Soda, and that the latter actually gave a lower yield of potatoes per acre than the unfertilized land.

Based on the results of the experiments with fertilizers and potatoes which have been described, another test was started and was continued in the experimental grounds for a period of eight years. The methods described in the former experiment will apply equally well for this test. Four of the fertilizers were similar to those used previously, viz., Royal Canadian, Potato, Superphosphate, and Muriate of Potash. In addition, a Home Mixed Fertilizer was used and potatoes were planted on unfertilized land as a basis of comparison. The test was conducted in duplicate each year. The following table gives the average results of the sixteen tests made in the eight years:

Fertilizers.	Average percentage marketable.	Average bushels per Acre per annum.
Home Mixed Fertilizer........	79.2	173.1
Royal Canadian	79.2	169.0
Potato Fertilizer	78.5	166.8
Superphosphate	76.3	162.0
Muriate of Potash	79.0	151.4
No Fertilizer	74.3	136.2

The fertilizers were used in the following quantities in pounds per acre: Muriate of Potash 160, and Superphosphate, Royal Canadian and Potato Fertilizer each 320. The Mixed Fertilizer consisted of Nitrate of Soda, Muriate of Potash, and Superphosphate in the proportion of one, one and two by weight, and was applied at the rate of 213 1-3 pounds per acre.

It will be seen from the results here presented that the fertilizers which were used in the two experiments come in the same comparative order in yield of potatoes per acre, viz., Royal Canadian, Potato, Superphosphate and Muriate of Potash. In this instance the Royal Canadian gave an average of 32.8 bushels of potatoes per acre over the unfertilized land, while in the other experiment the increase was 40 bushels per acre. An increase of over four bushels per acre per annum was obtained from 213 1-3 pounds of the Mixed Fertilizer in comparison with 320 pounds of the Royal Canadian Fertilizer.

In still another experiment extending over a period of six years cow manure applied at the rate of twenty tons per acre gave an average yield of 179.6 bushels per acre in comparison with 164.3 for the Royal Canadian, 174.3 for the Home Mixed Fertilizer, and 132.9 bushels for the unfertilized land.

In an experiment repeated in each of five years in which twenty tons of barnyard manure were compared with two tons of poultry manure in potato production it was found that the former gave an average of 176.9 and the latter of 172.8 bushels per acre in comparison with unfertilized land, which gave an average of 129.0 bushels per acre. The cow manure was well rotted. Both kinds of manure were applied in the early spring and were thoroughly mixed through the soil.

Farmyard manure at the rate of twenty and of five tons, and poultry manure at the rate of one ton per acre were used in each of two years for the potato crop. The average results show that the first gave an average of 162, the second of 149, and the third of 152.4 bushels per acre. Unfertilized land, under exactly the same treatment, gave an average of 133.7 bushels of potatoes per acre.

CO-OPERATIVE EXPERIMENTS WITH POTATOES AND FERTILIZERS.

There is no better way in which farmers can obtain a definite knowledge of the soil requirements on their own farms than to conduct experiments with fertilizers in a systematic way. In Ontario co-operative experiments are carried on through the medium of the Ontario Agricultural and Experimental Union. The methods of operation and the material selected for the co-operative work are based largely upon the experimental work at the College. Many of the experimenters are practical farmers who are now trained in experimental work, have good educations, some having attended our Agricultural College and all of them having a knowledge of farming operations. Great care is exercised in planning the various co-operative experiments in such a way that they can be successfully undertaken by the people who are to be benefited thereby. In every case the work is made as clear of comprehension, as definite in purpose, and as simple in method of operation as is consistent with the object in view. It has been the aim throughout to make the co-operative work as interesting, as valuable, and as instructive as possible.

An Eight-plot Experiment.—In each of the five years, from 1907 to 1911 inclusive, an experiment with fertilizers and potatoes was conducted throughout Ontario. The nitrate of soda and the muriate of potash were applied at the rate of 160 pounds, and the superphosphate at the rate of 320 pounds per acre. A home mixture, or complete fertilizer composed of one-third the amount of these fertilizers was applied at the rate of 213 1-3 pounds per acre. The Royal Canadian and the Potato Fertilizer which have given good results at the College were applied at the rate of 320 pounds each per acre. The nitrate of soda was sown on the land when the plants were about three inches in height, and all the other fertilizers at the time of sowing the seed. The advice to each experimenter was to apply 500 pounds of average cow manure per plot, the application being equal to twenty tons per acre. The cow manure was mixed with the soil to a depth of from four to five inches and the fertilizers were stirred in the soil to a depth of from one to two inches. All fertilizers and potatoes for the work were sent to the experimenters free of charge. The table here presented gives the average results of these co-operative experiments with fertilizers and potatoes carried on for **five years**, and including the tests conducted on ninety-eight Ontario farms.

Kind of Fertilizer Used.	Fertilizer per Acre.		Average Yield per Acre. 5 years, 98 tests (bushels).
	Exact Weight (lbs.).	Approximate Cost.	
Nothing	0	$ .00	129.2
Nitrate of Soda	160	4.80	153.4
Muriate of Potash	160	4.00	160.8
Superphosphate	320	3.92	156.8
Home Mixture	213⅓	4.24	166.3
Potato Fertilizer	320	5.52	167.5
Royal Canadian	320	5.60	164.5
Cow Manure	40,000 (20 tons)	6.00	174.7

The cost of each fertilizer as given in the table represents approximately, under normal conditions, the average cost per acre for the fertilizers as used in the co-operative experiments. The quotations were based on the factory prices for quantities of about one ton of each fertilizer. The twenty tons of cow manure would mean about twelve good sized loads per acre, and manure in Guelph has been selling at fifty cents per load, which is probably about the average for the Province. It is exceedingly difficult to place a price on farmyard manure as in most cases it is not purchased but is produced on the farm. Each person may place such value on the manure as he deems expedient and study the results according to his own circumstances. It should be stated that the freight on the fertilizers and the application of both the fertilizers and the manure are not taken into consideration in the foregoing statement, nor yet is there any account made of the influence of the different fertilizers and the manure upon the land after the first season.

According to the prices given for the manure and the fertilizers in the tabulated results the increased yield of potatoes was produced at a cost per bushel for the home mixed fertilizer of 11.4 cents; muriate of potash 12.7 cents; cow manure 13.2 cents; superphosphate 14.2 cents; potato fertilizer 14.4 cents; Royal Canadian 15.9 cents, and nitrate of soda 19.8 cents.

A Six-plot Experiment.—As a result of an experiment conducted at the Ontario Agricultural College in each of five years it was found that the potato fertilizer and the Royal Canadian fertilizer gave the highest yield of potatoes per acre of the different fertilizers used in the five-year experiment. In another experiment extending over a period of five years, in which several fertilizers were used, the highest yield per acre was obtained from a mixed fertilizer similar to the one used in our co-operative experiments, and which was composed of nitrate of soda, muriate of potash and superphosphate in the proportion by weight of one, one and two, and which was applied at the rate of 213 1-3 pounds per acre. This was followed by the potato fertilizer and the Royal Canadian fertilizer, each of which was applied at the rate of 320 pounds per acre. Based on these and other results an eight-plot co-operative experiment was conducted in each of five years previous to 1912, in which six different fertilizers were compared with each other, with farmyard manure, and with no fertilizer with potatoes. The home mixture, Royal Canadian and potato fertilizer again made good records.

Having before us the results of the experiments just referred to it was thought wise to start a co-operative experiment in testing different quantities of fertilizers per acre in comparison with each other, with farmyard manure alone, with farmyard manure and fertilizer, and with unfertilized land. We, therefore, placed on our list an experiment with fertilizers, cow manure, and no fertilizer with potatoes, in the spring of 1912, and we conducted experiments in 120 places throughout the Province in each of three years. We divided the number into four groups of thirty each, and used the potato fertilizer for one group, the Royal Canadian fertilizer for another, a fertilizer composed of nitrate of soda, muriate of potash, and superphosphate, in the proportion by weight of seven, nine and sixteen, for another, and a fertilizer composed of nitrate of soda, muriate of potash and superphosphate, in the proportion of one, one and two for the fourth group. Each of the first three fertilizers was applied alone at the rate of 320, 640 and 960 pounds per acre, and 320 pounds in combination with ten tons of cow manure per acre. In comparison with these, another plot received cow manure at the rate of twenty tons per acre, and one plot was left unfertilized. For No. 4 group the fertilizer was used in the same proportion, with the exception that the minimum amount was 213 1-3 instead of 320 pounds per acre. Owing to the unusual weather conditions in 1912 the potato rot was very prevalent and many of the results of the fertilizer experiments obtained could not be used on that account. There were, however, nineteen good reports of successfully conducted experiments with fertilizers and potatoes obtained in which the rot did not prove troublesome and which represented fairly well the four different kinds of fertilizers distributed. In 1913 we received in all thirty-one good reports, there being from six to ten good reports for each group. In 1914 twenty-eight good reports of successfully conducted experiments were received, there being exactly seven good reports for each separate test. We, therefore, have for the three years seventy-eight good reports of successfully conducted experiments.

The following table gives the average results of the various tests of each of the four fertilizers, and also the average results of the four fertilizers comprising in all seventy-eight separate tests conducted during the **three years:**

Fertilizers and Manures.	Fertilizer per Acre. Weight (lbs.).	Fertilizer per Acre. Cost.	Yield of Potatoes per Acre (bushels). A. Potato Fertilizer. 3 years, 17 tests.	B. Royal Canadian Fertilizer. 3 years, 19 tests.	C. Home Mixture. 3 years, 22 tests.	D. Home Mixture. 3 years, 20 tests.	A.B.C.D. Average 4 Fertilizers. 3 years, 78 tests.
		$ c.					
1. No Fertilizer....	0	00	158.8	119.5	106.7	142.3	**131.8**
2. Fertilizer.......	320	6.31	179.5	139.9	130.8	*165.9	**154.0**
3. Fertilizer.......	640	12.62	187.3	152.6	143.7	180.4	**166.0**
4. Fertilizer.......	960	18.93	196.0	169.0	160.0	190.4	**178.9**
5. {Fertilizer....... / Cow Manure....	320 / 10 tons	9.31	198.0	166.5	160.8	194.1	**179.9**
6. Cow Manure....	20 tons	6.00	203.0	166.0	163.8	194.3	**181.8**

It should be understood that the different fertilizers were tested on different farms. It is, therefore, not fair to make a close comparison of one fertilizer with another. The results are valuable in showing the yields from the different amounts of fertilizer in comparison with the yield from no fertilizer, from cow manure and from a combination of cow manure and fertilizer. It will be seen that on the average there was an increase in the yield of potatoes per acre of 22.2 bushels at a cost of 28 cents per bushel from 320 pounds of fertilizer; of 34.2 bushels at a cost of 37 cents per bushel from 640 pounds of fertilizer; and of 47.1 bushels at a cost of 40 cents per bushel from 960 pounds of fertilizer. The yield of potatoes per acre increased as the amount of fertilizer used became greater. From a study of these results it would seem as though the first 320 pounds of fertilizer increased the yield 22.2 bushels, the second 320 pounds 12 bushels, and the third 320 pounds 12.9 bushels per acre. It will also be observed that the twenty tons of cow manure per acre increased the yield of potatoes exactly 50 bushels over no fertilizer or 1.9 bushels per acre over the combination of ten tons of cow manure and 320 pounds of fertilizer per acre. The amount of fertilizer for Plot 2 in Group D consisted of 213 1-3 instead of 320 pounds per acre and was identical with the home mixed fertilizer used for five years throughout Ontario in experiments conducted on ninety-eight farms, the results of which have already been presented. This fertilizer increased the yield of potatoes 23.6 bushels at an average cost of 18 cents per bushel.

Each experimenter was asked to conduct his fertilizer test on the average soil of his farm. The results here presented are, therefore, for average soils of Ontario. On some farms the fertilizers paid better than they did on others. Every farmer who wishes to use fertilizers should become as familiar as possible with the requirements of his own particular farm. The results here given show in a general way the records of these fertilizers under the varying conditions of the farm lands of the Province, and should furnish valuable suggestions.

*Fertilizer D was used at the rate of 213⅓ instead of 320 pounds, and at a cost of $4.24 instead of $6.31 per acre.

SPRAYING WITH BORDEAUX MIXTURE FOR THE PREVENTION OF LATE BLIGHT, EARLY BLIGHT AND TIP BURN.

The late blight is considered the most destructive disease of the potato crops of this country. It is a parasitic fungus which develops on potatoes in late summer, and is particularly disastrous in moist seasons, and in low lying, damp locations. The first indication of the disease is the appearance on the leaves of brownish spots which rapidly grow darker in color, causing the leaves to curl and crumple, and in some instances to decay and produce an offensive odor. The brownish spots on the lower surface of the leaves show a delicate downy coat and soon form white bands around the borders. The spores which are produced in the spots on the leaves are said to be scattered by wind and water, thus conveying the disease to other plants. It is supposed that some of the spores of the late blight finally enter the potatoes, and that they frequently cause brownish spots under the skin and sometimes a dry rot of the tubers.

Bordeaux mixture is supposed to be efficacious as a preventative against the late blight (Phytophthora infestans), the early blight (Alternaria solani), and the tip burn, and in repelling flea beetles, and also if used in conjunction with Paris green or lead arsenate in killing the Colorado potato beetles. For best results, however, it is necessary to spray early in the season, to do the work thoroughly and to repeat the operations as required until the danger of trouble is past.

All the varieties of potatoes under experiment at the College have been sprayed with Bordeaux mixture from three to five times each year since 1906. Previous to 1906 different fungicides such as Bordeaux mixture and Bug Death were used. In a duplicate experiment conducted in 1901 potatoes which were sprayed with Bordeaux mixture gave an average of 288.1, and those which were left unsprayed an average of 268.4 bushels per acre.

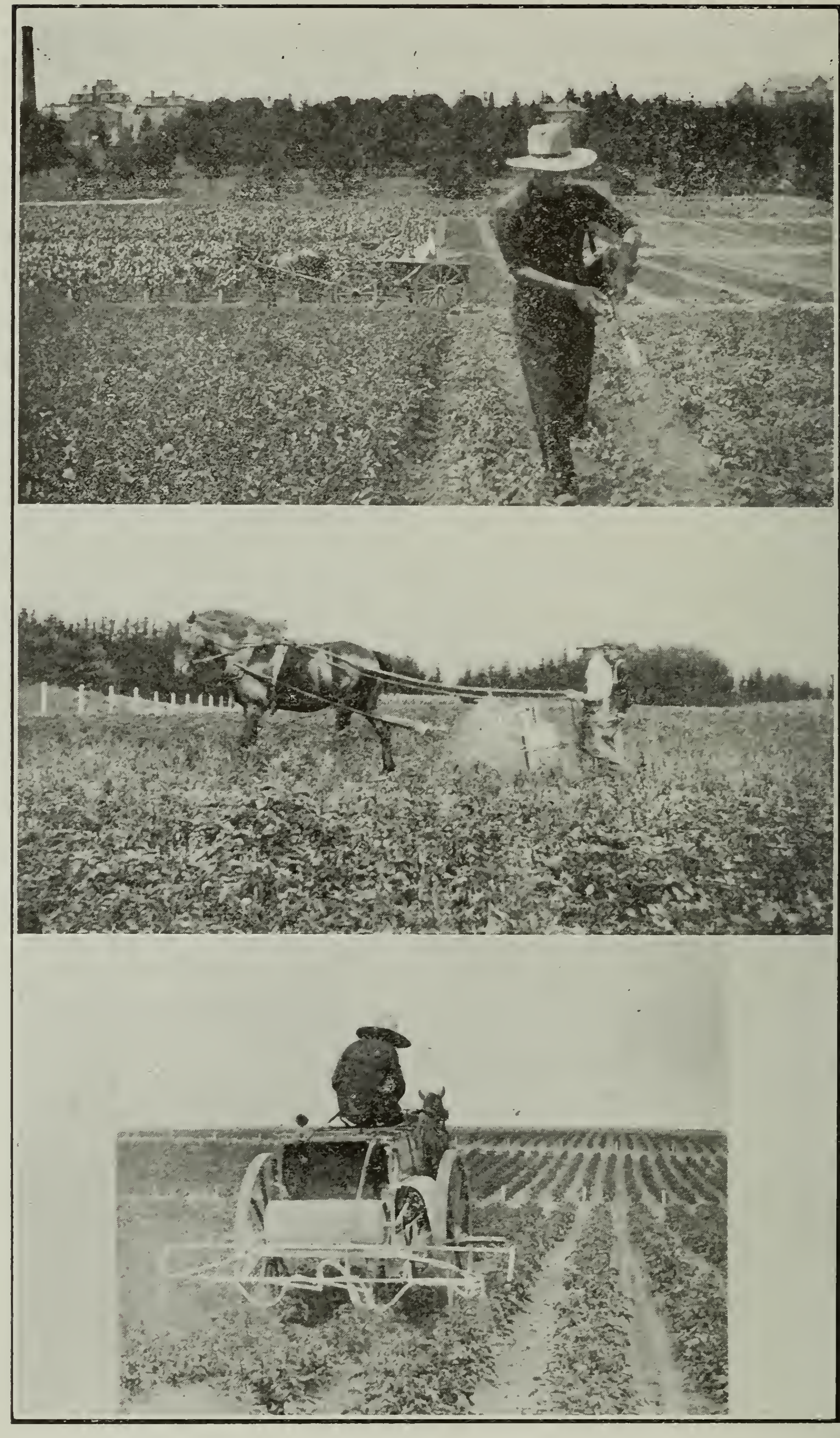
In 1907 an experiment was started in spraying potatoes at the College with two preparations of Bordeaux mixture. Three varieties of potatoes, an early, a medium, and a late were used for each preparation. Each test consisted of five plots as follows: 1, 2, 3, and 4, plants sprayed on top three, four, five and six times respectively; and 5, plants sprayed on top and underneath the leaves three times. In 1909 an extra plot which was left unsprayed was added, thus making six plots in each test, and a better basis of comparison.

One preparation of Bordeaux mixture was made according to the usual formula of 4-4-40, more fully described as follows:

Copper Sulphate (Bluestone)	4 pounds.
Unslaked Lime	4 pounds.
Water	40 gallons.

Stock solutions were made by suspending in a barrel one coarse bag containing twenty-five pounds of bluestone which was allowed to dissolve in twenty-five gallons of hot water, and by dissolving in another barrel twenty-five pounds of unslaked lime in twenty-five gallons of cold water. These two solutions were kept separately until required for the different sprayings. In preparing the Bordeaux for use the materials were mixed in the proportions of one gallon of the bluestone solution, one gallon of the lime solution, and eight gallons of water.

The other preparation of Bordeaux mixture was made in exactly the same way with the exception that six instead of four pounds of bluestone were used. The formula, therefore, of this preparation was 6-4-40.



Spraying Potatoes in different years in the Experimental grounds at the Ontario Agricultural College.

The experiment was conducted from 1907 to 1913, inclusive, making in all seven years. On the average of the whole period the first spraying in the season took place as follows: plot 4 on July 3rd, plots 3 and 5 on July 17th, plot 2 on July 31st, and plot 1 on Aug. 14th. Two weeks were allowed between each two sprayings. Care was taken to do the work thoroughly in the various years of the experiment. The sprayings were made with a one wheel, four nozzle, hand sprayer from 1907 to 1909, inclusive, with watering cans equipped with special nozzles for making a fine spray in 1910, and with a two wheel, four row, horse sprayer with nozzles arranged for spraying above and below the leaves from 1911 to 1913, inclusive. In the four years, from 1907 to 1910, however, a knapsack with the assistance of a wooden rake was used for spraying the potatoes both above and below the leaves. In the last three years of the experiment all sprayings were accomplished satisfactorily with a horse machine and the nozzle attachments. For each application the potatoes which were sprayed both above and below the leaves required about twice as much material as those which were sprayed only on top.

In the seven years of this experiment rot occurred in 1910 and in 1912, but in none of the other years. The results, therefore, will be presented separately for the years in which there was no rot, and for the years in which rot occurred. The sprayings on No. 4 plot were not complete in every year and consequently the results from that plot are omitted.

The following table gives the average results of spraying potatoes with Bordeaux mixture in the years 1907, 1908, 1909, 1911 and 1913:

Number of Sprayings.	Portion of Plants Sprayed.	Average Percentage of Green Vines on Sept. 6th. 18 tests.	Average Weight of 30 Largest Potatoes per Plot (lbs.). 18 tests.	Yield of Potatoes per Acre (bushels).			
				Marketable.		Total.	
				3 years, 18 tests.	5 years, 30 tests.	3 years, 18 tests.	5 years, 30 tests.
0	0	60	10.17	151.1	*....	179.1	*....
3	Top	67	10.57	156.3	169.0	184.1	200.2
4	Top	69	10.65	159.7	173.4	189.0	205.6
5	Top	71	10.78	167.3	179.9	195.2	210.8
3	Top & Bot'm	77	11.43	169.8	183.9	197.7	214.7

These results give the averages of a large amount of experimental work, including early, medium and late varieties of potatoes, and two different spraying preparations in each of five years. The three years' experiment is made up of 18, and the five years' experiment of 30 distinct tests.

Even in those years in which no rot occurred there was on the average an actual increase in yield of potatoes per acre from spraying with the Bordeaux mixture. It will be seen that the sprayings had an influence not only in increasing both the yield of marketable and total crop per acre, but also in prolonging the growth of the plants and in increasing the size of the potatoes. The results of the experiment both for three and for five years show the highest yields per acre from the plots which received three sprayings, both above and below the leaves. It is

* The unsprayed plot was not included in the test until 1909.

interesting to know that spraying machines are now made which will give satisfactory results in spraying, both above and below the leaves, and that three applications made in this way are likely to give better results than five applications in which the spraying material is conveyed to the tops of the plants only.

Of the two spraying materials used the 6-4-40 solution gave slightly better results than the 4-4-40 formula. Although an early, a medium and a late variety were used each year with each of the solutions the varieties were not the same, and this fact might have had some influence on the comparative results from the two preparations. Further experiments would need to be conducted before conclusions could be obtained regarding the comparative value of the two spraying materials.

As has already been stated a small amount of rot occurred in 1910 and a large amount in 1912. In the former year the percentage of rot which developed by the end of November in connection with the experiment here referred to was as follows: Unsprayed 5, sprayed three times 1, four times 1, five times 1, and sprayed both above and below the leaves 2. As was stated previously, the plot which was sprayed both above and below the leaves three different times received the treatment earlier than the plot which was sprayed only on top of the leaves on three separate occasions. It will be seen that while the spraying did not entirely eliminate the rot it reduced it greatly in every instance. In 1912 all the rotten potatoes in each plot were carefully counted, but unfortunately the number of sound potatoes was omitted in that year, and it is, therefore, impossible to give the percentage of rot according to number. In 1912, however, the spraying material, whether used on top of the leaves for three, four or five times, or both on top and below the leaves for three times, had practically no influence in reducing the amount of rot. As the spraying with Bordeaux mixture was done carefully and in different ways it seems evident that the rot in that year was not caused by the late blight.

Another experiment in spraying for late blight was started in 1907 and was conducted for seven years in succession. At the beginning the experiment consisted in spraying both an early and late variety two, three, four, five and six times. In 1909 an unsprayed plot was added to each test. The first sprayings in the season were made from June 26th to July 5th according to season, the average of the seven years being July 3rd. Two weeks were allowed between each two sprayings. The Bordeaux formula used for this experiment consisted of bluestone 6 pounds, lime 4 pounds, and water 40 gallons. For information regarding method of spraying, etc., the reader is referred to the description given in the last experiment. In all of the years, excepting 1910 and 1912, the weather conditions were favorable for the growth of healthy potatoes, no rot occurring in those years. In the average results for the three years in which there was no rot and in which the unsprayed plots were used as a basis of comparison the following average yields in bushels per acre from the different number of sprayings were obtained: two sprayings 181.7, three sprayings 195.9, four sprayings 200.4, and five sprayings 193.0. The unsprayed plot gave an average of 170.6 bushels per acre. It will, therefore, be seen that the highest returns were obtained from four sprayings, which gave an increase of practically thirty bushels per acre over the unsprayed plot. The results from the plots which should have received six sprayings were incomplete in one of these years, hence the average for the period cannot be presented. In the average for the five years' experiment in which there was no rot the results from the different sprayings in yield of potatoes per acre per annum were as follows: two sprayings 191.6, three sprayings 202.8, four sprayings 214.6, and five sprayings 209.7.

In 1910 both the rotten and sound potatoes of each of the varieties and from each of the plots belonging to this experiment were carefully counted. The average results in percentage of rot, yield per acre, etc., for this year are presented as follows:

Number of Sprayings.	Dates of Sprayings.						Average Date of Maturity. October.	Average Yield per Acre Sound Potatoes (bushels).	Average Percentage of Rot in Whole Crop.
	July.		August.			Sept.			
0...........	..	..	..	..	..	..	7	111.0	32
2...........	5	19	..	..	..	..	11	117.5	31
3...........	5	19	2	..	..	..	12	143.0	19
4...........	5	19	2	16	..	..	13	137.3	15
5...........	5	19	2	16	30	..	15	152.6	8
6...........	5	19	2	16	30	13	17	162.8	3

The results show that as the number of sprayings increased the date of maturity was extended, the average percentage of rot was decreased, and with one exception the average yield per acre was increased. The two varieties of potatoes used in this experiment were more subject to rot than the majority of the six varieties used in the previous experiment, which accounts for the large percentage of rot in the former as compared with the latter.

In 1912, when the rot was prevalent, the number of diseased potatoes was carefully counted in the autumn, but the number of sound potatoes was not determined, and consequently the percentage of rotten tubers cannot be tabulated as in the former test. It might be stated, however, that in 1912 none of the sprayings showed a beneficial influence in the reduction of rot. As in the case of the previous experiment, it seems apparent that the rot was not caused by the late blight in 1912.

THE RESISTANCE OF POTATOES TO ROT.

Within the past twenty-six years the potato crop was practically free from rot at the Ontario Agricultural College in each of sixteen seasons. Rot was somewhat troublesome in the years 1899, 1902, 1905, 1906 and 1910, and it was quite serious in 1897, 1903, 1904, 1912 and 1915. It is interesting to note that in 1898 and 1913 there was practically no rot in the potato crops, even though rot had been very prevalent in the two preceding years. As a number of varieties of potatoes were grown under uniform conditions at the College the results of the comparative resistance or susceptibility to rot forms an interesting study. Since 1902 the varieties were sprayed with Bordeaux mixture as a fungicide, and with either lead arsenate or Paris green as an insecticide, from three to four times, with the exception of the years 1904, 1905 and 1906, when Bug Death, which was claimed to be a fungicide as well as an insecticide was used in the dry condition instead of Bordeaux mixture and Paris green. The spraying was done with a one wheel, four nozzle, hand-sprayer from 1907 to 1909, inclusive, with watering-cans in 1910, and with a two wheel, four nozzle, horse sprayer from 1911 to 1915, inclusive.

Twenty varieties of potatoes were grown in each of the years 1903, 1904, 1905, 1906, 1910, 1912 and 1915, when rot was more or less prevalent. One other important variety was included in the test for six of these years starting in 1904, and another variety for five of the years starting in 1905. Very careful determinations were made of the number of sound and of rotten potatoes at the time of harvesting, and also after being stored in the winter. Unfortunately, some of the determinations in the crop of 1912 were omitted, and the results for that year cannot be tabulated.

The following table gives the color of the potatoes, the average number of days to mature, and the average percentage of potatoes partially or wholly rotten in the crops produced in each of **six years,** and including twenty-two varieties:—

Varieties.	Color.	Average number of days to mature (6 years.)	Average percentage of rotten potatoes 6 years 1903-4-5-6-10-15,
1. Davies' Warrior	White	115	(a) 2.97
2. Extra Early Eureka	White	94	(b) 4.10
3. Stray Beauty	Red	89	4.61
4. Early Pinkeye	Pink and white	89	5.33
5. Irish Cups	Rose	109	8.97
6. Lightning Express	Pinkish white	94	13.77
7. Sir Walter Raleigh	White	109	15.29
8. Six Weeks	Rose	91	19.44
9. Empire State	White	110	19.60
10. American Wonder	White	108	20.39
11. New White Beauty	White russet	108	20.71
12. Rural New Yorker No. 2	White	111	21.21
13. White Elephant	Rose and white	108	22.19
14. Burpee's Early Extra	Rose and white	108	23.44
15. Early Fortune	Rose	93	23.75
16. Rose's New Invincible	Rose	108	2[illegible].35
17. Carman No. 1	White	109	25.02
18. Pearl of Savoy	Light rose	110	25.06
19. Rose of the North	Rose	102	25.48
20. Early Ohio	Rose	92	26.59
21. Beauty of Hebron	Rose	108	27.52
22. Early Rose	Rose	104	27.66

(a) Average 5 years, (b) Average 4 years.

The average percentage of rot of the varieties here reported for each of the six years included in the attached table was as follows: 1903, 26.3; 1904, 40.2; 1905, 5.7; 1906, 5.0; 1910, 2.9; and 1915, 34.7. The amount of rot for the twenty-two varieties, therefore, in the average of these six years in which the rot was prevalent would be practically 18 per cent. The varieties of potatoes which have been grown at the College within the past twenty-six years have had an amount of rot equivalent to an average of probably 6 or 7 per cent. per annum.

Very careful records of the rainfall at the College have been kept by the Department of Agricultural Physics in each of the past sixteen years. In comparing the amount of rainfall during the months of July, August and September with the amount of rot in the potato crop in each of the past sixteen years some interesting information has been obtained. The annual amount of rainfall for the three months referred to for the eight years in which there was no rot was 7.1 inches, for the four years when there was a moderate amount of rot 9.8 inches, and for the four years in which the rot was abundant 11.7 inches. The amount of rainfall, therefore, appears to have a very marked influence in making conditions favorable or unfavorable for the development of rot.

In the average results of all the varieties grown in either four or five years in which rot was more or less prevalent the Davies' Warrior, gave the lowest percentage of rotten potatoes. According to the results here presented Davies' Warrior, Irish Cups, Sir Walter Raleigh, and Empire State were the freest from rot of the late varieties, and Extra Early Eureka, Stray Beauty and Early Pinkeye of the early varieties. Of the eight varieties freest from rot five were early in reaching maturity, and of the eight varieties most susceptible to rot two were early in maturing. It is interesting to note that the three varieties least subject to rot included one of the latest and one of the earliest varieties in the list. Some of the varieties which were most susceptible to rot, such as the Early Ohio, the Beauty of Hebron, and the Early Rose are well known, and have been grown considerably throughout Ontario.

The following table gives the percentage of rot of a few characteristic varieties in each of **four years:**

Varieties.	Percentage of Rotten Potatoes.				
	1905.	1906.	1910.	1915.	Average 4 years.
Davies' Warrior	.83	1.23	.72	12.09	**3.72**
Extra Early Eureka...	.35	.77	0	15.27	**4.10**
Stray Beauty	0	.69	0	17.34	**4.51**
Early Pinkeye.........	0	.44	0	20.75	**5.30**
Early Rose	.85	8.70	23.06	36.89	**17.38**
Pearl of Savoy	8.24	11.98	12.83	45.93	**19.75**
Early Ohio............	1.22	6.58	0	75.46	**20.82**
Carman No. 1	35.43	.70	.29	47.07	**20.87**

It will be seen that the very early varieties such as the Stray Beauty and the Early Pinkeye were entirely free from rot in 1905 and in 1910, and that the early potatoes such as the Extra Early Eureka and the Early Ohio were free from rot in 1910. It might be noted that the Davies' Warrior, which is a late maturer, was the only potato entirely free from rot out of one hundred and eight varieties grown in 1904. The Early Rose, which is now a medium late potato, had a comparatively large percentage of rot in each of the years 1906, 1910 and 1915. Fully one-third of the Carman No. 1 rotted in 1905, but the seed taken from this crop produced potatoes in 1906 which were almost free from the disease. The Pearl of Savoy rotted considerably in each year in which the disease was prevalent. It is apparent that very early varieties escape the rot almost entirely in some seasons. In other years, however, while a few of the early varieties are comparatively free from rot others are affected very seriously. These points are illustrated by the results of the Extra Early Eureka and the Early Ohio varieties.

There are still prominent varieties of potatoes in Ontario which we have not been able to include in the foregoing groups, and which will receive special consideration at this time. In the tests of three years in which rot occurred the Green Mountain had on the average three times, and the Delaware twice as much rot as the Stray Beauty, and the first named sort had slightly less rot than the Rural New Yorker No. 2. The Green Mountain and the Delaware varieties have several characteristics in common and sometimes one variety is sold for the other. In the years 1910 and 1915 the average percentage of rot of some of the varieties was as follows:—Davies' Warrior 6.4, Extra Early Eureka 7.6, The Hustler 7.6, Eldorado 8.2, First Choice 8.3, Solanium Commersoni Violet 9.5, Delaware 10.5, Irish Cobbler 13.6, Pearl of Savoy 29.4 and Early Rose 30.0. The Extra Early Eureka and the Irish Cobbler varieties resemble each other in certain characteristics and some people claim that they are identical. In the years 1910, 1912 and 1915, however, when these varieties were grown under uniform conditions the Irish

Cobbler had the largest amount of rot in each year. In freedom from rot in 1915 Dalmeny Acme came first, Late Faction fourth, Dooley eighth, Statesman fifteenth, Pan-American thirty-eighth, Wonderful forty-fifth, and Carman No. 1 eightieth on the list of varieties.

In each of the past six years we secured seed potatoes of the Empire State variety from Muskoka, where they have been grown on the same farm for twenty-three years continuously. The crops produced from the Muskoka seed potatoes purchased in the years 1910, 1912 and 1915 had about one-quarter less rot than those produced from the Empire State variety grown at the College continuously for the past twenty-six years.

In the spring of 1913 six lots of potatoes were secured from different localities in Ontario, and in the spring of 1915 the same varieties were again obtained from exactly the same sources. In 1915 six plots were planted with the second years' crop from the 1913 seed, and six other plots with the seed purchased from the outside localities. The average percentage of rot in the crops produced was 10.9 in the former and 9.9 in the latter.

An experiment in hilling and level cultivation for potatoes was conducted in duplicate in each of four years in which rot occurred. The average results of the eight tests showed 27.7 per cent. rot from the level cultivation, and 21.8 per cent. rot from the hills.

Each of six varieties of potatoes were planted on four separate dates in 1910 and in 1915. The first planting took place on May 31st, and the last on July 12th, and two weeks were allowed between each two dates of planting. The following table gives the average percentage of rot of the six varieties planted on different dates in each of two years:—

Dates of Planting.	Percentage of Whole Crop Rotten.	
	1910.	1915.
May 31	1.16	33.43
June 14	4.27	27.28
June 28	5.45	13.98
July 12	22.75	3.71

It will be seen that as the date of planting advanced the percentage of rot in the whole crop increased in 1910 and decreased in 1915. This was true in the case of each variety as well as in the average of the six varieties, of which two were early, two medium and two late. In 1915 the six varieties were also planted on May 3rd and on May 17th, and the average percentages of rot were 22.8 and 26.7 respectively. It will, therefore, be seen that in 1915 the maximum amount of rot was developed from the planting of the 1st of June.

In connection with these results it is interesting to study the amount of rainfall at the College in each of four of the growing months in 1910 and in 1915. The total number of inches of rainfall in each of the four months in the years referred to was as follows: 1910, June .78, July 1.89, August 3.18, and September 3.29; and 1915, June 2.27, July 5.87, August 6.16, and September 3.92. It will, therefore, be seen that the rainfall undoubtedly had a marked influence in the amount of rot produced in the potatoes grown from the different dates of planting.

Potatoes of different stages of maturity which were planted under uniform conditions in each of the years 1910 and 1915 showed but little difference in rot susceptibility.

ROT IN STORED POTATOES OF DIFFERENT VARIETIES.

In each of the eight years in which rot occurred the number of decayed tubers of each variety was counted, not only in the field at the time of digging, but also in the cellar when the potatoes were stored. As there is so little information in print regarding the comparative amount of rot in the field and in the stored potatoes of different varieties the matter will be referred to in detail as it relates to a few characteristic kinds for the past year. The eighty-four varieties of potatoes which were grown under similar conditions in 1915 were dug, the number of rotten potatoes counted, and the sound tubers stored in the basement of the Experimental Barn in September. The potatoes were sorted in October, and again in January, and the number of rotten potatoes was carefully determined on each occasion. In the average of the eighty-four varieties the amount of rot at the time of digging was 17.5 per cent., at the time of sorting the potatoes in October 4.6 per cent., and at the time of examining the stored potatoes in January 3.2 per cent. The winter temperature of the potato cellar was kept at about 33 degrees to 35 degrees Fahrenheit.

The following table gives the percentage of rot of each of fourteen characteristic varieties of potatoes when the tubers were examined at each of three different times:—

Varieties.	Percentage of Crop Rotten.			
	In the Field. September.	In the Barn. October.	In Storage. January.	Total.
Davies' Warrior	3.32	4.98	3.79	**12.09**
Extra Early Eureka	10.45	2.49	2.33	**15.27**
Irish Cups	5.89	5.69	4.87	**16.45**
Stray Beauty	9.36	5.26	2.72	**17.34**
Solanium Commersoni Violet	3.31	3.97	11.74	**19.02**
Irish Cobbler	13.83	6.07	6.96	**26.86**
Early Puritan	18.34	10.19	4.59	**33.12**
Empire State	29.05	5.87	3.35	**38.27**
Green Mountain	30.84	5.80	3.82	**40.46**
Pearl of Savoy	35.43	4.34	6.16	**45.93**
Carman No. 1	39.63	1.86	5.58	**47.07**
Derby's Early	35.14	12.89	8.28	**56.31**
Early Fortune	42.59	9.18	6.71	**58.48**
Early Ohio	45.71	22.25	7.50	**75.46**

The varieties here referred to were again examined for percentage of rotten potatoes on February 19th, 1916, and it was found that the rot had apparently ceased in five of the varieties, and only in three kinds did it amount to more than one-half of one per cent. The Solanium Commersoni Violet had 2.3 per cent. of rot, this being the largest percentage found in any of these varieties when examined on February 19th.

The results show that rot occurred not only before these potatoes were dug, but also when they were in winter storage. The amount of rot of the Davies' Warrior and of the Irish Cups was fairly constant in the three examinations. In the Extra Early Eureka, however, the greatest amount of rot was found at the time of digging the potatoes in September, and in the Solanium Commersoni Violet at the time of examining the stored potatoes in January. It is interesting to compare the percentage of rot in the Davies' Warrior and in the Early Ohio on each of the three examinations. The Extra Early Eureka and the Irish Cobbler varieties have several points in common, and yet it will be seen that the Irish Cobbler had a higher percentage of rot than the Extra Early Eureka at each time of examination. These results coincide with our observations of these two varieties in other years.

According to investigations made by Prof. D. H. Jones, Bacteriologist at our College, the rot occurring in these potatoes produced in 1915 was caused partly

Bacterial Soft Rot of Growing Potatoes.

by the Fusarium Wilt and partly by the bacterial disease known as Black Leg. These two diseases appeared to be somewhat prevalent in Ontario in the wet autumn of 1915.

TREATMENT FOR THE PREVENTION OF ROT IN STORED POTATOES.

As has been stated an unusually large amount of rot occurred in the potatoes in 1912. Just how much damage rot would do in the stored potatoes in the following winter was not definitely known. The question as to what could be done to check the development of the disease in the stored potatoes was considered. An experiment was started by setting aside eight lots of one hundred apparently

Fusarium Dry Rot of Stored Potatoes.

sound tubers each from an early, a medium, and a late variety of potatoes. In addition to these, eight lots with ten slightly decayed tubers each of the three varieties of potatoes were selected. On November seventh each of the two groups of potatoes of the three varieties were treated. Lots No. 1, 2, 3 and 4 were immersed for twenty minutes in solutions made as follows: No. 1, one pint of formalin in forty-two gallons of water; No. 2, four pounds of hydrated lime to forty gallons of water; No. 3, one gallon of commercial lime sulphur to thirty gallons of water, and No. 4, four pounds of bluestone to forty gallons of water. Lots No. 5, 6, and 7 were dusted as follows: No. 5 with hydrated lime, No. 6, with unslaked finely ground lime, and No. 7, with slaked lime. The 8th lot was left untreated. The potatoes were kept in the potato cellar during the winter at a temperature of about 33 degrees to 35 degrees F. The potatoes were examined every month until the seventh of June and on each examination the rotten potatoes were counted and removed. The experiment was repeated in a similar manner with the crop of 1915 excepting that the treatments were not made until the twenty-third of November. Notes were taken of the rotten potatoes removed from the different lots on December 23rd, 1915, and January 24th and February 23rd, 1916. The experiment, therefore, was conducted six times with the potatoes which were apparently sound and also with the potatoes which had started to decay, making a total of twelve separate tests.

The following table gives the average results from treating three varieties of potatoes in each of two years by using each of two selections of tubers, and including in the experiment about five thousand potatoes.

Treatments.	Materials.	Average percentage of Rotten Potatoes, 1912 and 1915.		
		Condition of Potatoes when placed in Storage.		Average two groups (12 tests.)
		Apparently sound (6 tests.)	Slightly decayed (6 tests,)	
Immersed for 20 minutes.	1. Formalin Solution	1.7	58.3	30.0
	2. Hydrated Lime Solution	1.5	66.5	34.0
	3. Lime Sulphur "	2.3	66.7	34.5
	4. Bluestone "	21.2	70.0	45.6
Dusted.	5. Hydrated Lime	.8	40.0	20.4
	6. Unslaked Lime........	2.5	41.7	22.1
	7. Slaked Lime	2.8	55.0	28.9
——	8. Untreated	4.5	58.3	31.4

The results show that in the potatoes which were selected and which had indications of being sound, but which apparently possessed the germs of disease at the surface, developed rot from less than one to over twenty-one per cent. The immersion in the bluestone or copper sulphate solution evidently injured the tissues in the skin of the potato without killing the germs of the disease sufficiently to prevent the development of the rot, as the potatoes so treated decayed much more readily than those which were left untreated. This was shown in the individual tests as well as in the average results. The sprinkling with the hydrated lime, however, seemed to have a wholesome influence in checking the disease. This is seen not only in the potatoes which were apparently sound but also in those which were slightly decayed at the time that the treatment took place. These results seem to indicate that in a season when rot is prevalent the disease may be checked somewhat by sprinkling the potatoes with hydrated lime before placing them in winter storage.

TREATMENT FOR THE POTATO SCAB.

(*Oospora scabies.*)

The potato scab is a fungus disease which causes rough, darkish brown spots on the surface of the potatoes. Botanical investigators inform us that the spores of the common scab may be conveyed to the land with farmyard manure as well as with potatoes, and that the spores may live in the land for several years and still have the power of producing the fungus. The amount of scab seems to increase with the amount of vegetable matter in the soil, and especially with applications of fresh manure or with alkaline fertilizers to the land.

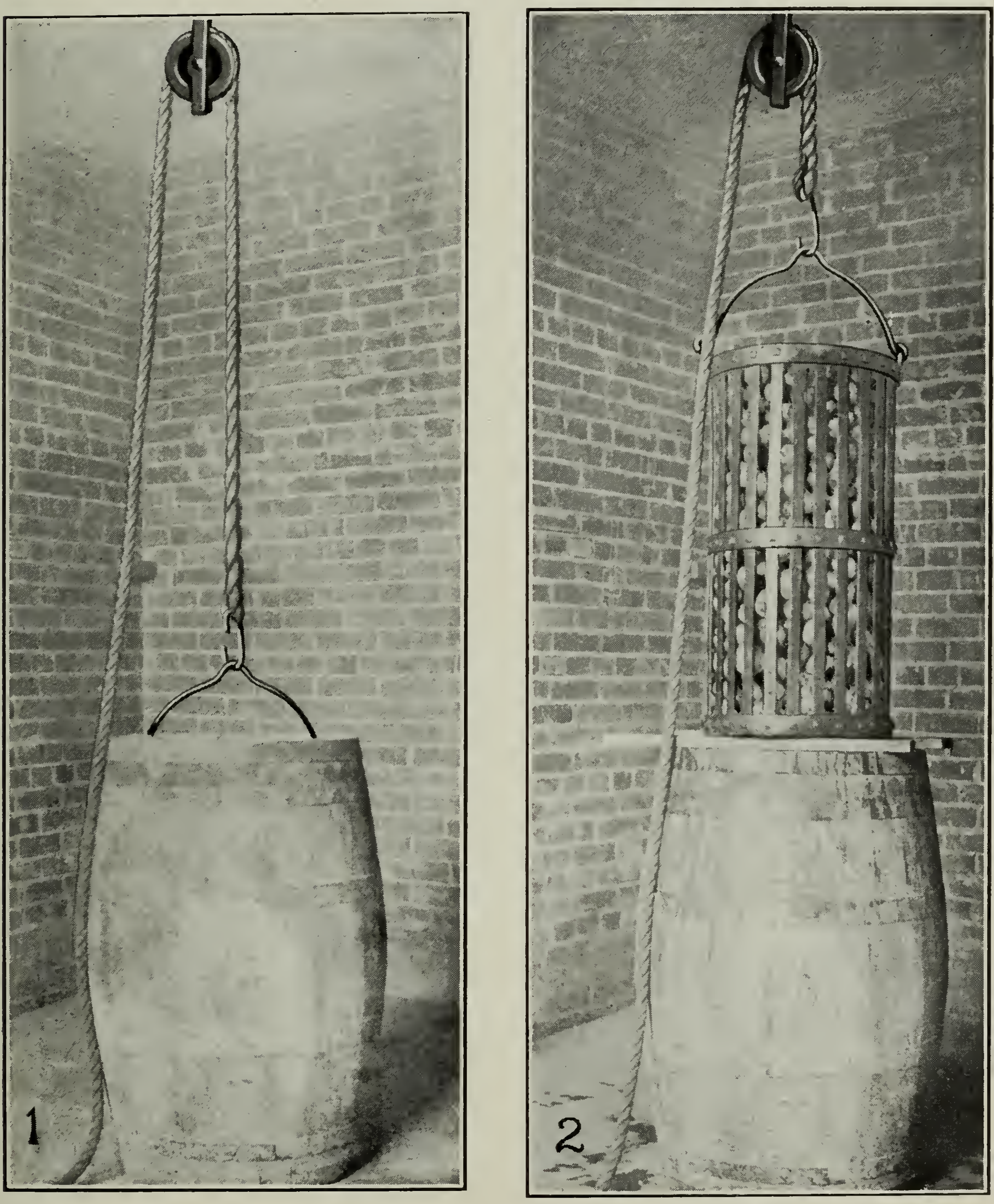
In each of ten years an experiment was conducted at the College in treating potatoes for the scab. The potatoes for one plot were left untreated, and those for another plot were treated with corrosive sublimate (mercuric bichloride) a poisonous material. The last treatment was prepared by dissolving two and one-quarter ounces of corrosive sublimate in two gallons of hot water, and after an interval of ten or twelve hours diluted with thirteen gallons of water. The whole potatoes were immersed in this solution for one and one-half hours, then spread out to dry, and cut and planted in the usual manner, in comparison with others which were left untreated.

In each of the past five years, in addition to the corrosive sublimate, another plot was added for testing the potatoes which had been treated for the scab by the formalin method. This consisted in soaking the seed potatoes for two hours in a solution of formalin (40 per cent. formaldehyde) made by mixing one pound of the formalin with thirty gallons of water.

The experiment in testing the corrosive sublimate for ten years, and both the corrosive sublimate and formalin for five years was conducted in duplicate each season. Generally two varieties of potatoes were used for the two tests, but occasionally one variety was used for both tests. In the average results for the ten years it is interesting to note that the average yield of potatoes per acre per annum was 145 bushels from the seed which was left untreated, and it was also 145 bushels from the seed which was treated with corrosive sublimate. This test, therefore, showed that the corrosive sublimate had no injurious effect on the seed. In the experiment for five years the seed which was treated with the formalin gave practically the same average yield of potatoes per acre as the seed which had been treated with the corrosive sublimate. In some of the years both of the treatments reduced the amount of scab in the potatoes to a considerable extent, and in other years the reduction was not very pronounced. This is probably due to the fact that the land received manure either in the autumn or in the spring previous to the planting of the potatoes. The manure was purchased in the City of Guelph and would probably contain spores of the scab conveyed to the manure by means of peelings of scabby tubers. Of the two treatments under test the immersion of the seed in the diluted formalin was perhaps the most effectual in reducing the percentage of scab in the crop of potatoes produced.

Some years ago an experiment was conducted in comparing flour of sulphur and corrosive sublimate for the prevention of scab. The flour of sulphur, however, did not give as good satisfaction as the corrosive sublimate.

In order to grow potatoes free of scab it would be well to plant clean seed on land which had not grown potatoes or roots for four or five years previously. If farmyard manure is used it should be free of spores obtained from scabby tubers, peelings, etc., and applied to the land at least one year previous to the planting of the potatoes. Alkaline fertilizers such as wood ashes and lime should also be



Method of Treating Potatoes for Scab by Immersion in Formalin Solution. (1) Potatoes being immersed for two hours; (2) Potatoes draining after immersion.

avoided. Even though seed potatoes are apparently free of scab it would be safer to immerse the whole seed potatoes for two hours in a solution of one pound of formalin and thirty gallons of water. After the potatoes have been treated care should be taken that they are not again contaminated with spores from dirty bags, boxes, baskets, etc.

SUGGESTIONS FOR ERADICATING POTATO DISEASES FROM AN ONTARIO FARM.

It is advisable to grow the best potatoes which are resistant to rot. A judicious system of manuring and a long rotation of suitable crops assist greatly in preventing the spores of a number of diseases from reaching the potatoes. Seed potatoes should always be examined with the object of selecting those which show no signs of disease such as scab of any kind, abnormal colorings, and the presence of rot. Immersion in formalin solution to kill the spores of disease on the surface of the tubers is a further precaution. Each person cutting seed potatoes should have two knives and a dish containing a twenty-five per cent. solution of formaldehyde. When a tuber showing signs of rot is cut the potato should be discarded, and the knife which was used should be exchanged for the one in the solution before the next potato is cut. It is a good practice to remove and discard a thin slice from the stem end of each tuber, even though the potato shows no signs of rot.

Spraying the crop with Bordeaux mixture and with Paris green or lead arsenate, or both, insures against blight, protects against insects, stimulates and prolongs growth, and increases the yield per acre and the percentage of marketable potatoes.

A thorough roguing of the growing crop once or twice during the summer is one of the most effectual ways in ridding diseases from the potatoes. This operation would insure the immediate removal and destruction of plants showing signs of such diseases as Black Leg, Rhizoctonia, Fusarium Wilt, Spindling-sprout, Mosaic, Curly Dwarf and Leaf Roll. The removal of these weak and unhealthy plants tends to develop the uniformity of the potatoes and to increase the value of the crop. If all the potatoes on the farm cannot be rogued the first year, thorough work should be carried out on a sufficiently large patch to insure an adequate supply of good seed for the year following, when the roguing can be accomplished more easily. Potato growers sometimes go through their fields and remove all plants which are not true to variety. When roguing is done with the double object of eradicating diseases and of purifying the variety, decided advantages are sure to follow.

The writer believes that if care and good judgment are exercised in carrying out the suggestions here indicated an Ontario potato grower may hope to clear his potato crops almost entirely from diseases within a comparatively short time.

ONTARIO FREE FROM SOME SERIOUS POTATO DISEASES.

Ontario is, indeed, fortunate in being free from some of the serious potato diseases which are prevalent in Europe, amongst which two are here mentioned.

The Potato Canker.—What is known as Potato Canker or Potato Wart is a fungus disease forming warty excrescences on the tubers which change from a greenish white to a dark color. It has spread rapidly in several of the European countries, but it has not obtained a foothold as yet in either Canada or the United States, although it was found in Newfoundland by Dr. H. T. Gussow in 1909.

The Powdery Scab.—This appears on tubers as discolored, slightly raised blotches which gradually form pits, and these become filled with brownish dust. Although it has been troublesome in Northern Europe for many years its introduction in some localities in the Maritime Provinces and in a few of the States of the

American Union has been quite recent. It is still unknown in Ontario, but as potatoes are being imported from the Maritime Provinces to Ontario there is danger of its introduction into this Province, even though certain precautions are taken to prevent it. If potatoes are seen in Ontario which cause suspicion, samples should be sent at once to Professor J. E. Howitt, Botanist, Ontario Agricultural College, Guelph, or to Dr. H. T. Güssow, Botanist, Central Experimental Farm, Ottawa.

TREATMENTS FOR THE COLORADO POTATO BEETLE.

(*Doryphora decemlineata*).

The Colorado Potato Beetle was first found about ninety-five years ago in the Western part of the United States, near the base of the Rocky Mountains, where it was feeding on wild plants closely related to the potato. It was not, however, until about 1860 that it became troublesome in the potato gardens of the Central-Western States. From this section of the country it gradually moved eastward and later crossed the Atlantic to Europe. It has been one of the greatest pests in connection with potato production. The orange-colored eggs are laid in masses on the underside of the potato leaves. They hatch in a few days, and the grubs feed on the potato plants for a few weeks, when they descend to the ground and rest under rubbish or immediately below the surface, where they change into the pupæ form. In about ten days perfect beetles appear on the potato plants. There are usually two or three broods in the one season, and the beetles pass the winter in the adult form.

For twelve years in succession an experiment was conducted in duplicate by using different methods for destroying the Colorado Potato Beetle. The experiment consisted in treating the potato plants with Paris green and water, Paris green and plaster, and Potato Bug Finish. In nearly all seasons three applications were made on each crop. The solution was sprinkled from watering-cans and the powder was applied from perforated tins. As a basis of comparison one plot was allowed to remain untreated. All cultural methods were similar for the different plots, with the exception of the treatment referred to. After the experiment had been conducted in each of six years two other treatments were added consisting of Commercial Bug Death, the material being used in the dry condition and with water.

In each of the past six years, therefore, six lots of each of two varieties of potatoes were carefully selected and planted on separate plots. After the potatoes had made sufficient growth and the Colorado Potato Beetles had made their appearance five plots of each variety were treated in different ways to destroy the beetles, and one plot of each variety was left untreated. The five treatments made in each of the years were as follows: 1st, Paris green and water, by using one pound of Paris green and 96 gallons of water per acre; 2nd, Paris green and plaster, by using one pound of Paris green and 38 pounds of plaster per acre, and applying the mixture to the potato plants in the dry condition; 3rd, Potato Bug Finish, by using the material in the dry form at the rate of 20 pounds per acre; 4th, Bug Death and water, by using on an average 32 pounds of Bug Death and 96 gallons of water per acre; and 5th, Bug Death, by using 32 pounds of the material per acre in the dry condition.

The average results in bushels of potatoes per acre per annum of the smaller experiment conducted for twelve years, and of the larger experiment conducted for **six years** are as follows:—

Treatment for Potato Beetles.	Average Yield of Potatoes per Acre per Annum (bushels).	
	12 years, 24 tests.	6 years, 12 tests.
Not Treated	87.1	98.2
Potato Bug Finish	129.7	138.9
Paris Green and Plaster	150.3	175.6
Paris Green and Water	160.9	186.9
Bug Death Dry	....	197.7
Bug Death and Water	....	203.4

In ten out of twelve years those potatoes which were sprinkled with Paris green and water surpassed those which were dusted with Paris green and plaster in yield of crop per acre. In each of the twelve years the untreated potatoes gave decidedly the lowest yield of tubers. In the experiment conducted for the shorter period the Bug Death gave the highest production in five out of the six years. In four out of the six years the Bug Death in solution gave better results than the same amount of material applied in the dry condition. In the average of the six years' experiment the Bug Death and water gave a yield of potatoes per acre per annum of 5.7 bushels over the Bug Death, dry, 16.5 bushels over the Paris green and water, and 27.8 bushels over the Paris green and plaster. The usual prices of these insecticides when bought in quantity were about as follows: Paris green 20 cents, Bug Death 7.5 cents, and Potato Bug Finish 1 2-3 cents per pound. The average cost per annum, therefore, for each material used in the experiments conducted in the last six years, when three applications were made each season, was approximately as follows: Paris green and water 60 cents, Paris green and plaster 88½ cents, Bug Death $7.20, and Potato Bug Finish $1 per acre.

The Bug Death is an insecticide which has been sold in Ontario for fully sixteen years. It was analyzed by the Chemical Department at the College in 1902 and again in 1903, and gave the following average percentage composition: Moisture .36, volatile matter 2.77, sand, etc., 3.72, lead oxide 3.94, zinc oxide 85.25, and iron oxide 3.96. It will be seen that the bug death is composed largely of crude zinc oxide, with smaller quantities of the oxides of lead and of iron. The plant food which the Bug Death contained was about one-half of one per cent. of ammonium sulphate, which is not much more than a trace. For good results as an insecticide it needs to be used in fairly large quantities, and is, therefore, rather expensive. When considering the yields of potatoes in the foregoing table the cost of material should be taken into consideration.

Another experiment was started in 1909 in testing different proportions and different preparations of lead arsenate in comparison with Paris green for the prevention of the ravages of the potato beetle. The experiment consisted of eleven plots. Four of these received varying quantities of Paris green and of water, three of commercial lead arsenate, three of home-made lead arsenate, and one plot was left untreated. The commercial lead arsenate was obtained from the Cold Storage and Forwarding Company, of St. Catharines, Ontario, and was the same as is used extensively in the Niagara fruit district. The home-made preparation consisted of the following formula for the weakest solution:—

Arsenate of Soda	10 ounces.
Acitate of Lead	24 "
Water	150 gallons.

The medium strength was prepared by using 112½ gallons, and the strongest solution by using 75 gallons of water and the same quantities of the other constituents as above indicated. These three solutions were each used at the rate of forty gallons per acre for each application. The material was applied to the plants by spraying with a watering-can furnished with a specially made attachment for producing a fine spray. The experiment was conducted in duplicate each year, and in each of five seasons, thus making ten separate tests. An early variety and a late variety of potatoes were used each year. In the five-year period fourteen applications were made, or an average of practically three sprayings per year.

In the average results of the five years' experiment it was found that the commercial lead arsenate applied at the rate of three pounds per acre with forty gallons of water gave 205.9 bushels of potatoes per acre per annum. This was a higher yield than that made by any other treatment. It gave slightly better results than either two or four pounds of commercial lead arsenate per acre. One pound of Paris green with forty gallons of water gave an average of 202 bushels of potatoes per acre per annum, which was a higher yield than that produced from one pound of Paris green and ninety-six gallons of water, or from one and one-half pounds of Paris green with forty gallons of water. Forty gallons per acre of the strongest solution of the home-made preparation of lead arsenate gave an average annual yield of 190 bushels of potatoes. The approximate cost per acre for each of the three best treatments here referred to was as follows: One pound of Paris green, 20 cents; three pounds of commercial lead arsenate, 26.4 cents; and eighteen ounces of the home-made preparation, or the strongest solution of lead arsenate, 23.7 cents. To obtain the cost of each per acre per season these amounts would need to be multiplied by the number of applications.

The treatment recommended at the Central Experimental Farm, Ottawa, is from eight to ten ounces of Paris green, from one and one-half to two pounds of arsenate of lead and forty gallons of water per acre.

Twenty-one separate examinations were made of the number of potato beetles per plant a few days after the first treatment and of the percentage of foliage eaten a few days after the second and the third treatments in the season. The examinations were made of each of the eleven plots on each occasion. The summary results of all these examinations are interesting, and are presented in the following table:—

Materials.	Number of Tests.	Average Number of Beetles per Hill after the First Application.	Number of Tests.	Average Percentage of Foliage eaten by the Beetles after the Second and the Third Applications.
Paris Green and Water (4 preparations)	32	3.3	54	5.0
Lead Arsenate (Commercial) (3 preparations)	24	4.0	39	8.1
Lead Arsenate (Home-made) (3 preparations)	24	10.7	39	33.1
Hand Picking	8	2.8	13	14.9

It will be seen that on the average after the first treatments were made the smallest number of beetles was found after hand-picking, the second smallest number after the use of Paris green, and the largest number where the home-made lead arsenate had been applied. In the average percentage of foliage eaten the smallest amount was where Paris green had been used, and the largest amount where the home-made preparation of lead arsenate had been sprayed on the vines.

A short time ago a material called Phenyle was advertised as a treatment for sprinkling seed potatoes to protect them from the bugs or beetles. The Department of Field Husbandry received a can of the material, gratis, for experimental purposes. An experiment consisting of three plots was conducted. For one plot the potatoes were sprinkled lightly, for another they were sprinkled heavily with the Phenyle, and for the third plot the potatoes were left untreated. The experiment was conducted in duplicate. From careful observations made, no beneficial results whatever were seen from the application of the material in either preventing the beetles from working on the vines or in increasing the yield of potatoes per acre.

METHODS OF HANDLING THE POTATO CROP FOR SATISFACTORY RESULTS.

The adoption of the most improved method of cultivating potatoes of the best variety is necessary for the highest returns from the land. After the crop is pro-

Davies' Warrior variety of Potatoes grown in the Experimental grounds at the Ontario Agricultural College.

duced, however, much care is required in handling the potatoes if the ultimate results are to be the most satisfactory.

Digging.—If the potatoes are grown for very early market they are often dug when about two-thirds grown, which is probably from eight to twelve weeks after planting. The crop at this time is frequently dug with a potato fork owing to the abundance of the green tops and the tender condition of the skin of the immature tubers. One man can dig by hand from one-eighth to one-half of an acre per day. Carefully handled potatoes are decidedly the most attractive and command the highest prices.

The potatoes of the general crop can usually be dug to advantage after they have become ripened and the tops have been dead for ten days or two weeks. The method of digging the potatoes depends largely upon the area of land used for the crop. If the potatoes are grown in a garden or in a small lot the potato fork is generally used. When the crop is produced in long rows, however, the ordinary plow or the double mould-board plow with special attachments is frequently brought into service. If it is the intention to grow more than an acre or two of potatoes annually a two-horse potato plow with forked appendages for leaving the potatoes on the top of the soil can be used economically. There are different makes of these potato plows in Ontario, and the usual prices are about the same as those of ordinary plows. When potatoes are grown extensively for commercial purposes an elevator

Extra Early Eureka variety of Potatoes grown in the Experimental grounds at the Ontario Agricultural College.

potato digger is almost essential. There are a number of different styles of these diggers manufactured at the present time which usually sell for one hundred dollars and upwards according to the size and the make. They are operated by two or by four horses, and the capacity of a machine is from three to four acres, or from five to twelve hundred bushels per day.

Sorting and Grading.—The sorting of potatoes for early market takes place largely in the field. When the potatoes are scattered on the surface of the soil there is a good opportunity for gathering the perfect tubers of the right size for market or for home use. The remainder can be gathered and used for feeding stock. It is unusual for the early potatoes to have many culls, excepting those which are too small for market.

In harvesting the late crop care should be taken not to allow the potatoes to lie in the hot sun longer than is necessary. The potatoes should be gathered in dry weather. If the patch is not large the sorting can be done at the time of gathering by first picking up the sound, smooth, marketable tubers, and by leaving for the second picking the small, irregular, scabby potatoes, and especially any which have started to decay. If the area used for the crop consists of a few acres, however, it is an excellent plan to run the potatoes through a potato-grader and to sort the tubers by hand at the same time. This can be done either in the field at the time of harvest or at some convenient place before the potatoes are stored for the winter. Only the very best potatoes should be stored. All small, irregular, unsound and diseased tubers should be boiled and fed to stock or disposed of in some other way as soon as possible. There are several kinds of potato-graders on the market at the present time which do fairly good work. The proper grading of potatoes is sure to receive more attention in the future than it has received in the past.

Storing.—If potatoes are grown only for home use the crop is usually stored in the cellars of the houses or of the barns. Occasionally potatoes are stored in pits. When the crop is grown commercially, however, it is generally placed in a potato storage cellar erected for the purpose. In all cases it is important to store only well sorted, sound, clean, dry potatoes and to keep them constantly in a dry, cool, dark and well ventilated place. The temperature usually recommended for the best results is from 33 degrees F. to 35 degrees F. It is stated[1] that potatoes when placed in storage shrink about two per cent. per month for a period of six or seven months.

Marketing.—The potato grower should cater to the wishes of the most particular and exacting customers. He should furnish a choice product in a most attractive form and should carefully study the demands of the market he wishes to serve. For the best prices the potatoes should be uniform, sound, smooth and of good table quality, whether selected by the pound, the basket, the bushel, the bag, the barrel or the car load. The commercial potato grower should not be confined to the local market, but should be in a position to put his potatoes on the best market available either through his own efforts or through the medium of a co-operative association. It sometimes occurs that of the price paid by the consumer for a bushel of potatoes about two-thirds are required to defray the cost of transportation and of distribution, and one-third is left for the grower. This is not as it should be. Undoubtedly one of the best remedies for such a condition of affairs is co-operation on the part of the growers themselves. This matter is discussed under the heading of "Organized Agencies in Connection with Potato Production" in another part of this bulletin.

COST PER ACRE OF GROWING POTATOES.

The cost of producing an acre of potatoes varies with the season, the soil, and the area of the crop; with the kind of machinery used, and the method of culture followed; with the price placed on the labour of the men and on that of the horses; and with the amount allowed for cost of seed, interest on money invested, rent of land, fertilizers used, etc. The writer has in his office estimates worked out in detail and printed in reports issued in Ontario and in the Northern States giving the cost of producing potatoes, and these vary from $15 to $60 per acre. It is not necessarily true that the greatest cost per acre will give the least profit, nor that the smallest cost per acre will give the highest profit. Exactly the opposite may be true. Much depends upon management and upon local conditions.

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[1]The Encyclopedia Americana, Volume XII.

Mr. W. T. Macoun, Central Experimental Farm, Ottawa, has placed the cost[1] of producing three hundred bushels of potatoes on an acre of land at $52.14.

The average cost of producing acre lots of potatoes in Ontario for the years 1913 and 1914, as determined by the twenty-three young men who took first prizes in the Acre Profit Competitions conducted by the Department of Agriculture, through the District Representatives, was $39.75. The average yield of potatoes per acre for the two years was two hundred and seventy-seven bushels.

In 1915, M. H. Goltz, Muskoka, Ontario, produced a yield of five hundred and fourteen bushels of Davies' Warrior potatoes on an acre of land, and at an estimated cost of $42.02. This was the highest production for the year made in the Acre Profit Competitions conducted throughout Ontario.

ORGANIZED AGENCIES IN CONNECTION WITH POTATO PRODUCTION.

In growing potatoes in Ontario farmers may work independently of each other or they may co-operate with some organization which is working in a definite and systematic way. The work of some of these organized agencies will probably be increased in the near future.

Ontario Agricultural and Experimental Union.—There is but little excuse for any farmer in Ontario to grow for himself or to sell to his neighbors any but the very best varieties of potatoes. The safest way is to use the carefully tested varieties and not to rely on highly advertised sorts which are sold at double prices to the profit of the seller and to the risk of the buyer. Many of the new and of the old varieties are carefully grown at the Ontario Agricultural College in comparative tests. The results of the experiments are reported frequently. Particular attention is directed to those kinds possessing the best combination of the desirable characteristics and which make the most satisfactory records.

Potatoes of two or three choice varieties are distributed each year through the medium of the Ontario Agricultural and Experimental Union to be tested on the various soils of the Province by the farmers who wish to conduct the tests, and who apply for the material. Leading varieties of potatoes now grown in Ontario such as Rural New Yorker No. 2, Empire State, Carman No. 1, Green Mountain and Early Ohio were introduced in this way. In the past three years only two varieties have been distributed, viz., Davies' Warrior and Extra Early Eureka. Other co-operative experiments with potatoes which might be mentioned deal with methods of cultivation, preparation of seed, cutting and planting of tubers, application of commercial fertilizers, farmyard manures, etc. The Experimental Union is an organization under the *Agricultural Associations Act* and receives a grant from the Ontario Government. It has about five thousand co-operative experimenters throughout the Province. Its headquarters are located at the Ontario Agricultural College, Guelph, and its Secretary is the author of this bulletin. The results of the co-operative experiments are published annually in the reports of the Experimental Union, copies of which are obtainable from the Department of Agriculture, Parliament Buildings, Toronto.

Canadian Seed Growers' Association.—This is a Canadian organization which receives a grant from the Dominion Government and has its headquarters at Ottawa. According to the constitution of the Association the main object is to advance the interest of seed growers and other farmers by:—

[1]The Potato and Its Culture, Bulletin No. 49, Central Experimental Farm, Ottawa.

"(a) Making regulations respecting the growing, selecting and preserving of seed of various kinds of farm crops for the guidance of its members;

"(b) Causing records to be kept of the history of seeds produced by members;

"(c) Fixing standards for seeds that may be eligible for registration;

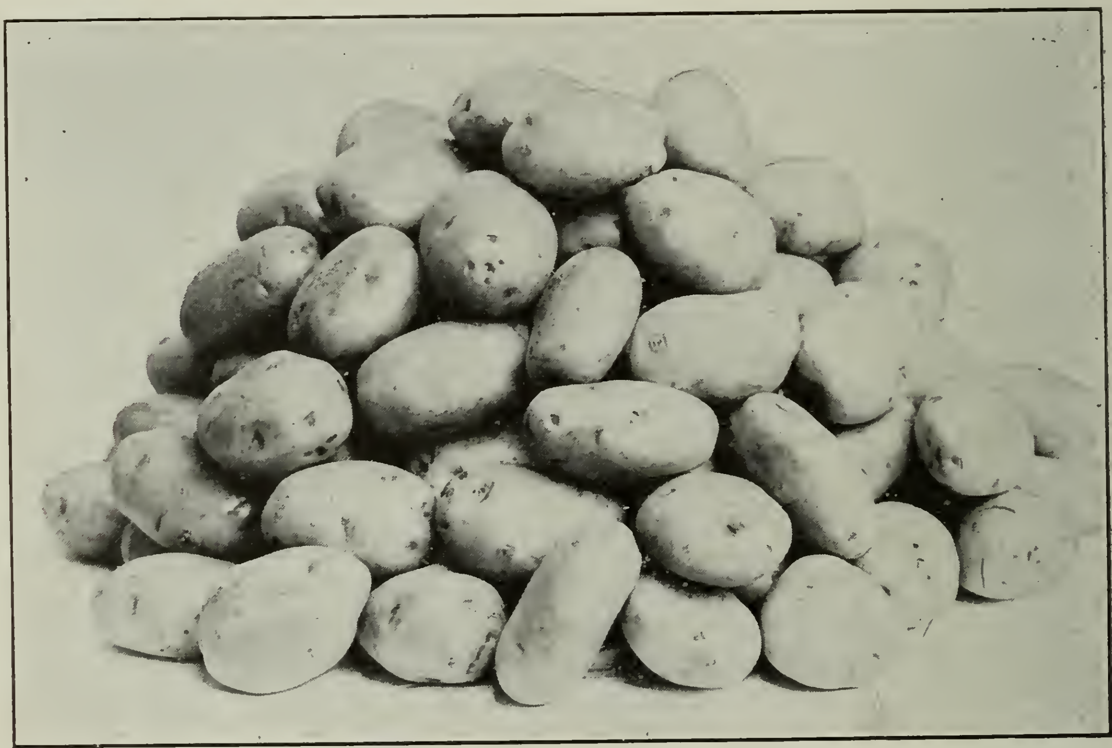
"(d) Publishing information as to standards;

"(e) Issuing certificates of registration to members by which hand-selected seed or the product thereof may be distinguished from other seed;

"(f) Such other means as may be expedient from time to time."

A meeting of the Association is held annually in Ottawa. Reports of work accomplished and catalogues of pedigreed seed for sale by the members are issued from time to time. An interesting line of work in selection as it applies to potato production has been devised for the improvement of this crop. One regularly organized seed centre for potato production has been started under the name of the Manvers Green Mountain Potato Centre, and is located at Pontypool, Ontario. Other centres are likely to be organized in the near future. Particulars regarding the work in potato selection and the establishment of Seed Centres are available on application to Mr. L. H. Newman, Secretary, Canadian Seed Growers' Association, Canadian Building, Ottawa.

Acre Profit Competitions.—The Ontario Department of Agriculture has inaugurated, through the District Representatives, Acre Profit Competitions with potatoes and other farm crops. The County Competitions have been conducted for



At the Provincial Winter Fair held in Guelph in December, 1915, this lot of Davies' Warrior Potatoes, grown by Mr. H. L. Goltz, took Second Prize in the entries in connection with the Field Crop Competitions open to all varieties.

three years and are confined each season to the farmers' sons who complete the Agricultural Courses of from four to six weeks held by the District Representatives. The work has been very valuable in showing the advantages of good seed and of thorough cultivation, and in demonstrating the financial possibilities of an acre of land. The person in each competition making the highest score is given a free course of two weeks in Stock and Seed Judging at the Ontario Agricultural College, the expenses being paid by the Department of Agriculture.

The following table gives the average results of the first prize records in the County Competitions with potatoes:—

Years.	Number of Competitions with Potatoes.	Average Yield of Potatoes per Acre (bushels).	Average Cost of Production per Acre.	Average Profit per Acre.
1913	7	258	$38.64	$114.84
1914	16	337	40.43	91.71
1915	19	271	40.06	154.25

For information regarding the County Short Courses or the Acre Profit Competitions, applications should be made to the District Representatives or to Mr. C. F. Bailey, Assistant Deputy Minister of Agriculture, Parliament Buildings, Toronto.

Field Crop Competitions.—In 1907 Standing Field Crop Competitions were started in Ontario with cereals, and in 1908 potatoes were added to the list. The work during the past eight years has been conducted through the medium of the Agricultural Societies of Ontario. Each society entering potatoes must have at least ten fields in competition. In each potato competition fifty dollars is granted by the Government, and twenty-five dollars by the Agricultural Society, which amount is divided into the following prizes: Twenty, fifteen, twelve, ten, eight, six and four dollars. The official judges are furnished by the Government, and the potatoes are judged according to the following scale of points:

General Appearance	15
Freedom from Blight and Insects	17
Method and Thoroughness of Cultivation...............	20
Purity of Variety	10
Apparent Yield	38
Total	100

The entries each year number several hundred, and the competition is keen and wholesome. An Appendix to the Annual Report of the Agricultural Societies is published each year by the Ontario Department of Agriculture, and contains the name and address of each competitor, the name of the variety of potatoes entered, and the score of points allotted to the crop. For information regarding the work of the Field Crop Competitions the reader is referred to Mr. J. Lockie Wilson, Superintendent of Agricultural Societies, Parliament Buildings, Toronto.

Potato Growing Contest for Boys.—Through the kindness and the liberality of Mr. R. B. Whyte, of Ottawa, who donated the prizes, a potato growing contest for boys between the ages of twelve and eighteen years has been conducted for four seasons in Carleton County, and for three seasons in Russell County. An average of twenty-eight boys conducted the work in each of the past three years. The size of each plot was one-tenth of an acre, and from the returns of the plots the results per acre were determined. The prizes were awarded on the following basis:

Report of Inspector on thoroughness of field culture, etc.	100	points.
Certified report of yield as submitted by competitor	100	"
Award of Judges one bushel exhibit sent to County Fair	100	"
Written report of competitor showing expenses, profits, etc	100	"

In 1915 the average net profit per acre was $100 in Carleton County and $113.87 in Russell County. In the average of all the plots in the two counties the estimated cost of producing a bushel of potatoes was 21.3 cents in 1915, 22 cents in 1914, and 34.8 cents in 1913.

The following scale of points was used in judging the potatoes at the County Fairs:

Purity of Variety	10	points.
Uniformity	10	"
Size	10	"
Smoothness	10	"
Shape	5	"
Nature of Skin	5	"
Color	10	"
Freedom from Disease	15	"
Quality	25	"
Total	100	"

The potato growing contest in operation in these two counties is suitable for adoption in other places. Persons interested in the scheme and desiring information should write for full particulars to the Secretary, Mr. L. H. Newman, Canadian Building, Ottawa.

Potato Growers' Co-operative Associations.—In some parts of Ontario potatoes of excellent quality are grown rather extensively for commercial purposes. These potato growing districts have special opportunities for earning for themselves good reputations by furnishing potatoes which will command the highest prices in our best markets. In order to bring this about, however, a united effort on the part of the growers seems essential. The real value of a Co-operative Association depends largely upon the organization being established on sound and up-to-date business principles, and upon the loyalty and co-operative spirit of the members. A properly organized and established Potato Growers' Association could grow one or two of the most suitable varieties of potatoes, grade the crop into uniformity, give the product the stamp of the Association, and distribute in car-load lots when necessary. The officers could keep in constant telegraphic communications with the best markets, and thus secure a wide distribution and avoid shipping to centres already over-stocked. By supplying potatoes in large lots in this way the cheapest transportation could be obtained and the best service secured, or the supply might be sent forward f.o.b. (free-on-board) shipping point. The growers would thus be enabled to secure the just returns for their crop, to avoid many discouragements, and to place the produce with the consumer in the best condition and at a reduced price. Advantages would accrue, therefore, to both the producers and the consumers.

The following local Co-operative Associations have been organized in Ontario for handling potatoes alone or in conjunction with other farm crops:—

Hillsburg Potato Growers' Association: R. D. Nodwell, Sec., Wellington Co.

The Rainy River Potato Growers' Association: A. G. Crawford, Mgr., Rainy River Dis.

Independent Vegetable Growers' Association: Henry Broughton, Mgr., Lambton Co.

Lambton Co-operative Association: Geo. French, Mgr., Lambton Co.
Blezard Valley Association: Leandre Prevost, Sec., Nipissing Dis.
Farmers' Co-operative Association: Henri Bourassa, Sec., Nipissing Dis.

If the separate Co-operative Associations could be organized so as to embody uniformity in essential business principles and methods, and so as to allow certain variations to meet important local conditions a great advancement would be made. This would in time permit of the establishment of a central or Provincial organization which would unify and strengthen the local Associations. Potato growers wishing to form a local Co-operative Association should write to Mr. F. C. Hart, Director, Co-operation and Markets Branch, Department of Agriculture, Parliament Buildings, Toronto.

THE FARMER FEEDS THE PEOPLE.

According to the present production and consumption in Ontario from twenty-five to thirty people, or from five to six families are supplied with potatoes for one year from each average acre of land which the farmer plants with this crop. An increase of fifty per cent. in yield would mean an increase in the quantity of potatoes produced on each average acre of land sufficient to supply about one dozen people for twelve months. In most years Ontario imports potatoes from the Maritime Provinces, and at the present time a part of our supply is coming from the Province of Alberta. Ontario is well adapted to the production of potatoes of excellent quality and should supply at least her own demands. It is to be hoped that the information furnished in this bulletin may be instrumental in increasing both the quality and the quantity of Ontario's potato crop.

The man who grows good potatoes when potatoes are needed is a public benefactor.

ACKNOWLEDGMENTS.

The writer wishes to state that in the preparation of this bulletin he has received valuable help from a study of the reports of investigations of such men as W. T. Macoun, H. T. Gussow, Wm. Stuart, H. J. Webber and E. N. East.

Acknowledgment is due, and is heartily given, for assistance rendered in conducting the experiments and in preparing the material reported in this bulletin to the following persons: A. E. Whiteside, Plot Expert; A. W. Mason, Assistant Experimentalist; W. J. Squirrell, Associate Professor; G. H. Clark, Dominion Seed Commissioner, and formerly Assistant Experimentalist; and Miss G. K. Robinson, Office Assistant.

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BULLETIN NO. 240] [JUNE, 1916

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Some Bacterial Diseases of Vegetables Found in Ontario

DAN. H. JONES.

During the last fifteen or twenty years it has been found that some very destructive diseases of plants are caused by certain species of bacteria. As we are frequently getting inquiries regarding some of these diseases, and the methods for controlling them, we have thought it advisable to prepare this bulletin for distribution to those interested.

Bacteria are microscopic plants that to be seen have to be very highly magnified. On an average they are about 1/5,000 of an inch long and 1/15,000 of an inch thick. Of all living organisms that are known they are the smallest and most simple in structure. Under favorable conditions they multiply very rapidly. One bacterium can multiply to ten millions or more in twenty-four hours. Their method of reproduction is simply to absorb food and divide in the middle. This dividing takes place about every twenty minutes or half an hour under suitable conditions of food supply and temperature. They are found in large numbers wherever other forms of life—man, animal or plant—exist. An ounce of good garden or field soil contains many millions of them, many species being represented in this number. Most species are very beneficial, in fact plants could not grow without them in the soil. A few, however, are injurious. Of these latter, some cause disease in man and animals, such as tuberculosis, typhoid, etc., and others cause various diseases of plants.

TYPES OF BACTERIAL DISEASES OF PLANTS.

The bacterial diseases of plants fall naturally, according to the changes which they induce in the host plant, into four types as follows: 1, Bacterial Soft Rots; 2, Bacterial Wilts; 3, Bacterial Canker or Blights; 4, Bacterial Galls.

BACTERIAL SOFT ROT OF VEGETABLES.

Bacterial soft rot is a disease liable to attack fleshy vegetables and flowers, particularly carrots, cauliflower, turnips, celery, tomatoes, potatoes, German iris and calla lily, and in a lesser degree onions, asparagus, salsify, sugar beet, mangel, muskmelons, rutabaga, and some others. Occasionally the disease results in heavy losses to the grower of these crops.

GENERAL APPEARANCE OF THE DISEASE.

As the name signifies, the disease results in a soft, wet rot of the plant attacked. The rotted portion of the plant is darker in color than the rest of the plant. The color of the diseased part varies from a light, reddish brown to a very dark brown in the case of white or creamy fleshed plants, such as cauliflower, turnips, or heart of celery, and a very dark green, almost black, in case of the green tissues which are attacked. The diseased tissue is very soft and mushy and frequently has a strong and offensive odor. There is a clear line of demarcation between the diseased and healthy tissues, the disease inducing complete destruction of the tissue as it advances from the point of inoculation.

The Cause of the Disease.

The cause of the disease is a bacillus which has been given a variety of names by different men, who at different times in various countries have studied the disease in different species of plants. Prof. L. R. Jones, of Vermont, studying the disease in a crop of carrots, named the causal organism *Bacillus carotovorus.* Prof. Harrison, of Ontario, studying the disease in an outbreak in a crop of cauliflower, named it *Bacillus oleraceae;* Prof. Potter, in England, studying the disease found it to be destructive to quite a number of varieties of plants and named it *Pseudomonas destructans.* N. J. Giddings, of Vermont, studying the disease in a crop of melons, named it *Bacillus melonis;* C. O. Townsend, of Washington, studying the disease in a greenhouse of calla lilies, named it *Bacillus aroideae.* More recent investigations have shown that the disease is practically one and the same in all the plants mentioned. While to the bacteriologist there may be a few slight differences in the nature of the bacillus causing the disease in the melon from that causing the disease in the lily, or that causing the disease in carrots, turnips and cauliflower and other vegetables, yet the disease is for all practical purposes to the horticulturist one and the same—a soft, wet rot of the plant attacked.

Histology of the Disease.

When the *soft rot bacillus* gets on to a freshly made wound, either small or large, in plants liable to the disease, it feeds on the plant juice which emerges on to the wounded surface, and on this it grows and rapidly multiplies. As it multiplies it produces digestive enzymes, *e.g.*, cytase, which digests cellulose; diastase, which digests starch; and proteolytic enzymes, which digest proteids. These are diffused through the living bacterial cells and act upon the healthy vegetable tissue around them, making it soluble to be used as food material by the bacilli. The action of these enzymes is greatest on the middle lamellæ, *i.e.*, the thin strip of tissue which lies between the walls of adjacent plant cells. The lamellæ are quickly dissolved and form good food for the multiplying bacilli, which, as they multiply, pass along between the cells, filling the intercellular spaces and separating the cells from one another. The protoplasm within the plant cells is plasmolised, that is, it is made to shrink from contact with the cell walls and to contract into an irregular mass within the cell, by the action of the enzymes produced by the bacilli in the intercellular spaces. In this way the collapse of the tissue is brought about, and such tissue constitutes the rotted part of the plant.

In *cauliflower* the disease is found more often in the flower than in the leaves or stem; the latter parts, however, are also subject to attack.

The disease in the flower is very easily noticed, the normal color of the flower being white or creamy and that of the diseased portion light to dark brown and very soft, and having an offensive odor. The writer has noticed a number of times dark brown areas varying in size which looked at first sight like soft rotted areas, but which on investigation proved to be discolorations due to excreta of

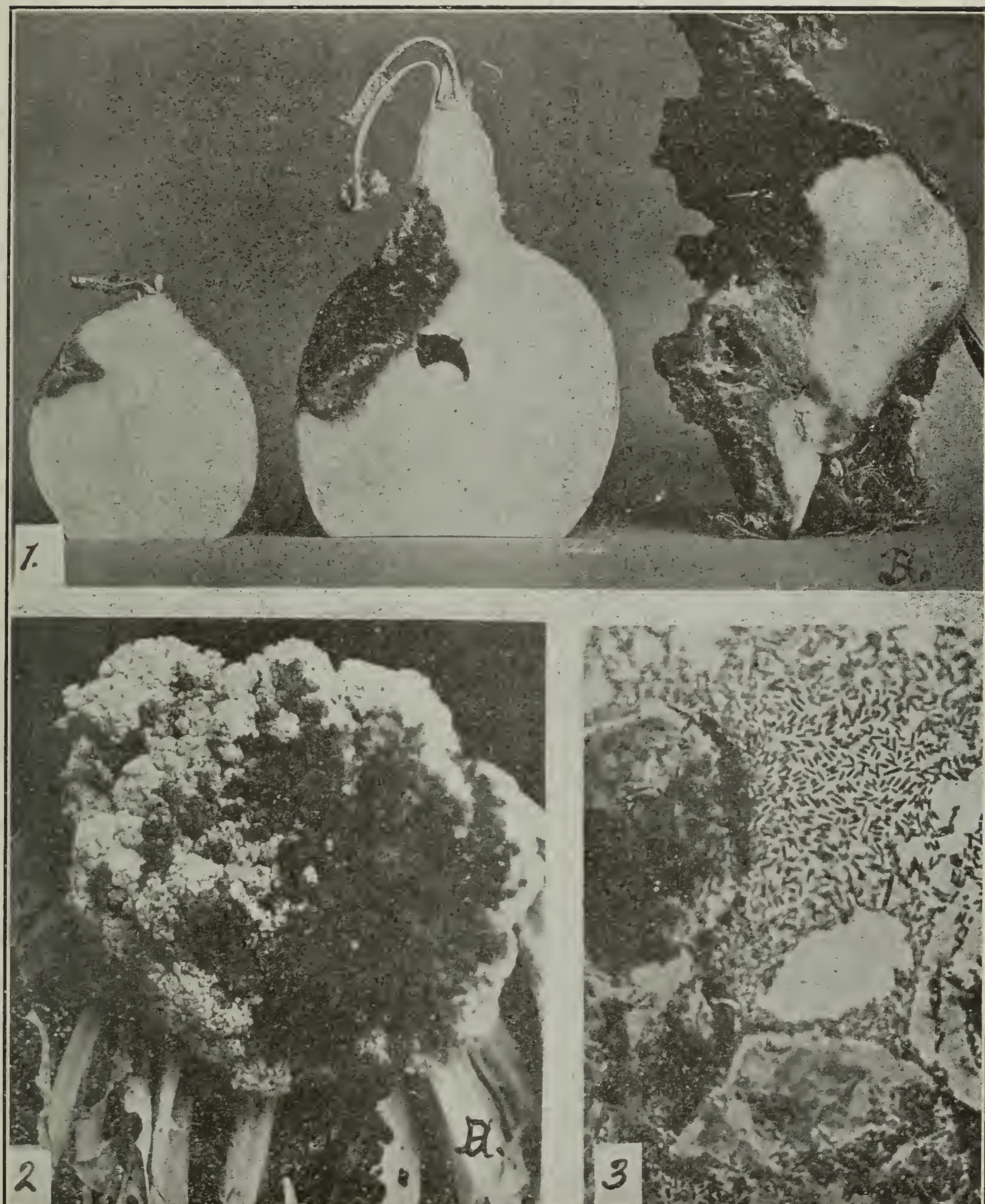


PLATE I.

Fig. 1. Bacterial soft rot of turnip. Specimens obtained from the field and cut through the middle. Each specimen had been accidentally inoculated with the hoe or cultivator near the crown.

Fig 2. Bacterial soft rot of cauliflower, natural infection; specimen taken from the garden.

Fig. 3. *B. carotovorus*, the vegetable soft rot bacillus seen between the cells of the broken-down rotting cauliflower tissue (x 1000 di.).

cabbage caterpillars which had been feeding on the leaves overhanging the flower. In such cases the tissue immediately below the surface of the discolored area is not softened as it is in the case of the rot, and the discoloration is only on the surface. Observations have shown, however, in a number of such cases that the rot has later developed within such discolored area, thus indicating that in all probability the caterpillar had previously been feeding on a rotted plant, and all the bacilli in the portion consumed had not been killed in the process of digestion, but had passed through the alimentary tract of the caterpillar with the excreta, or that the mouth parts and feet of the caterpillar had been contaminated from a diseased plant, and on crawling over the surface of the healthy plant had inoculated it.

In the stem the disease results in a complete softening of the interior, the softened tissue becoming a dirty gray in color with strong odor. The disease may enter the stem from injury to the exterior caused by the breaking of leaves, or the biting of insects, slugs and caterpillars during cultivation, etc., and from the stem pass up into the flower, or the stem may become so far rotted that the head will fall off. The stem may also become infected through the flower.

In the leaves the disease is more often found in the petiole or midrib rather than the blade. It appears as a dirty gray softened area, which, when in the petiole, soon results in collapse of the leaf.

In *turnip* the disease most frequently enters at or near the crown through caterpillar or slug attack. or through injuries received during hoeing or cultivation. It softens or rots the leaf petioles at their base, causing them to fall over, and spreads slowly in dry weather, rapidly in wet weather, through the tissue of the root, inducing a brown-colored soft rot with strong odor.

In *carrot* the disease enters and develops in much the same way as described for the turnip. It is more apt to spread rapidly through a crop that is thickly sown and not well thinned out, the shade produced by the heavy tops making ideal conditions by keeping the ground moist for the development of the disease when once it gains entrance, and harboring slugs and caterpillars that spread the disease. Carrots which crack beneath the ground are liable to be attacked by the disease, the soft rot bacillus gaining entrance to the tissue through the cracked surface.

In *celery* the disease is not very common, but when present is most often found starting at or near the tops of the young growth. The affected parts become dark brown and very soft and mushy. The parts so affected cease growing, the growing tips being destroyed, and the disease slowly passes down the stem, completely rotting the tissue as it progresses. If the disease starts below the end of the stem, the upper part soon topples over as a result of the softening of the part attacked. The disease spreads from plant to plant through the agency of slugs, caterpillars, etc., and during the process of handling when cultivating and banking up. When the plants are stored away for winter use, if a plant having the disease is stored with the healthy plants, the rot is liable to spread to the healthy specimens.

The bacterial soft rot is very common in tomatoes during wet seasons. It is found most frequently in the fruits that are in contact with the soil after they have commenced to ripen. The bacillus will not readily penetrate through the unbroken skin of the tomato. But when a tomato is resting on the damp earth, that part of the skin in contact with the soil is frequently weakened, thus providing a means of access to the bacillus. This, however, is not the only means whereby the disease enters the fruit. Slugs are very partial to tomatoes just ripening. In their attack on the fruit they eat through the skin, leaving the interior flesh ex-

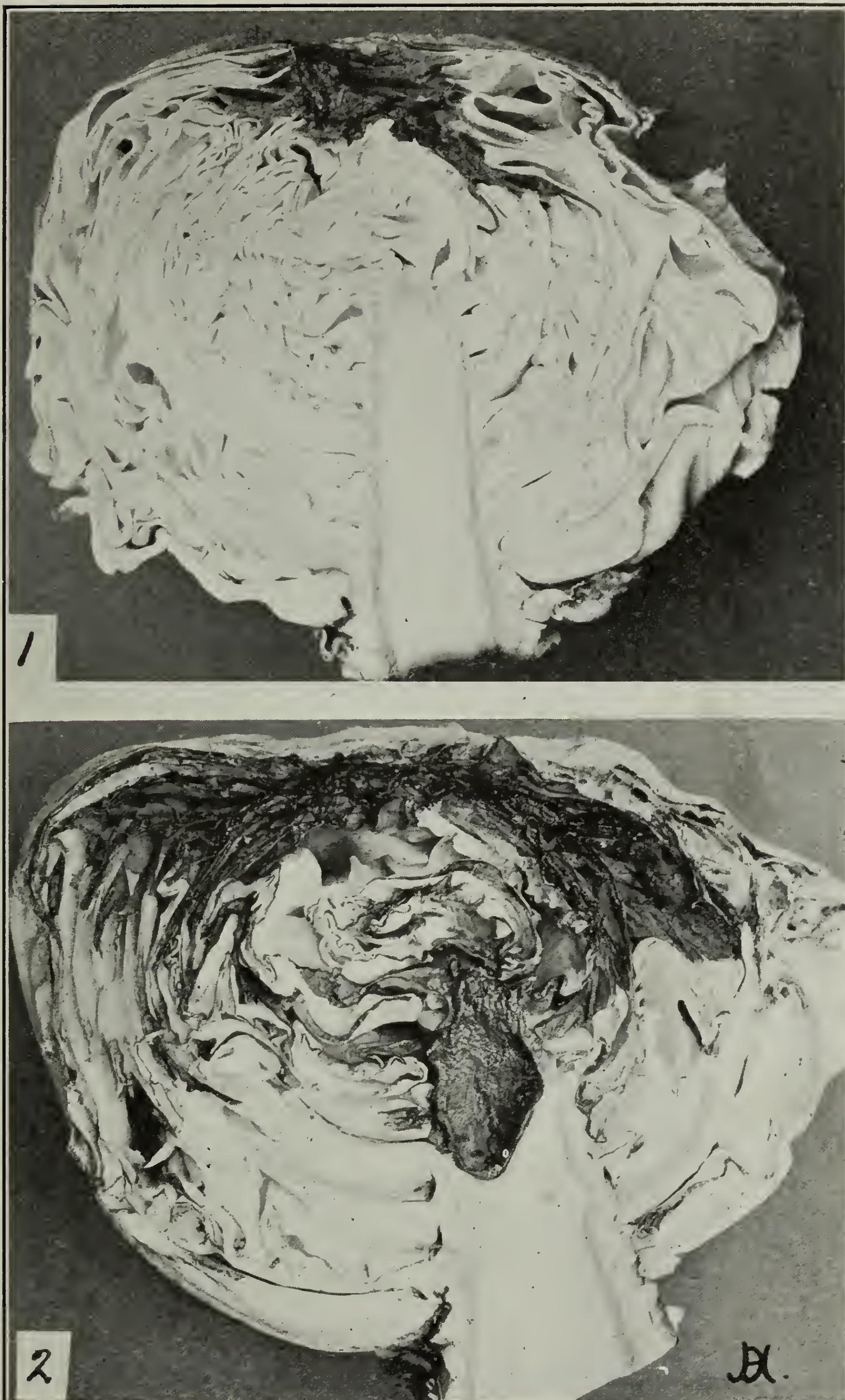


PLATE II.

Fig. 1. Bacterial soft rot of cabbage. Artificial stab inoculation of a pure culture of B. carotovorus in healthy cabbage. Seven days after inoculation.

Fig. 2. Same as Fig. 1, twenty days later.

posed. This exposed surface is an ideal medium for the bacillus of soft rot to develop in. The writer has found many tomatoes, particularly in wet seasons, when slugs are plentiful, that have contracted the disease in this way.

Eradication and Control of the Disease.

Spraying with fungicides, which is so effective in controlling the fungous diseases of plants, is of no avail with bacterial diseases, as the bacteria which cause the disease act in the interior tissue rather than on the surface; hence the spray will not reach them.

Spraying with insecticides is helpful indirectly, as it tends to keep in check the insects, slugs, caterpillars, etc., which are one of the most common means of spreading bacterial diseases from one plant to another.

As a rule the best method to adopt in dealing with a plant affected with bacterial disease is to carefully remove and burn it. Insects, garden tools, etc., coming in contact with it will spread the disease to the plants with which they come in contact later. This is particularly the case with the bacterial soft rot of plants, as the affected tissue is so very soft and pulpy that it cannot be touched without heavily contaminating whatever touches it.

Again, if affected plants are allowed to remain on the ground they infect the soil with the organisms of the disease to such an extent as frequently to cause the disease to establish itself in the succeeding crop of any plants which are susceptible to the disease, but particularly plants of the same species.

Some time ago we received for examination a box of rotting, half-developed turnips from a farmer, who said that five per cent of his crop were similarly affected. Upon enquiry we found that the affected ones were growing on soil on which turnips had been grown the year previous, and 25 to 30 per cent. of these having been affected with the same rot had been allowed to remain on the ground at harvest time, and later were plowed in. In was evident that the soft rot bacilli from the diseased turnips had remained alive in large numbers in the soil, and that many of the turnips of the subsequent crop had been inoculated with these bacteria during cultivation and possibly by insect attack also, see Pl. I., Fig. 1. The hoe or the teeth of the cultivator would get contaminated from the soil, and accidental wounding of a turnip with such an implement would result in the inoculation of the turnip with the germs of the disease.

Another man sent a head of celery for examination which we found to be suffering from the bacterial soft rot in the young growing tips. In reply to our enquiries he sent word as follows: "I had celery on this ground two years ago, and the row that was where the rot is worst now was so bad then that I lost all, but only that row was affected. This year two rows have it, but one a great deal worse than the other. There were five rows in this patch all planted about the same time. The healthy rows matured away ahead of the two which were diseased." Here it is evident that the soft rot bacteria had remained in the soil for two years, and that cultivation had spread the bacilli to some extent through the soil, as on the second occasion that celery was grown on that patch the plants in two rows developed the disease.

The writer had under observation a garden where turnips and carrots were both affected with the bacterial soft rot. The affected plants were not removed, but were dug in. The next year tomatoes were planted on the same ground. The disease did not develop in the growing plants, as care was taken not to wound them. However, about 60 per cent. of the fruit became affected before it was fully ripe.

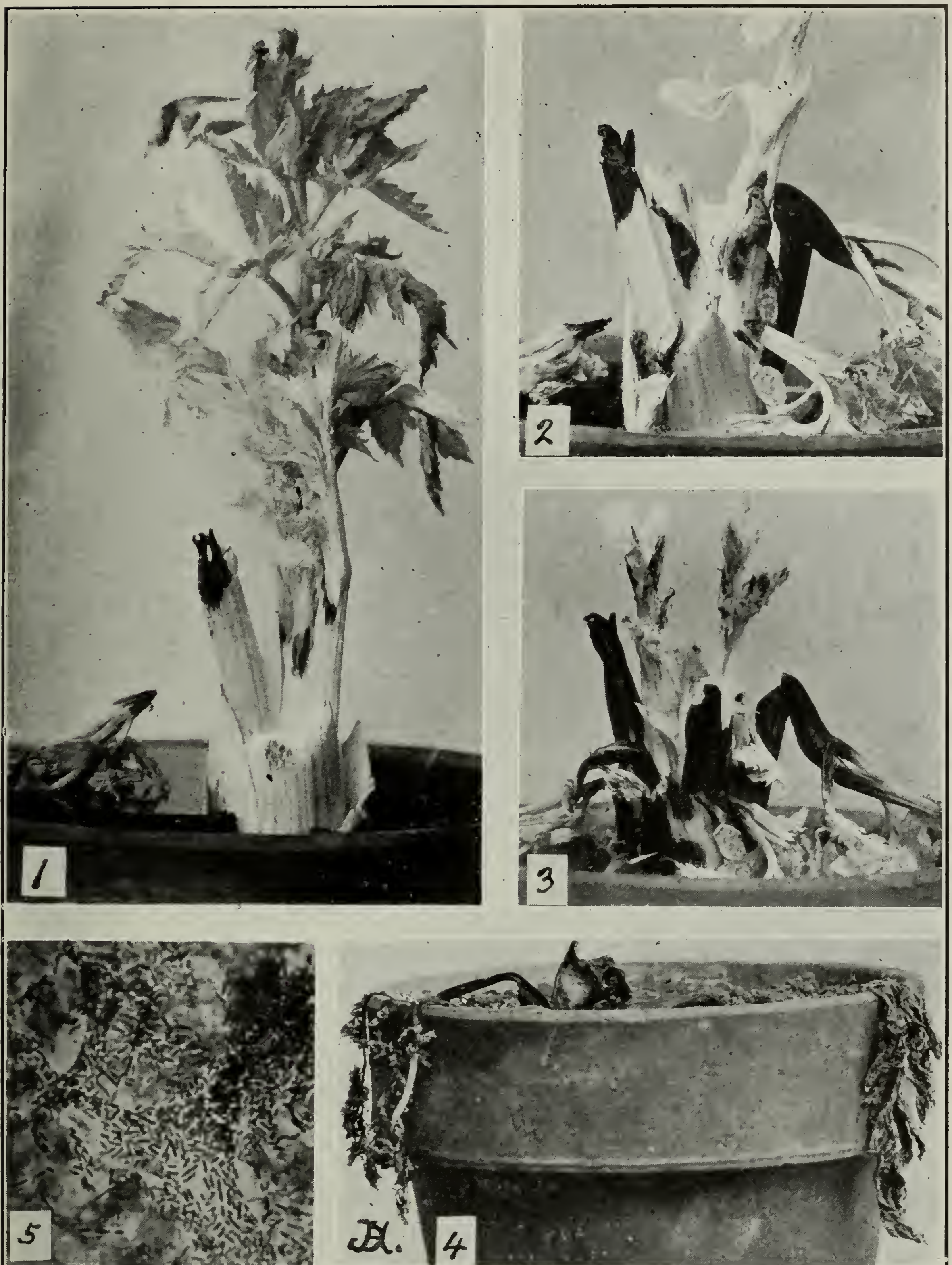


PLATE III.

Bacterial Soft Rot of Celery.

Fig. 1. Artificial needle inoculation of pure culture of B. carotovorous (isolated from rotting cauliflower) into the young vigorous growth of celery. Five days after inoculation, kept at 25° C.

Fig. 2. Same as Fig. 1, five days later.

Fig. 3. Same as Fig. 1, ten days later.

Fig. 4. Same as Fig. 1, three weeks after inoculation, showing complete collapse of plant.

Fig. 5. B. caratovorus, the vegetable soft rot bacillus, between the cells of rotting celery tissue (x 1000 di.).

The affected specimens were either those that were in contact with the soil or had been bitten by slugs. The soft rot bacteria, which cannot penetrate through the sound skin of a tomato, found entrance through the slug bites or through the weakened skin that had been in contact with the soil.

Therefore, in order to prevent losses from bacterial soft rot of plants, remove and burn affected plants, or parts of plants, as soon as observed; be careful during cultivation not to wound plants, and keep caterpillars, slugs and biting insects in check. Affected plants should never be put on the compost heap or manure pile.

Harvesting and Storing.

When harvesting and storing turnips, cauliflower, cabbage, celery, tomatoes or other vegetables from crops in which the disease has been present, great care should be taken not to include any specimen that shows the slightest appearance of the disease, or to smear the healthy specimen with the soft rotted parts of diseased specimens. If these precautions are neglected, the disease is liable to establish itself and spread more or less rapidly through the entire crop stored.

Soft Rot of Potatoes.

The diseases to which potatoes are subject are numerous. Various species of fungi are responsible for most of them, but bacteria are involved in some cases. This is particularly so in the case of soft rot.

The soft rot is more prevalent in wet weather than in dry weather, and in low lying, undrained wet soils, than in high, dry or drained soils.

During the season of 1915 potato soft rot was prevalent in many districts of Ontario, and the writer devoted considerable time to observing and studying the rot throughout the season in the neighborhood of Guelph, and investigations are still in progress in this connection.

Black leg was found common in the early part of the season and this disease killed many young plants. Later in the season the soft rot developed and destroyed a large percentage of the tubers that had formed.

Similar bad outbreaks of the soft rot occurred at Guelph in 1904 and 1905, at which time Prof. F. C. Harrison of this Department made an extended study of the disease. Outbreaks of less severity and extent have occurred from time to time since.

The following is a partial quotation of Prof. Harrison's description of the disease as published in the Centralblatt für Bakteriologie, 2 Abte. Vol. 17, 1906-7.

General Appearance of the Disease in Growing Plants.

"In the majority of cases the first symptoms appear when plants are in full vigor of growth. A plant here and there will present a sickly appearance—drooping leaves, discolored yellowish. In a few days the stems gradually droop, finally rest on the ground and shrivel up.

When the leaves are turning yellow, black areas may be seen on the stems and petioles, and if these are cut through the fibro vascular bundles and adjacent tissues will be found brown or black according to the progress of the disease. The stems are usually most discolored near the ground. The leaves occasionally turn black without previous yellowing.

PLATE IV.

Potato tubers, showing bacterial soft rot in various stages of development, some tubers entirely rotted, others only partially affected.

Fig. 1. Six tubers that contracted the disease directly through the stem from the parent plant.

Fig. 2. Six tubers that contracted the disease at the eye end from coming in contact with other diseased tubers.

The tubers show the most characteristic indications of the disease. Even when the plant appears in a fairly thrifty state, the tubers may be badly diseased, out of all proportion to the apparent vigor of the plant. At first sight, most of the potatoes appear to be sound, but on closer examination the skin over certain areas may be found discolored a reddish-brown, something like a bruise, with a firm consistency, but as the disease progresses, the flesh beneath the dark portion becomes soft. There is a sharp line of demarcation between the healthy and diseased portions, frequently marked by a black line, the darker color being toward the sound part of the potato and gradually shading to a lighter brown on the diseased portion.

On breaking the skin a white, turbid liquid which may contain gas bubbles can be pressed out. This liquid rapidly turns black on exposure to the air. The skin over the diseased area easily peals away and the exposed flesh is watery and white, but soon discolors in the air, becoming almost black. In later stages of the disease the flesh softens to a watery pulp and becomes highly offensive with a putrefactive odor. In the final stage the potato becomes a mass of black soft pulp.

Several modifications of these conditions may be noticed. Thus the discoloration and blackening may be confined to only one portion of the tuber, and at other times the whole of the tuber beneath the skin is softened and discolored with the center portions quite sound. In some cases the most rotten tuber was the seed potato, in others the new potatoes.

The rot seemed to extend from the one first infected to the rest, infection evidently caused by actual contact.

If the potatoes are allowed to dry out, the tissues between the healthy and already softened portions undergo a corky modification.

After the potatoes are dug, and the apparently sound ones are put into a cellar or pit, the disease continues to spread, and on cutting open affected potatoes they will be found with brown or blackened areas. Such areas are not confined to the fibro vascular ring, but may be of any size and in any portion of the potato.

Natural Method of Infection.

One of the principal means of infection is the diseased condition of the seed potato when planted. In a large number of plants examined in the field the seed potato was found to be badly rotted and the young potatoes around were infected on the side nearest the rotted tuber. While it is doubtful if the potato rot bacillus can penetrate the unbroken epidermis, yet, if a small amount of rotted potato is placed on the unbroken surface of a healthy tuber, it will in a short time cause infection. This is probably due to the large amount of cytase in the rotted mass, which is able to bring about a solvent action on the cement substance of the cells of the healthy potato.

In the event of the organism being in the soil, infection may take place through wounds made while cultivating."

Prof. Harrison isolated a bacillus from the affected tissues, which he named *Bacillus solanisaprus*. He found it present in the stems and tubers or other parts of the plant affected.

He states: "In the stems the bacteria first make their appearance in the vessels of the fibro vascular bundles and from thence invade the surrounding tissues dissolving the middle lamella causing disintegration of the cells and

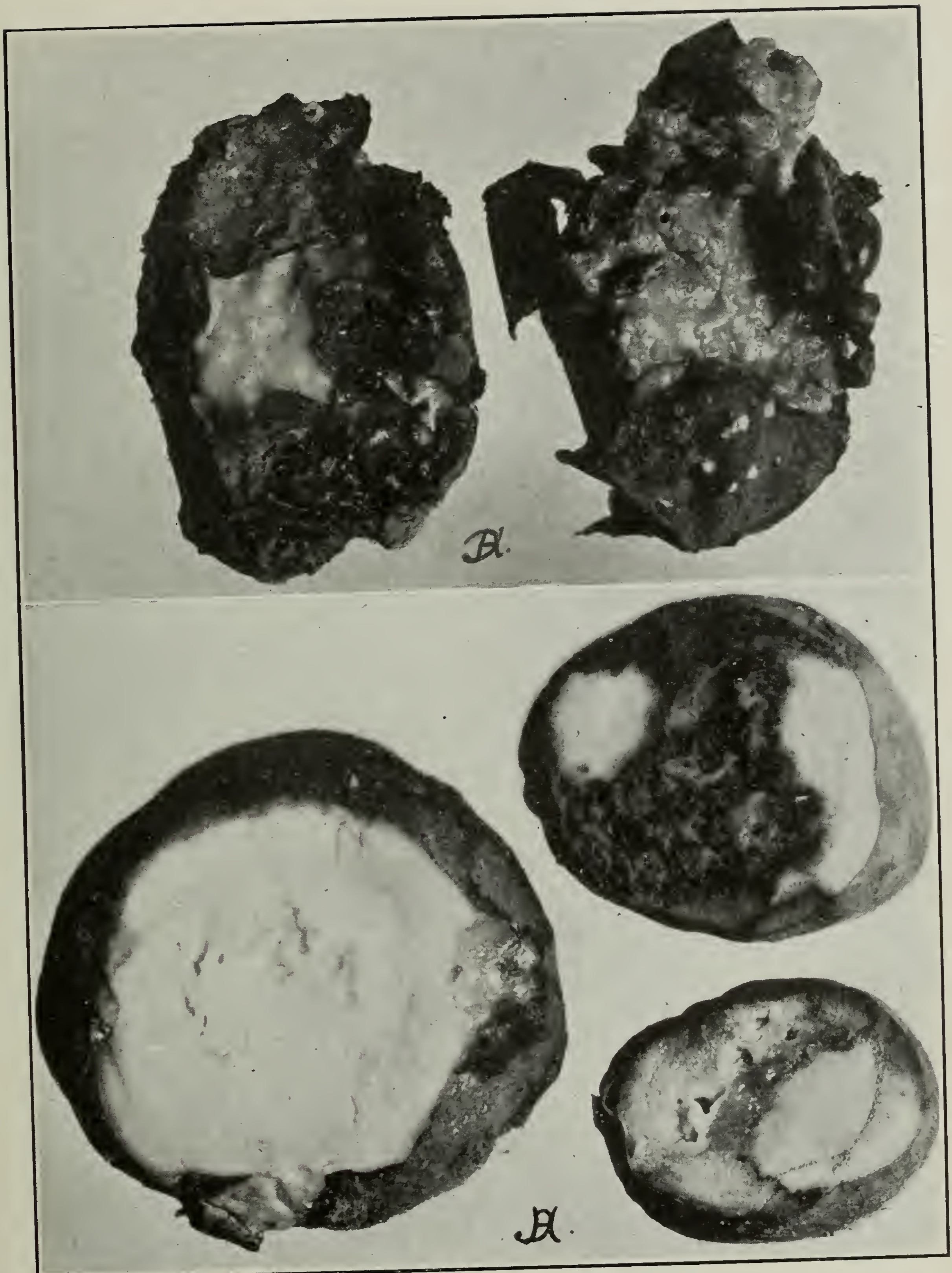


PLATE V.

Tubers in advanced stages of the bacterial soft rot.

forming cavities. In the tuber the action of the bacteria is first on the lamella of the cells and in fresh made preparations of partially rotted tissues free cells are abundant, showing the dissolving action of the enzymes of the bacteria on the cement substance or pectase layer of the cells."

The writer found all the above symptoms common in the rotting potatoes during investigations in 1915. A bacillus was isolated from several diseased tubers which corresponded in almost every particular, morphological and cultural, with *B. solanisaprus*, as described by Prof. Harrison. This bacillus when inoculated into raw potato kept in a moist chamber, caused a soft wet slimy rot to develop rapidly, completely destroying the potato in a few days.

Other Causes of Soft Rot in Potatoes.

In addition to finding *B. solanisaprus* causing the soft rot in the potatoes examined in 1915, the writer found many specimens which were affected with a species of *Fusarium*, a fungus which produces a wilt of potato tops and a dry rot of the tubers affecting them both in the soil and in storage. This disease has been described by Dr. Erwin Smith. (See Bul. 55, Bureau of Plant Industry, U.S. Dept. of Agriculture, also Bul. 229, "Fusarium Blight and Dry Rot of Potato," by T. F. Manns, Ohio Agricultural Experimental Station.) Growing potatoes which are affected with this fungus in wet weather are apt to present an appearance strongly resembling that described above as being due to *B. solanisaprus*. The plant, weakened by the disease, becomes an easy prey to the ordinary decay bacteria of the soil and other fungi and the result on the tubers of the combined action of these various micro-organisms is a soft rot both of the plant and the tubers. If, however, the season is a dry one a wilt of the affected plant and a dry rot of the tubers is the result.

Control of the Disease.

1. Do not plant potatoes that show any brown discoloration or other indications of either wet or dry rot.
2. Plant in well drained land.
3. Destroy by burning all diseased plants and tubers.
4. On land where the disease has been prevalent, do not plant potatoes or tomatoes for several years as both *B. solanisaprus* and the *Fusarium* live in the soil a considerable time, how long has not been determined.
5. Plant those varieties of potatoes that have proven most resistant to the rot.
6. Spray with insecticides as Paris green, to keep down insects and with Bordeaux mixture to prevent both the so-called Early Blight and Late Blight from developing in the tops of the plants. The latter is liable to lead to a soft rot of the tubers somewhat similar to that which follows the *Fusarium* affection.

BLACK LEG OF POTATOES.

As the name of this disease implies, there is a darkening of the lower stems of affected plants. This discoloration may range from brown to black; usually it is dark brown. It is most often found below the soil surface from the seed tuber up, but may extend upwards an inch or two above the soil. The discolored part shrinks and is liable to rot.

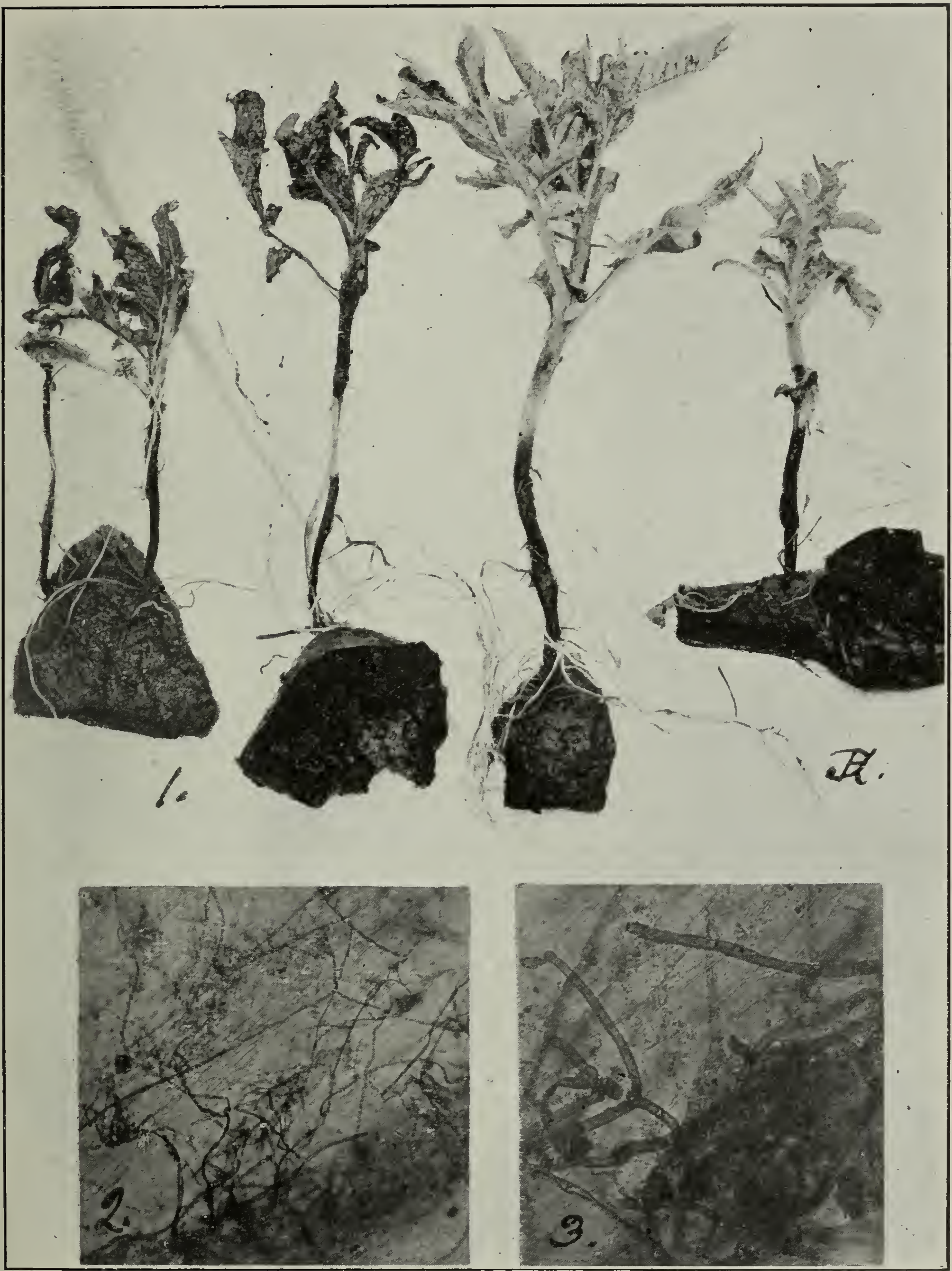


PLATE VI.

Fig. 1. Young potato plants showing *Black Leg*. The three stems to the left killed; the two to the right badly affected. (Both Rhizoctonia mycelium and soft rot bacilli found in affected parts).

Fig. 2. Small portion of epidermis from affected area, showing Rhizoctonia mycelium, low magnification.

Fig. 3. Small portion (Fig. 2) under higher magnification.

The disease affects young plants more particularly and kills them off early in the season. A disease of this character is common in Europe, particularly in Germany where it has been known for years. It is considered that it was introduced to the American continent from Europe on imported seed.

The disease was first described by Appel in Germany. He considered that it was bacterial and named the bacillus which he isolated from diseased specimens, *B. phytophthorus.*

The tops of plants affected with the disease lose their bright green color which fades away to a brownish or dirty yellowish green, presenting a withered and drooping appearance. On examining the lower stems of such plants the brown or black discoloration will be noticed. In many cases such discolored tissue will be soft rotting and an examination of the seed tuber usually shows it to have rotted away with a soft, slimy wet rot, often nothing but the skin being left. The soil underneath such a rotted seed tuber appears as though it had been wet puddled, due to the rapid extraction of water from the seed tuber during the rotting process. A microscopic examination of this soft rotting tissue, both in the seed tubers and the stems, shows large numbers of bacteria, usually several species being found in the older rotted parts.

In other cases of black leg where the stem of the plant is badly discolored, the soft rot may not be in evidence. A microscopic examination of the discolored epidermis shows no bacteria, but strands of fungus mycelium, most of which presents the typical appearance of the sterile fungus, *Rhizoctonia*, a species of fungus which is responsible for the root rot or canker of many vegetables. In some cases potato plants so affected appear later to get the better of the disease. That is, they do not die down or rot off; or, if some stems on the hill which are the worst affected die down, other stems not so badly affected or not affected at all develop apparently all right. However, later in the season when the crops are harvested, hills which have very vigorous tops, heavy foliage, and thick stems, may have also aerial tubers, that is, tubers as very irregular swellings on the stems above ground and usually a large cluster of very small malformed tubers crowded together at the surface of the soil. Examination of the underground stems of such plants usually shows discolored brown shrunken areas which evidently have been affected by the *Rhizoctonia*. The theory which has been advanced regarding the formation of such heavy top growth and the production of aerial tubers on the stems of the plant, with large clusters of small malformed tubers at the crown, is that the growth of the fungus on the stems of the plant interferes with the transmission of the reserve food substance manufactured in the foliage which, under normal conditions, is returned to the roots where it forms the tubers. The injury to the underground stems caused by the *Rhizoctonia* prevents the passage of this reserve food material to the usual parts of the root system and forces its deposition in abnormal places, either at the surface or above the surface of the soil in the shape of malformed tubers, which are usually small and numerous.

In many cases of the bacterial soft rotting type of black leg, the writer has found on the epidermis of the discolored stem, interlacing strands of *Rhizoctonia* mycelium. It is possible that this fungus is the primary cause of most cases of this disease and that the bacterial soft rotting of the affected tissue in such cases is secondary owing to an invasion of the weakened epidermis by the decay bacteria common in the soil.

The disease is most common in wet, backward seasons when the resistance power of the young growing plant is low.

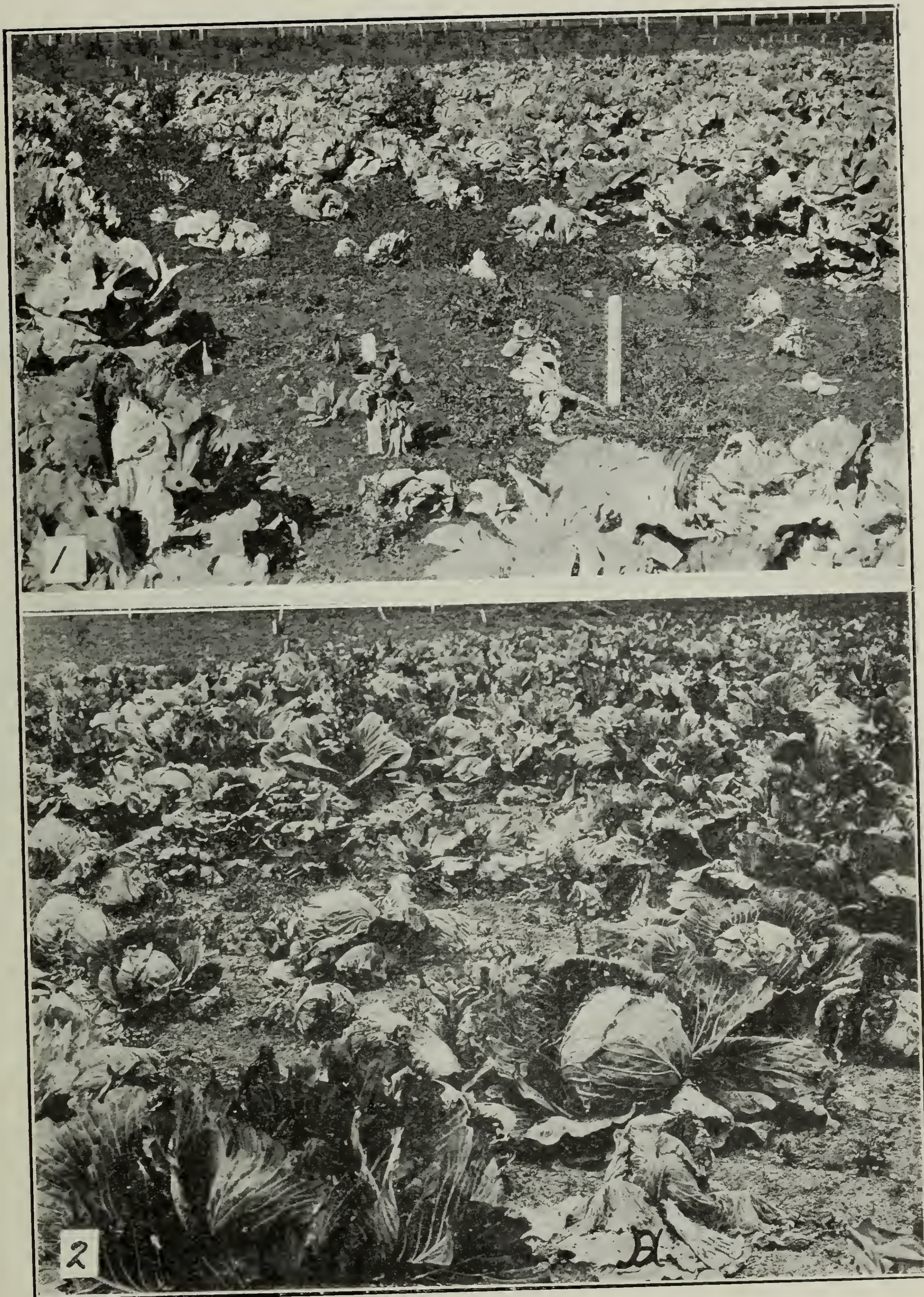


PLATE VII.

Bacterial Wilt of Crucifereae (Black Rot of Cabbage).

Figs. 1 and 2. Views in a cabbage plantation, showing numerous cases of the disease in all stages of development.

The disease of both types is carried over both in the soil and on or in the seed tubers.

The *Rhizoctonia* may be present on the surface of sound seed tubers as black or dark brown rough spots, raised above the surface, varying in size from a pin head to masses half an inch in diameter very irregular in shape. These are the resting stages of the fungus called sclerotia. When a tuber so affected is planted, these sclerotia germinate at the same time that the eyes and young roots of the potato develop. The mycelium from the germinating sclerotia spreads all around and comes in contact with the young growth of the potato, and if the young plant is not sufficiently resistant it falls a victim to the disease. The part attacked turns brown and shrinks, and the symptoms previously described develop.

The dark sclerotia masses on the seed tuber may be made much more distinct by dipping the potato in water; this will make them quite black in color. Potatoes with these sclerotia black spots on them should not be planted, and all seed tubers should be carefully looked over for them before planting. Also any tubers which show brown discolorations under the skin or brown areas in the flesh when they are cut should not be used, as the bacteria which cause the soft rotting type may be present in such discolored tissue.

BACTERIAL WILT OF CRUCIFERÆ.

(Black Rot of Cabbage, Turnip, Rutabaga, Etc.)

Causal organism—*Ps. campestris.*

This wilt, commonly known as Black Rot of Cabbage and sometimes as Brown Rot, is a very bad disease and causes much loss to the kitchen gardener. It is found attacking many cruciferous plants including cabbage, cauliflower, collards, Kohl rabi, kale, brussels sprouts, broccoli, rutabagas, turnips, wild radish, and mustard, the latter, unfortunately, only to a very slight extent.

It is widely distributed, occurring throughout Canada, United States, Great Britain, Holland, Germany, Denmark, Austria, France, Switzerland and other countries.

The specific cause of the disease was first ascertained by Pammela of Ames College, Iowa, in 1895 when on investigating a bad outbreak of a black rot of rutabagas he isolated a germ which he named *B. campestris,* grew it on various culture media, and, by inoculating healthy plants with the cultures so obtained, produced in them the disease and from these plants reisolated the germ. (Bulletin 27, Iowa College Experiment Station, 1895.)

Erwin Smith in 1896 (see Centralblatt für Bakteriologie, II Abte., Vol. 3, 1897) on investigating a brown rot of turnips and a black rot of cabbages, infected material of which was forwarded to his laboratory, isolated a germ which proved to be identical with that isolated by Pammela the year before from rutabagas. He conducted numerous inoculation experiments and established the germ as being the specific cause of the wilt of many cruciferous plants which is so common in moist weather, and which causes heavy losses to market gardeners.

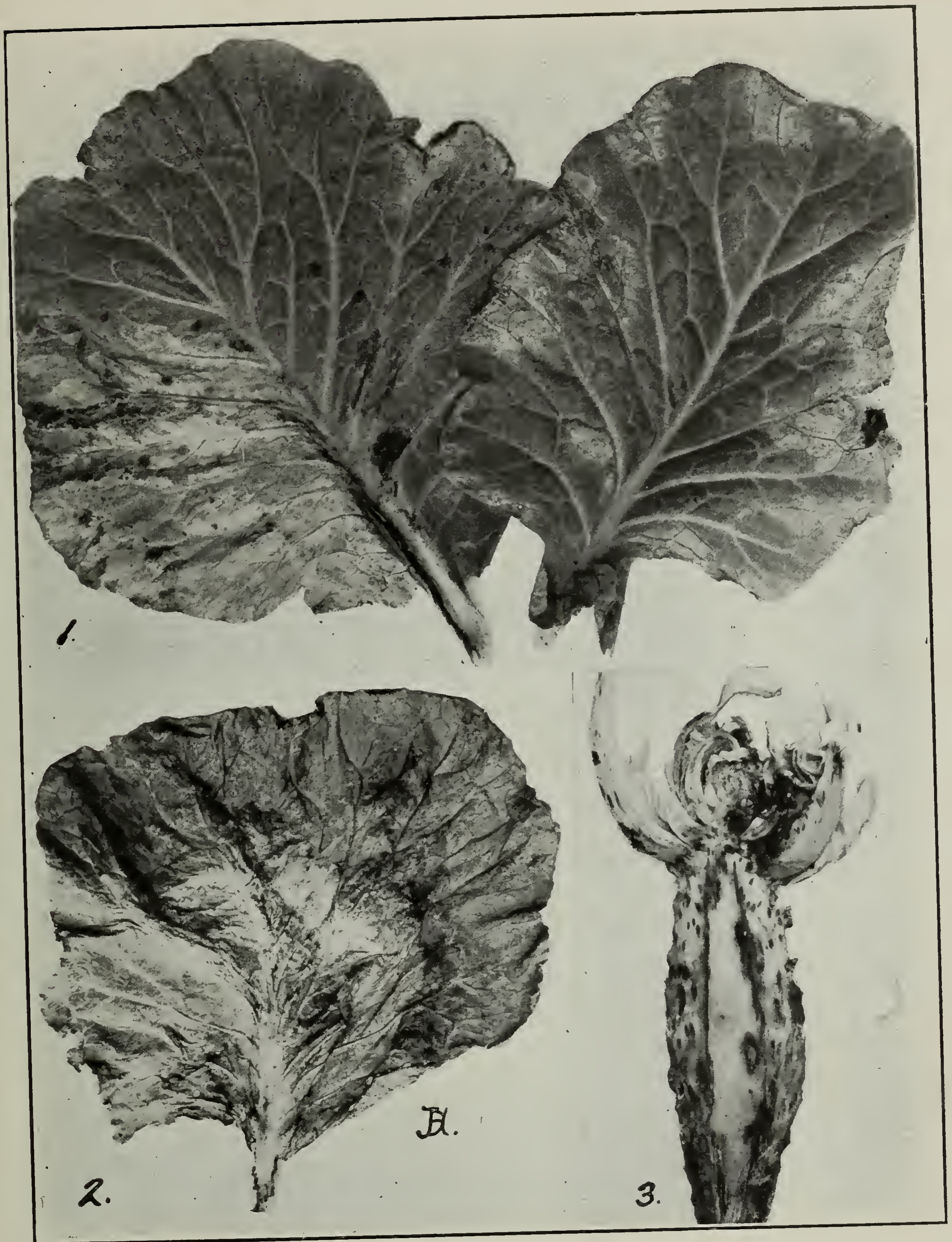


PLATE VIII.

Fig. 1. Cabbage leaves affected with the bacterial wilt or black rot. The lighter-shaded areas around the outer edge of the leaves are the diseased parts showing natural inoculation through the water pores on the edge of the leaves.

Fig. 2. The lighter shade part of the leaf near the base indicates the diseases, and the blackened vascular bundles of the stem, where it is cut, indicates that the disease entered this leaf from the main stalk of the cabbage.

Fig. 3. Cabbage stalk and stunted head; the blackened vascular bundles indicate that the disease was general throughout the plant. The leaf of Fig. 2 was taken from this plant.

Appearance of the Disease.

In the growing cabbage plant the disease manifests itself as a yellowing or browning of the leaves. This yellowing occurs in irregular areas sharply defined, which gradually enlarge until the whole leaf becomes browned, wilted and shrivelled.

If the plant be attacked by the disease when young it will not develop normally, but will be dwarfed, and will present a pale, sickly appearance and often no head will be produced in the case of a cabbage, and no bottom produced in the case of a turnip or rutabaga. (See illustration.)

The browning and wilting of the leaves is due to the supply of sap being cut off in the veins and midribs that are situated near or within the brown areas.

If the midrib of a diseased leaf or the veins leading from a diseased part of a leaf be cut it will be noticed that the vascular bundles or fibres are black or dark brown instead of yellow or white. This discoloration is due to the presence and action of immense numbers of the disease-producing bacteria within the veins or fibro-vascular bundles. Here they feed on the sap, multiply rapidly and choke up the passages so that the supply of sap is cut off from the surrounding tissue, thus causing it to yellow, wilt and die.

If the whole head of cabbage be yellowish, sickly, and wilted, or if several leaves of a cabbage present such an appearance, a section of the stalk, either cross or longitudinal, will almost invariably reveal the disease in the blackened vascular bundles forming the vascular ring, the woody portion of the stem. In such a case the germs will have spread almost throughout the entire vascular system of the plant, passing down the veins of one leaf into the stem where they would pass both up and down the veins of the stem to veins of other leaves until the whole plant became affected and worthless. (See illustration.)

Means of Infection. Infection is most common at the water pores around the margin of the leaf. In the early morning, especially in moist weather, dew-drop-like beads of water may be noticed around the leaf margins of growing cabbages. This is usually water of transpiration given off by the plant through the water pores. If the atmosphere were dry this water would not be found there as it would evaporate as soon as it came to the surface of the plant. But when the atmosphere is moist this evaporation does not take place and so the water extruded from the pores forms little beads.

Should the disease germs by any chance get into these drops of water it is very easy for them to enter the vascular system of the plant through the open pores. Thousands of cases where such has been the means of entrance of the germs into a plant have been observed.

The question remains: How do the germs get into the drop of water? This may occur in several ways. Slugs and caterpillars crawling around after feeding on or crawling over a diseased plant may carry and deposit the germs wherever they crawl on the healthy plants. The cultivator in passing along the rows may brush against and wound a diseased plant and some of the germs thus get onto the cultivator and so be carried along and brushed off on healthy plants. In transplanting, the hands of the workman may become contaminated from handling a diseased plant, and plants subsequently handled have the germs deposited on them from the hands of the workman. Even should the plant be dry at the time it is so contaminated, the germs may remain alive on the plant for days until the right conditions occur, that is, sufficient moisture be present in the atmosphere and in the soil to allow of the formation of water drops at the water pores when infection would take place.

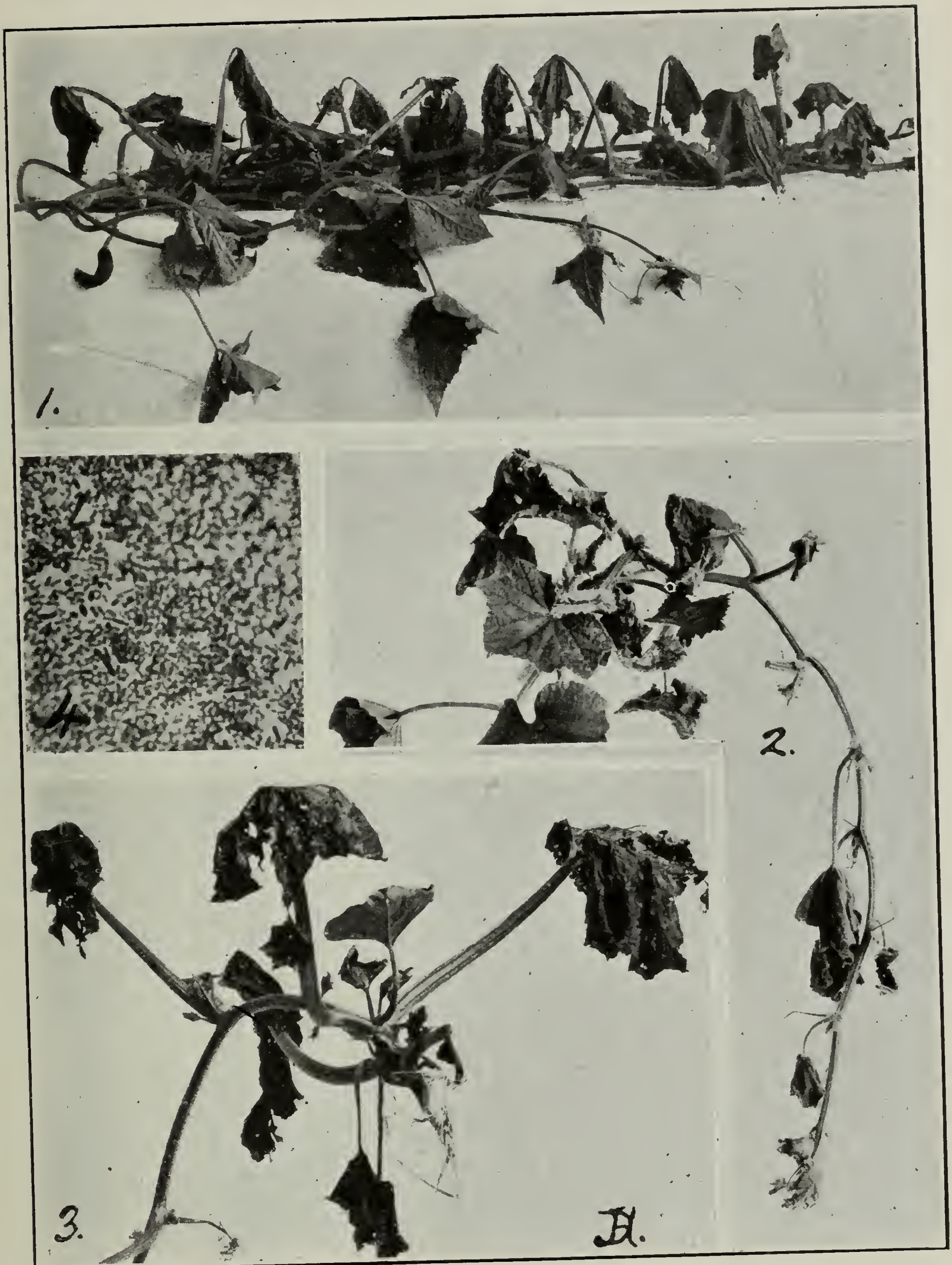


PLATE IX.

Bacterial Wilt of Cucurbits.

Fig. 1. Bacterial wilt of cucumber.

Fig. 2. Bacterial wilt of cucumber.

Fig. 3. Bacterial wilt of squash.

Fig. 4. Stained microscope preparation from the viscous slimy exudate of a vascular bundle of a wilting cucumber plant, showing the bacteria (B. tracheiphilus), (x 1000 di.).

Again, biting insects, caterpillars, slugs, and other forms of animal life which feed on growing cabbages, may, after feeding on a diseased plant, inoculate directly a healthy plant by biting through one of the small leaf veins and depositing there some of the germs adhering to their mouth parts after their visit to the diseased plant. Such means of inoculation have been observed again and again. Caterpillars and slugs feeding on diseased leaves have been transferred by hand to healthy plants and in a large percentage of cases the disease has subsequently developed in the healthy plants at the point where the caterpillar was placed.

Infection through contaminated seed may occur. By a series of experiments conducted at the New York Experiment Station, Geneva, it has been proven that the germ can live on dry seed for longer than nine months. Such contaminated seed when germinating is liable to infect the young plant, and cases of such infection may occur in seed beds.

Again, seed beds are often badly contaminated with the germ by spreading on them material from the manure pile or compost heap where diseased plants have been deposited to rot. And while it is very doubtful that the germ enters the plant through the root hairs, any injury to the root, or leaves that are near the ground, may result in the inoculation of the plant with the disease. Caterpillars and slugs crawling over such soil would be very liable to inoculate the plants growing there by crawling over and feeding on them.

Control of the Disease.

The best way to keep the disease under control is to prevent its development.

Disinfecting the Seed. It was proven at the Geneva station that germs on the seed may be killed without any injury to the seed by soaking it for fifteen minutes either in a corrosive sublimate solution or in formalin.

If corrosive sublimate is used, the strength of the solution should be one part corrosive sublimate to one thousand parts of water. The most convenient method of preparing this solution is to use the corrosive sublimate tablets sold by druggists for making disinfecting solutions. One tablet, costing one cent, is sufficient to make a pint of solution which is about the quantity required to treat one pound of seed. The seed should be soaked in this solution fifteen minutes and then spread out to dry.

If formalin is used the strength of the solution should be one part formalin (40 per cent. formaldehyde) to 240 parts of water and the seed soaked for fifteen minutes.

A convenient method of treating the seed is to place it in a small bag made of any loose cloth readily penetrated by water and suspend the bag in the disinfecting solution for the required length of time. The seed should be dried without delay in the shade.

Handling Diseased Plants. Should the disease be noticed among seedlings in the seed bed, the diseased plants should be removed and burned. If they are not burned the germs within them are liable in many ways to get transferred to the healthy stock, and so the disease be spread instead of being checked.

Seedlings that show signs of the disease should not be planted out. It is not usually of much service simply to break a diseased leaf from what appears to be an otherwise healthy plant. If the disease is confined to the marginal areas of the leaf entirely, then breaking off the leaf would prevent the rest of the plant from developing the disease. But, should the vascular bundles in the midrib of the

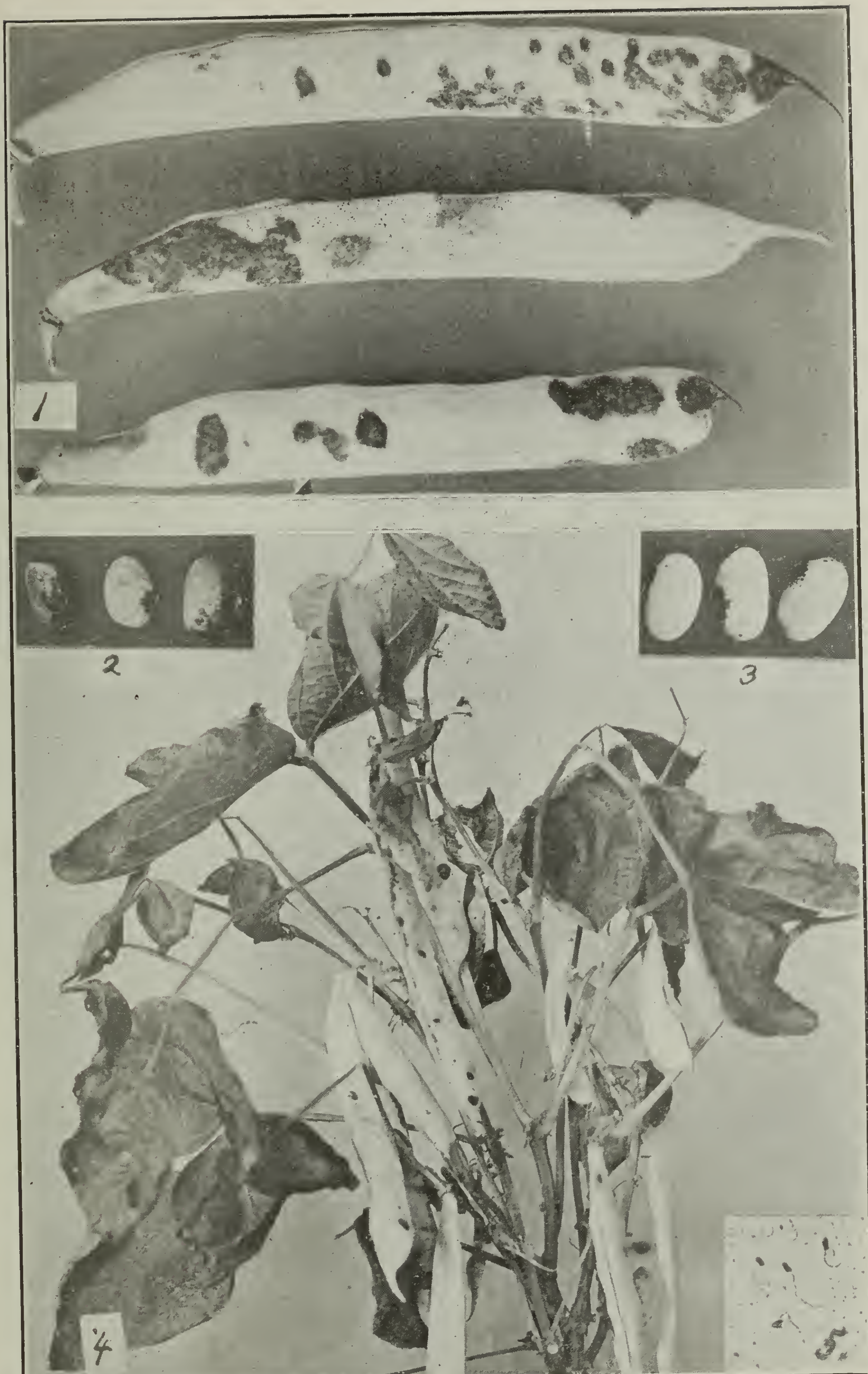


PLATE X.

Bacteriosis of Beans.

Fig. 1. Diseased pods.
Fig. 2. Diseased beans from diseased pods.
Fig. 3. Healthy beans.
Fig. 4. Bean plant badly affected with bacteriosis in foliage and pods.
Fig. 5. *Ps. phaseoli*, the cause of the disease.

leaf at the point of its contact with the plant stalk be discolored brown or black, we may take it for granted that the germs are already established in the vascular bundles of the stalk. So after breaking off a diseased leaf one should look to see if any discoloration of the vascular bundles exists, and should there be any, the whole plant should be destroyed.

If an entire bed, or a considerable portion of a bed be badly attacked, all the plants should be pulled and burnt and the broken leaves, etc., raked up and burnt also. Cabbage or turnips should not be planted again on such ground for one or two years.

Insects and caterpillars, slugs, etc., should be kept in check as they are noted carriers of the disease germ by feeding on diseased plants and then going to healthy plants.

BACTERIAL WILT OF CUCURBITS.

Causal Organism, *Bacillus tracheiphilus.*

This wilt often causes serious losses to the growers of cucumbers, squashes, melons, and other cucurbits. Whole plantations of these plants are sometimes completely destroyed, and the disease will pass rapidly through a house of cucumbers.

A diseased plant loses its bright green color and turns to a dull, dirty yellowish green. The leaves and stems become flaccid and droop, hang down limp and lifeless, having lost all turgidity. The fruit when affected becomes soft and appears somewhat water-soaked, and if squeezed will readily yield to pressure, and often under such treatment the skin will rupture and a slimy clear liquid will ooze out. If this liquid be touched with the finger or any instrument, it will be found to be viscid, slimy or gummy, and will string out in long strands. If a diseased stem be broken or cut, similar conditions will be found to exist, i.e., the plant juice will be viscid, slimy and will string out in long strands when the cut surface is scraped with a knife or rubbed with the finger.

This sliminess or viscidity is the most characteristic feature of the disease, for a plant may wilt for lack of moisture and present an appearance something like a diseased plant. But if such a plant be cut and its juice expressed, this juice will prove to be quite watery and will not draw out in threads.

A microscopic analysis of the slimy juice from a diseased plant will show millions of bacteria within the smallest drop that can be obtained. While a similar preparation made from the juice of a healthy plant or a plant that has wilted merely from the lack of moisture will not show a single germ.

If a little of this slimy juice from a diseased plant be transferred on the point of a needle to the inner tissue of a healthy plant by puncturing the healthy plant with the contaminated needle, in a day or two the plant will wilt, the bacteria inserted on the point of the needle having multiplied so rapidly and spread through the vascular system of the plant.

Pure cultures of the germ on artificial media are rather difficult to obtain as the germ will not grow readily on the ordinary media. However, pure cultures have been obtained on special media, and these inoculated into healthy plants have rapidly produced the disease.

In the stem and leaf the disease germ is found mostly in the vascular bundles, in the plant juice of which it lives and rapidly multiplies, spreading up and down and plugging the sap channels. Eventually the walls of the vascular bundles are broken down and the organism gets into the surrounding tissue to a limited extent.

The flesh of diseased fruit is transparent and water-soaked in appearance.

The plant juice in all affected parts becomes slimy or viscid and strings out in long strands.

Methods of Spreading.

1. The disease is spread from plant to plant mostly by biting and sucking insects, particularly the striped cucumber beetle and the squash bug. These insects after feeding on a diseased plant have their mouth parts covered with the germs of the disease and on subsequently feeding on healthy plants they inoculate the healthy tissue with the disease.

2. The gardener in removing and destroying the diseased plants cannot help but get his hands and the tools used badly contaminated with the disease germs even when exercising the greatest care, and so if he does not take the precaution to disinfect his hands and the tools used before handling any healthy plants, he is very likely to inoculate them with the germs of the disease.

Methods of Control.

All diseased plants should be carefully removed and burned immediately. If they are allowed to lie around insects will swarm about them, get themselves contaminated with the germs and thus spread the disease wherever they go.

Hands and tools used in removing and destroying diseased plants should be thoroughly disinfected by washing them in five per cent. carbolic acid, or in corrosive sublimate of a strength one to one thousand, or some other good disinfectant.

Biting and sucking insects, especially the striped cucumber beetle and squash bug, should be kept under control by spraying and hand picking.

BEAN BLIGHT.

Bacteriosis of Beans.

Causal organism, *Ps. phaseoli* (Smith).

Whilst there has been no record of heavy losses from this disease in Ontario, we get every year bean plants suffering from the disease forwarded to us. Letters accompanying these plants often state that considerable damage was done to the fields from which the plants were taken, many plants being attacked in the same way. Scarcely a season passes but what more or less of this disease is present in the beans of the College garden and in the bean plots in the experimental grounds. In the United States where wax beans and lima beans are grown extensively, heavy losses are caused by the disease, and it is getting more general in Ontario.

Beach of the Geneva Station established the bacterial character of the disease on lima and wax beans in 1892, and Halstead of the New Jersey Station in the same year arrived at similar conclusions after making a series of experiments. Erwin Smith in 1897 first described the causal organism, *Ps. phaseoli*. Work dealing with this disease has also been done in this laboratory.

The disease may be found on the foliage, the stems, the pods and the beans within the pods. At first the disease on the pods appears as small, water-soaked areas. These areas gradually enlarge and usually are outlined by a reddish-brown border. As the disease progresses and the areas continue to enlarge, the whole of the affected area becomes a light brown, and does not develop the black or pink color or the sunken spots produced by anthracnose. The foliage becomes spotted and yellowed in large areas of the leaf surface, soon withers and falls away.

Method of Infection.

Leaves. The disease usually begins at the margin of the leaf, or where the leaf has been torn by insects, wind or hail. Here the germs find entrance into the plant tissues through the wound. A yellow spot is formed and the green color destroyed. The spot increases in size rather slowly, and the diseased tissue becomes brown and papery, turning dry and brittle in the sun and soft in the rain, and then is often torn away leaving ragged margins and holes in the leaf. The whole leaf may die and fall to the ground or remain withered on the stem.

Stems and Pods. The disease usually enters the stem by way of the leaf stalk, and advances in the stem to other leaves and to young pods. In severe cases the pod may wilt and die, and on opening it the half-grown seeds will be found shrivelled and discolored by irregular brownish areas outlined by the characteristic reddish-brown margin. The beans may be apparently sound or only slightly discolored or they may be much discolored. The whole plant does not usually die outright, but lingers through the season. Separate infections may occur at any place on pod or stem.

Seed Beans. In germination tests of diseased beans less than half the number sown germinated. The remainder rotted. Those that germinated never produced healthy plants but plants that were weak and soon wilted. Healthy seed sown under the same conditions germinated a ninety-eight per cent., and produced vigorous healthy plants.

The germs live over winter in the bean tissue and infect the plant on germination.

In appearance the disease is somewhat similar to bean anthracnose or "pod spot" caused by the fungus *Collitotrichium lindimuthianum*, but this latter may be distinguished by its making rather deep pits in the affected areas which are pinkish and produce spore-bearing pimples.

Causal Organism, *Ps. Phaseoli.*

In morphology and cultural characteristics *Ps. phaseoli* is practically identical with *Ps. campestris* which causes wilt or black rot of cabbages. But while it is pathogenic for beans, peas and lupines, it is not pathogenic for cabbage or cauliflower. And while *Ps. campestris* is pathogenic for most crucifers, it is not pathogenic for the legumes.

The organism has been isolated by Delacroix from French grown plants at Paris.

Eradication and Control.

Do not sow seed from diseased plants. Remove infected plants and burn them.

BULLETIN 241] [JULY, 1916

Ontario Department of Agriculture

FRUIT BRANCH

HORTICULTURAL EXPERIMENT STATION

Peach Growing in Ontario

F. M. Clement and A. G. Harris.

INTRODUCTION.

When prices are high or above normal for any particular product the tendency is to produce more. With crops that are produced from seed or plants each year, such as onions and cabbage, the tendency is toward extreme variations in price each year. With tree fruits the extremes of variation in price must, of necessity, be several years apart. Peaches are no exception. Comparatively high prices for the product led to heavy plantings for a number of years. These plantings are now at their best or coming into their best. It was predicted by the leading fruit men several years ago that the price would be low when the young orchards came into bearing. It was even felt by some that quantities of fruit would be unmarketed. These conditions, however, have not been so serious as expected. Production has increased as was assured from the largely increased acreage, and prices for the years 1913 and 1915 have been comparatively low (1914 was a complete failure), but no great quantity of fruit has gone to waste. Good fruit has been in demand.

With the improved distribution of the past season, the aid of advertising, the improvement of packages and packs, and the more extended use of refrigeration, it is reasonable to expect that the markets will recover. One other factor seems to be pointing in an upward direction. The planting of young trees was heaviest during the years of 1908, 1909 and 1910, gradually decreasing to the years 1913 and 1914. The 1915 plantings were comparatively light, and at the time of writing prospects for heavy plantings in 1916 are not bright. No figures are available for the last few years, but it is apparent to the observer that the tendency to plant heavily is not as strong as from five to seven years ago.

Peach-growing in most of the tender fruit sections of Ontario has long passed the experimental stage, but habits and customs are changing constantly. It is only fair to expect, however, that the number of plantings will centre around normal until high prices again coax the growers into sudden and extensive plantings.

HISTORICAL.

The first record, available to the writers, of peaches grown in Ontario is taken from the diary of Mrs. Simcoe, Niagara, July 2, 1793: "We treated them with cherries, we having large May Duke cherry trees behind the house and three standard peach trees which supplied us last autumn for tarts and desserts during six weeks besides the number the young men ate. My share was trifling compared with theirs, and I ate thirty in a day. They were very small and high flavored. When tired of eating them raw, Mr. Talman roasted them, and they were very good."

The next record appears in the journal of Captain Langslow, who visited Niagara in 1817, and spoke of peaches being very plentiful. There is, I believe, also a written record of Mr. Dennis Woolverton, of Grimsby, selling natural fruit in Hamilton market as early as 1820. In 1856, Mr. C. E. Woolverton, of Grimsby, planted five acres of commercial orchard of such varieties as Barnard, Crawford, Old Mixon and Mountain Rose, and was the first to ship by express to distant Ontario markets.

When the Prince of Wales visited Toronto in 1860, on the menu card of the Queen's Hotel occur the words: "Brown's peaches," showing that the trees must have been planted many years before this date. This orchard was near Niagara-on-the-Lake, and from written records we are given to understand was on a commercial scale.

It was not, however, until about the year 1890 that peaches were planted generally. The years following this date they were planted very heavily. In the winter of 1897 and 1898 the severe freezing did much to delay the growth of the industry, but by 1904 and 1905, it had grown to such proportions that the demand was scarcely equal to the supply. In 1904, the first car was sent West as far as Winnipeg by freight. The following years saw heavier shipments and the extension of markets elsewhere. This relieved for the time all possibility of congestion and fair to good prices prevailed until 1913. The situation brought to a head in 1913 is still faced, but relief is looked for in better marketing and extensive advertising. Generally speaking, the growth of the industry has been steady and prices have been such that the greatest quantities ever produced in Ontario are being marketed at the present time.

EXTENT OF THE INDUSTRY.

Ontario Peach Census, 1911.

County	Non-Bearing 1910	Bearing 1910
Brant	2,525	3,159
Bruce	1,217	2,628
Elgin	18,800	19,331
Essex	83,822	48,932
Grey	1,110	1,123
Haldimand	2,234	2,618
Halton	5,649	5,394
Huron S.	3,733	4,863
Kent	33,710	33,408
Lambton	64,227	32,727
Lincoln	491,886	398,320
Middlesex	5,180	3,416
Norfolk	34,685	19,216
Oxford	3,529	4,611
Perth S.	558	445
Waterloo N.	352	736
Welland	61,261	45,382
Wentworth	67,623	155,535

The above list includes areas with a total of at least 1,000 trees. The total for Ontario, according to the 1911 census was as follows:—

Non-bearing	890,455
Bearing	794,192
Total	1,684,647 Trees

County lines cannot, however, be said to mark the commercial areas. The industry is well established in but five sections of the Province: Niagara District, Leamington District, Forest District, Cedar Springs District, and Sparta District. A number of other sections are experimenting with varying degrees of success and give promise of development. The county lists show the Niagara District has approximately 1,250,000 trees; Leamington District, 130,000 trees; Forest District, 100,000 trees; Cedar Springs District, 60,000; Sparta District, 50,000.

Climate, soils and conditions vary somewhat in these districts, but in many respects they are very similar.

Soil conditions are very similar, in that the most successful orchards are on land that is warm and dry and in which the root systems of the trees have an opportunity to spread.

Atmospheric conditions are very similar. Either the district is influenced directly by a large body of water or the trees are on a gravel ridge some distance from the water, so high that they are directly influenced by air currents.

Limiting Factors.—Many trees are planted outside of and beyond the commercial districts, and consequently a few words on the factors limiting successful production may not be amiss.

The native home of the peach is almost sub-tropical, but many years of growth under very varied conditions have gradually fitted it for severer climates. Undoubtedly we can reasonably expect that varieties will be developed that will withstand severer climates and more adverse conditions than our present varieties. At present, however, a minimum of 20 degrees F., not continued for more than a few hours is considered the limit of hardiness of wood and bud. The tree must be well prepared, or it will not stand even this extreme.

A soil either too wet or too dry is not the most protective to the roots. A wet soil freezes deeply and is conducive to sappiness in the new growth, consequently conducive to weakness. A soil too dry cannot readily replace the evaporation loss from the twigs, and a shrivelling is noted which leads to loss.

A soil too rich in nitrogen also is conducive to a sappy growth which will not stand the extremes of cold.

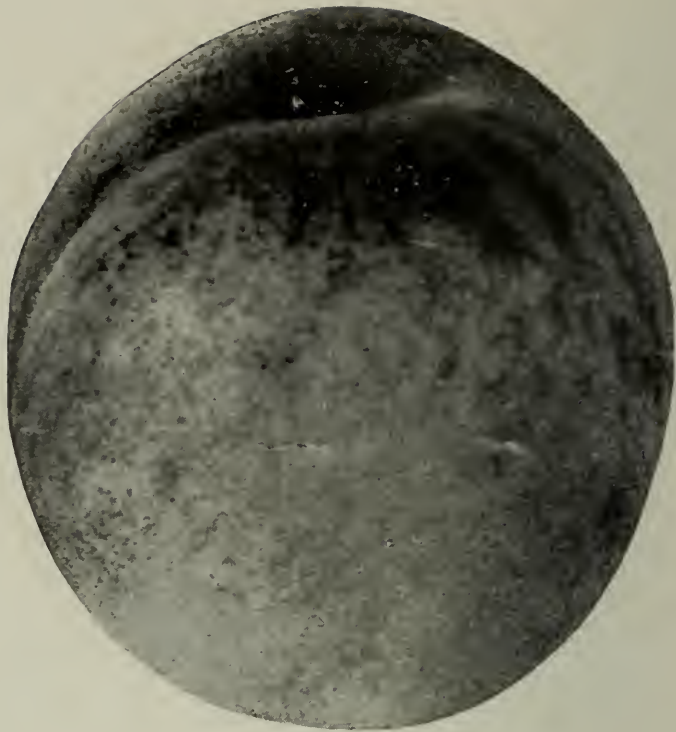
Generally speaking, the medium rich, deep, warm, well-drained soils produce the hardiest trees. A disregard of any one of these factors is fatal. The smaller, slower growing varieties are hardiest, and the limit of 20 degrees F. below zero may be set as a mark even under the most ideal conditions.

VARIETIES.

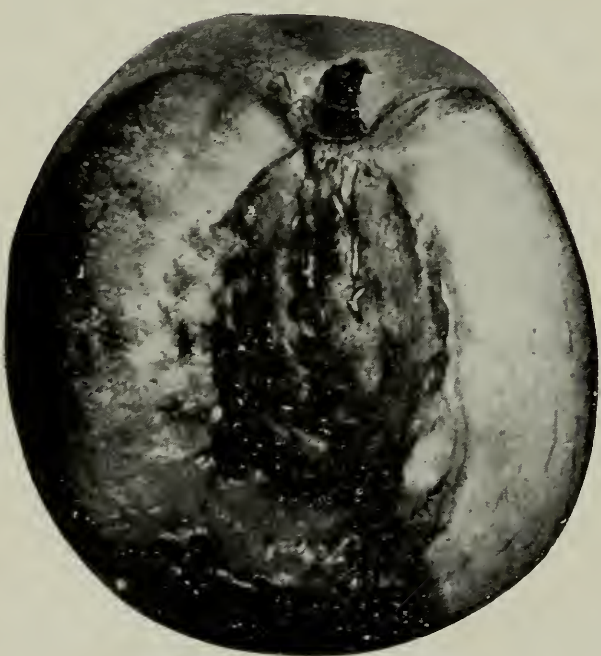
The selection of the best varieties is one of the first and most important steps in successful peach culture. In some cases, varieties entirely unsuited to the demands of the market have been planted. White-fleshed peaches cannot be said to be in demand, but a few varieties are mentioned for home use and early market.

TREE: vigorous; very productive; an early bearer.

FRUIT: large and flattened; color a deep cream; very downy.



GREENSBORO.



SECTION OF GREENSBORO.

FLESH: cream colored, tender, melting, very juicy, almost a free stone.

QUALITY: good.

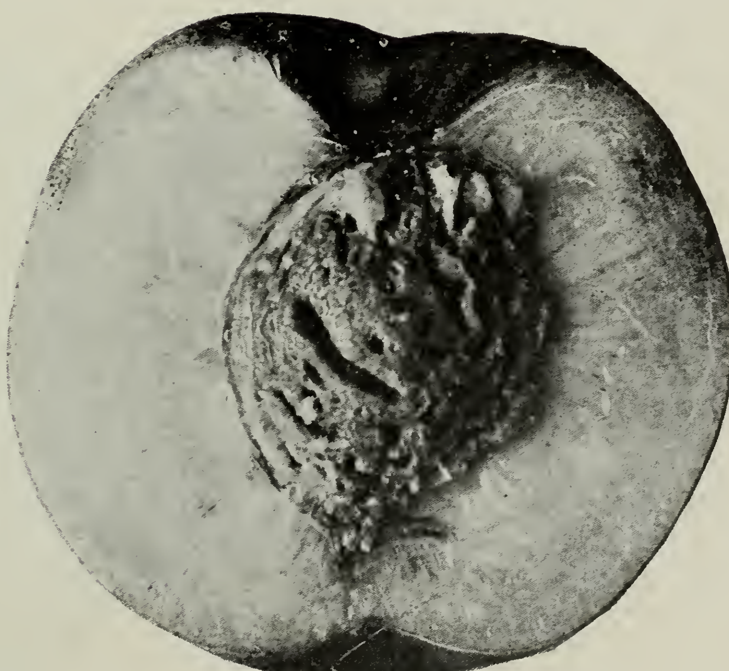
SEASON: mid-August.

A good early peach for nearby markets.

CARMEN.

TREE: hardy, vigorous and productive.

FRUIT: a handsome, white flesh peach, easily bruised, large, resembling Elberta, creamy white with deep red blush.

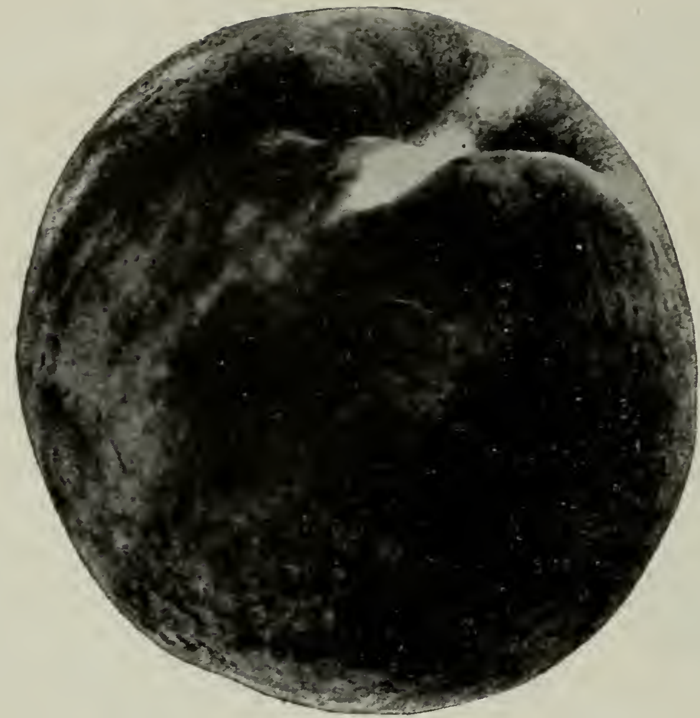


SECTION OF CARMEN.

FLESH: white, tender and of fine flavor.

QUALITY: Very good. Is at present quite popular.

SEASON: early September.



ADMIRAL DEWEY.

TREE: vigorous, hardy and productive.

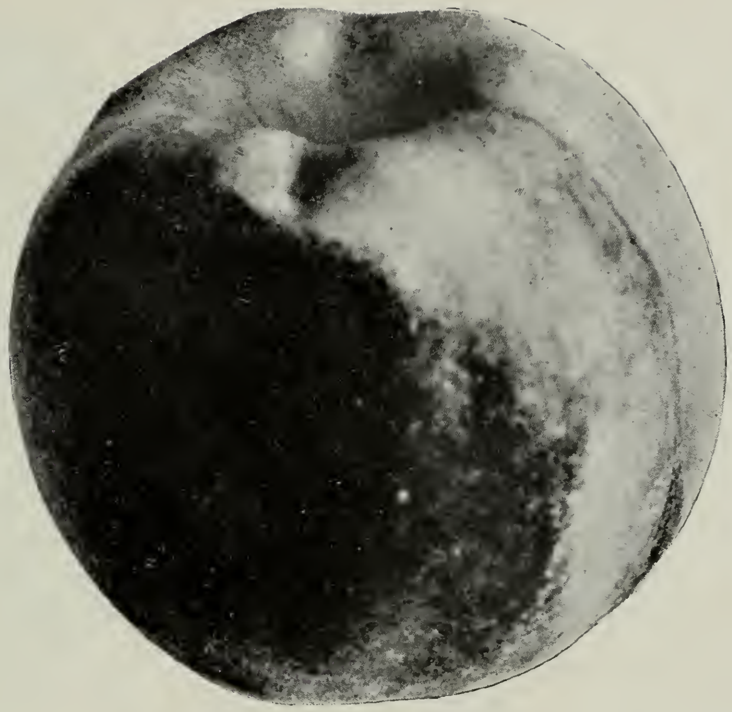
FRUIT: medium size, yellow flesh; semi-cling to free stone.

FLESH: yellow and firm.

QUALITY: fair to good but will not hold up well. Rots badly in damp weather.

SEASON: just before the Yellow St. John.

SECTION OF ADMIRAL DEWEY.



TREE: vigorous and productive.

FRUIT: form round, size large, skin yellow with dark red cheek.

FLAVOR: sweet, rich and agreeable.

ST. JOHN.

QUALITY: dessert, very good; canning, good.

SEASON: late August.

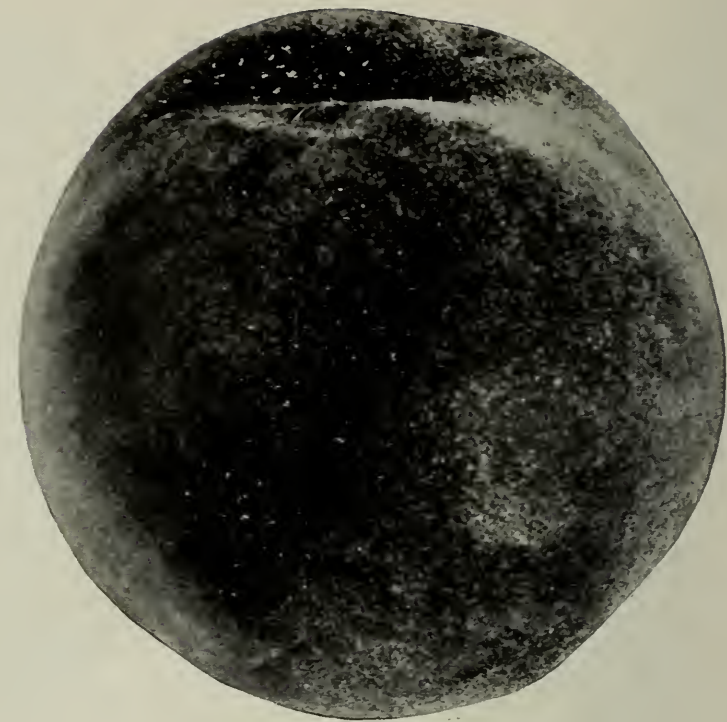
By a great deal the best early yellow fleshed peach.

SECTION OF ST. JOHN.

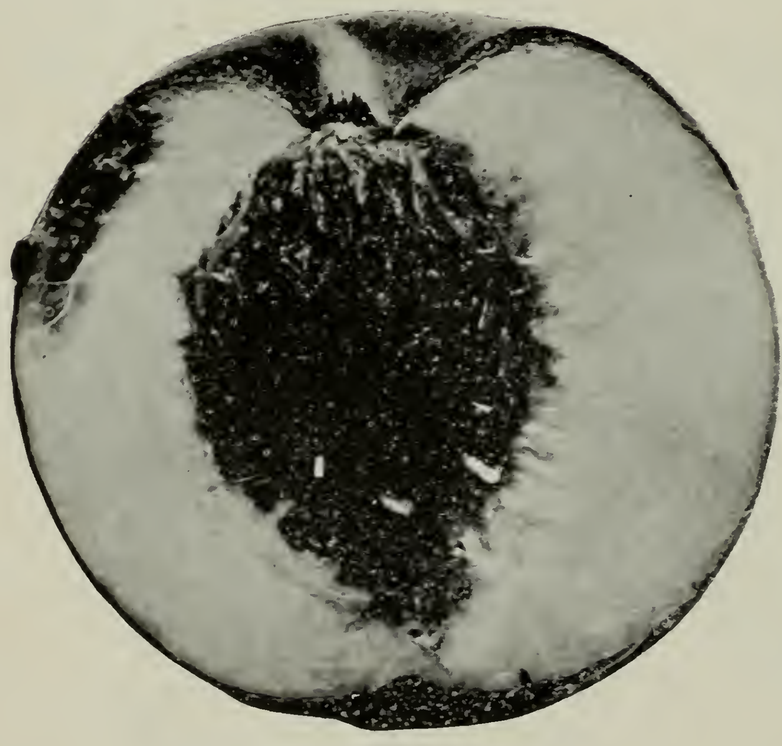
TREE: vigorous; productive.

FRUIT: large, of the Crawford type, roundish oval, color, yellow with red cheek.

FLESH: yellow, free stone, texture tender, very juicy, flavor rich.



BRIGDON OR GARFIELD.

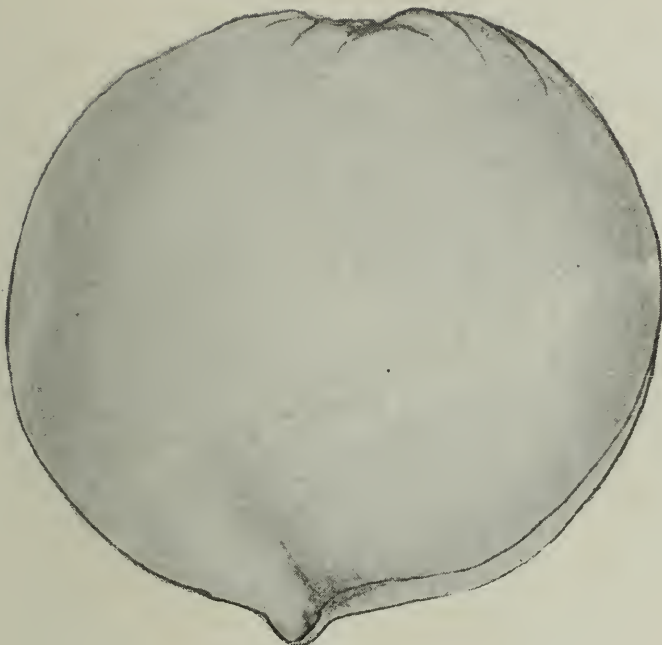


SECTION OF BRIGDON OR GARFIELD.

QUALITY: first-class for all purposes.

SEASON: late August to early September.

Very good peach; better bearer than Crawford, but a little smaller in size.



EARLY CRAWFORD.

TREE: vigorous, productive under favorable conditions, but in many orchards a light bearer.

FRUIT: large to very large, oblong, apex prominent, color golden with red cheek.

FLESH: color yellow, freestone.

FLAVOR: sweet, rich.

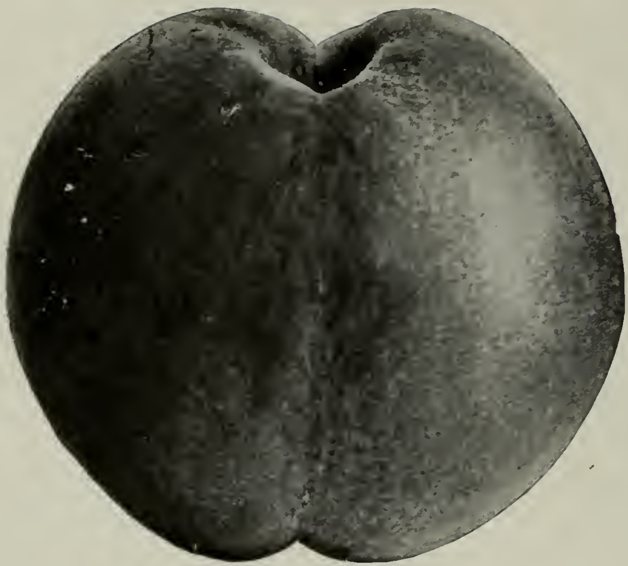
SECTION OF EARLY CRAWFORD.

VALUE: first-class for market.

QUALITY: dessert and canning very good.

SEASON: early September.

This variety has given its name as a market term to other varieties of the same season.



New Prolific.

Tree: healthy, vigorous, very productive.

Fruit: size medium, form round color yellow with bright red cheek.

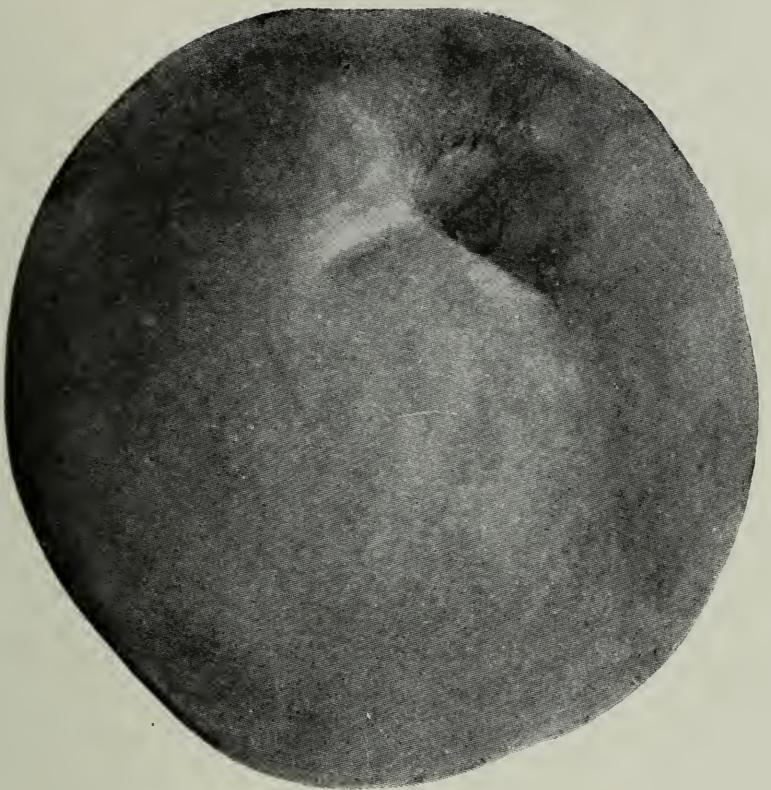
Flesh: yellow, slightly red at the pit, texture tender, flavor sweet and delicious.

Quality: dessert fair; canning good.

Season: mid-September.

Bears very heavily and very often requires thinning.

Section of New Prolific.



ELBERTA.

TREE: vigorous, hardy and very productive.

FRUIT: large, roundish oval, one side larger than the other, lemon yellow with fine red cheek.

FLESH: yellow, texture coarse, but moderately juicy.

QUALITY: dessert fair, good for canning.

SEASON: late September.

This peach is desirable in every orchard owing to its productiveness and its good shipping qualities. Elberta is the standard in commercial peaches.

SECTION OF ELBERTA.

Smock.

Tree: moderately vigorous, productive, wood brittle.

Fruit: large oval, color orange with red cheek, bloom heavy, apex slightly extended.

Section of Smock.

Flesh: Color yellow, red at pit, free stone, texture tender, mealy, flavor agreeable but not sweet.

Quality: cooking or drying good.

Season: early October.

WHITE FLESH.

Mayflower.

Tree: fairly vigorous, thrifty, hardy, productive.
Fruit: medium size, light colored with red cheek, round oval, slightly flattened, cling stone; flavor fair.
Season: the earliest peach ripened August 2nd at the Vineland Experiment Station. It is not recommended except for home use.

Sneed.

Tree: vigorous, but slender in young growth; productive; an early bearer.
Fruit: small, light colored with red cheek, white, downy, form, roundish oval, slightly flattened, semi-clingstone.
Flesh: white, tender, juicy.
Season: early August.
Recommended for home use and nearby markets.

Steven's Rareripe.

Tree: vigorous and productive.
Fruit: medium size, roundish ovate, color whitish with a dark red cheek.
Flesh: white with red streaks at pit, freestone, tender and juicy.
Season: mid-October.
A popular, late, white flesh peach and a good shipper.

Alexander.

Tree: vigorous, hardy, productive.
Fruit: medium size, greenish color covered with dark red, form, roundish, flesh, white.
Flesh: color, greenish white; texture, firm; clingstone.
Quality: dessert fair; poor cooker.
Season: early August.
Some other varieties are equally good or better.

Belle of Georgia.

Tree: hardy and productive.
Fruit: very large; skin very white with red cheek.
Flesh: white and firm.
Quality: fair to good.
Season: with Elberta.

Mountain Rose.

Tree: vigorous, productive.
Fruit: size medium, form roundish, color white with red cheek.
Flesh: creamy white, texture tender, melting, flavor excellent.
Quality: first-class for dessert.
Season: mid-September.

This is an exceptionally good peach for home use, but does not ship well and is subject to rot.

YELLOW FLESH.

Arp Beauty.

Tree: hardy, vigorous and productive.
Fruit: large, roundish, oblong, skin yellow, splashed with purple.
Flesh: yellow, texture coarse, moderately juicy, semi-cling, to clingstone.
Season: late August.
One of the best peaches of its season and worthy of further trial.

Late Crawford.

Tree: vigorous, only fairly productive.
Fruit: large, color yellow, dull green with red cheek.
Flesh: Deep yellow, red at the stone, texture juicy and melting, rich flavor.
Quality: dessert good; cooking very good.
Season: late September.
The tree is not very productive, and has gradually been discarded in spite of its quality.

Jacques Rareripe.

Tree: vigorous, healthy and productive.
Fruit: size large, form roundish oblate, color dark yellow, shaded with red.
Flesh: color deep yellow, free stone, flavor good.
Quality: dessert very good; canning excellent.
Season: mid-September.

Lemon Free.

Tree: medium strong grower; hardy, productive.
Fruit: small to medium greenish yellow turning to yellow when ripe.
Flesh: yellow, free stone, texture coarse and juicy.
Quality: excellent canner.
Season: early October.
Very productive.

Captain Ede.

Tree: quite large, hardy, productive.
Color: yellow with red cheek.
Flesh: deep yellow, free stone.
Quality: dessert and canning, fair to good.
Season: immediately following Elberta.

The following list is a personal choice for commercial orchards that might be extended from the descriptions previously given. St. John, Garfield, New Prolific, Elberta, Captain Ede.

For the information of those who wish to select varieties for their particular districts, the following lists are given:

The varieties most hardy in wood are: Hill's Chili, Crosby, Steven's Rareripe, Kalamazoo, Wager, Greensboro.

The varieties most hardy in bud are: Crosby, Hill's Chili, Triumph, Steven's Rareripe, Kalamazoo.

The varieties most tender in bud are: Early Crawford, Late Crawford, Chair's Choice, Reeves' Favorite, Elberta.

The varieties recommended in the first list may be considered medium hardy or medium tender in bud. As a general rule the smaller growing rather than the large growing trees are hardiest, and these, when on a warm, dry, gravelly soil, show the greatest resistance to cold.

Location and Site.—The location of an orchard has to do with its general surroundings. It may relate to transportation facilities, convenience to markets, general climatic conditions, or to any of the economic factors that influence success in fruit growing.

The site has to do with the particular piece of land occupied by the trees. It relates to the slope, atmospheric drainage, and other natural factors, which in turn affect growth and habit of fruit and tree.

Many promising orchard undertakings have failed to give the expected results because of bad roads, distance from loading station, poor transportation facilities, convenience to markets, and other economic factors that have not been given careful consideration. An isolated individual, unless there is a home demand for his produce, has little hope of success. A community where all growers fight diseases and insect pests, where all take an interest in the community, and where there is an efficient selling organization, has every chance of success. A location in such a community is desirable. These points, however, require little discussion here, as they are discussed fully in all good horticultural works. The same principles that apply to apples usually discussed apply to peaches and other fruits also.

Soil.—The soil is very important. It must be warm, dry, and deep. Warmth is an indication that the soil is dry and the absence of excessive moisture is an indication that the soil is warm. A dry soil is not necessarily one that will not retain moisture, but one that retains the necessary moisture and allows to escape only excess moisture. Depth of soil includes also the openness of the subsoil. Peach roots should have a minimum of thirty inches of open drained soil in which to feed and grow. If the natural drainage is not such that this depth is available, tile drainage will aid a greal deal. The kind of soil—sand, sand loam, loam, clay or clay loam—is not so important if the other factors, those of warmth, dryness, and depth, are placed first. Peaches are doing equally well on all kinds and grades of soils, but the most favored by growers are the sands, sand loams, and gravels. These are apparently the deeper, warmer, and drier.

The soil for peaches must be moderately fertile. One very rich in nitrogen is not to be recommended, as it is likely to induce an excessive growth of foliage. On the other hand, a poor soil is equally undesirable.

Roots for Peaches.—In an attempt to decrease the loss due to adverse soil conditions and from winter freezing, an effort was made at the Vineland Experiment Station to grow peaches commercially on plum roots *Prunus americana.* The soil was a heavy clay with a very hard subsoil about eight inches below the surface.

The plum root is very dwarfing to the peach. Part of the trees in the experiment were removed in the fall of 1915 at seven years of age, and part are still standing. The trees on the plum roots have not made more than one-half to two-thirds the growth the trees on peach roots have. The union, in most cases, though fairly good, has not been (Fig. 1) as complete as could be desired. Owing to the fact that Prunus americana is shallow-rooted on such a soil, many trees were blown sideways or completely over when the soil was soft and wet. This is due to the heavy top on the small root system. This root is also inclined to sucker and

Fig. 1. Peach on plum root. Notice the constriction at point of union of root and trunk.

become a general nuisance. The trees have not yet borne a crop of fruit, but every year from three years of age except 1914, scattered fruits have been produced.

The loss in trees from various causes has been as great as in the adjoining blocks where the trees are on their own roots. From our observations so far peaches on plum roots have no place in orchard practice under conditions similar to ours.

Nursery Stock.—Buy the trees from a reputable nursery firm. Any firm represented by any agent does not always offer the best trees. A low price is not a guarantee of cheapness. The stock, besides being of good quality and size, should be free from insect pests and diseases and not injured by careless handling or careless fumigation methods. Experiments show that fumigation will completely destroy all scale without injury to the tree. Insist on fumigated trees. Trees from one locality are as good as another. If well ripened when dug and carefully stored, it is policy to buy from the firm that can give the best grade of trees for the least money. Consider well, also, freight charges and duty if purchasing from a distance.

Seedling peach trees are grown from pits of the ripened fruits. A few years ago it was thought that pits from the natural fruit found growing in the mountains in the South-Eastern States were hardier and produced stronger root systems than the pits of cultivated varieties. Now the practice is to some extent discontinued and the pits of hardy Northern varieties are used.

The pits may be either planted in the fall or spring. If in the fall. they may be planted in rows three to four feet apart in places where the trees are expected to grow. The action of the frost and moisture cracks the stone, so that in the spring the kernels come in contact with the soil.

If stones are to be planted in the spring, they may be stratified or bedded in the fall in moist sand. In the spring, they are sifted from the sand and stones, cracked, and the kernels are planted in the field in rows or in beds to germinate. The seedling plants from these beds are then set in the field in rows. The usual method of propagation is by budding. The stock should be large enough to receive the bud by August, of the year the pits are planted. The buds are taken from a bearing tree of known variety or from the nursery row of known variety and budded about four inches from the ground. The operation of budding is very complicated to a beginner, but practice is practically all that is required.

The bud is usually cut about three-quarters of an inch long. Most budders cut from below upwards. It does not matter how the bud is cut so long as a clean cut is made and as little wood as possible is left adhering to the bark; the slit or wound to receive the bud is made by two incisions, one vertical and one transverse, made by a rocking motion of the blade. In most illustrations these are shown to be horizontal, but in actual practice it is found that they are usually more or less at an angle. The cut is so made that the corners can easily be lifted by the blade of the knife and the bud inserted.

The bud is placed and then requires to be tied. This is done with raphia which has previously been soaked in water, beaten out and cut to the desired length; the bud is tied by this raphia being wrapped twice below the petiole, then three or four times above it. A single knot is made. Supposing this operation to be done in the first week in September, the raphia will be ready to be cut in about ten days. To do this simply take a knife and sever the wrap on the opposite side to the one on which the bud has been inserted. This is left until the following spring, then the seedling stock is cut away just above the bud. This is then allowed to grow, and should be ready for orchard planting in the fall of that year.

Only thrifty, well-grown trees should be planted. This does not mean necessarily the largest trees. Medium sized trees are often just as desirable for planting as the large ones. Small trees are not advisable to plant, as frequently they have poor root systems.

When trees are delivered from the nursery it is essential that the root be kept from drying out. The most satisfactory way of doing this is to "heel in." This consists of completely covering the roots with soil. A trench wide enough to admit the roots and about eighteen inches deep is dug and the roots of the trees placed in a slanting position in it.

Fall vs. Spring Planting.—Experiments indicate that the only safe time to plant peach trees is in the spring of the year as early as the ground can be put in a good state of cultivation. Practically every tree has been lost when fall-planted at the Experiment Station. If banked up carefully, they invariably freeze down to the top of the mound of earth when planted in the fall.

Preparation of the Land.—Land that is to be planted to peaches should be prepared the previous season. This may be done by growing a hoe crop, such as potatoes, tomatoes or corn or by plowing the sod quite early in the season, and cultivating until it is in a good state of tilth. The habit of planting in sod cannot be too strongly condemned. The tree loses too much on the start. It is cheaper to wait a year than to plant in unprepared soil.

Distance to Plant.—The distance apart to plant depends on several things:

(1). The fertility of the soil.

(2). The topography of the land.

(3). The pruning system to be followed.

(4). The preference of the individual grower.

The distances recommended are 18 ft. x. 18 ft., 18 ft. x 20 ft., 16 ft. x 20 ft., and 20 ft. x 20 ft., requiring respectively 134, 121, 136, and 108 trees per acre. Some growers plant as close as 16 ft. x 16 ft.

This table, taken from Bulletin No. 201, shows the distance apart trees were planted previous to 1910 ·

	Orchards.		Orchards.
18 ft. x 18 ft.	129	20 ft. x 20 ft.	57
16 ft. x 16 ft.	111	16 ft. x 18 ft.	45
15 ft. x 15 ft.	89	16 ft. x. 20 ft.	19
18 ft. x 20 ft.	62	Other distances	137

The tendency today is to use the greater distances, 18 ft. x 18 ft. and 20 ft. x 20 ft., or to plant wide one way and close the other, such as 16 ft. x 20 ft.

PLANTING.

In setting out an orchard great care should be taken to plant the trees in straight rows, and also to have them in perfect lines in both directions.

Where the orchard is to be from small to medium size, stake out the land before setting the trees. There are two common methods:

Place the first row of stakes along one side of the field. About the centre run another row at right angles to the former row across to the far side of the field. Take a pole the length of which is the distance apart the trees are to be set, and placing one end of each against a stake in each row, swing the free ends till they meet, and then set a stake at that point. Continue this till the whole field is staked. Care must be taken to get the first row straight and the second one perpendicular to it.

When the orchard is to be a large one and the necessary labor has been secured, the following method may be used to advantage. Place a row of stakes along two opposite sides of the field, with the stakes the required distance apart. Stretch a wire cable with *the distance apart the trees are to be set markd on it* between two corresponding stakes. Plant the trees at the marks on the wire, at the same time having a second wire stretched for the next row. With this method no stakes are set and planting goes on continuously. Watch the wire carefully and plant accurately to avoid error.

Before planting a tree it is always advisable to prune the roots, that is, cut away any bruised or damaged parts, and if the roots are very long cut back to eight or ten inches or to the vigorous parts. Dig the hole large enough to admit the roots without bending or cramping. To fill the hole use only finely pulverized earth and work it in around the roots carefully. After the first soil has been put in and worked around the roots, partly fill the hole, tramp the soil to make it firm, then completely fill the hole, being careful to leave a mulch of loose soil on top to check evaporation.

Peaches as Fillers.—The peach cannot be said to be an ideal tree for a filler. In a few cases peach trees have been planted with other trees with the hope of obtaining fruit while the trees were reaching bearing age. The various fruits are somewhat different in their cultural requirements. The peach is also very thrifty and rapid growing, and in four years attains as great a size in both top and root as the average apple does in eight to ten years. Either the permanent tree or the filler must suffer. Ordinarily the tree that suffers will be the one that is not yielding immediate returns.

PRUNING.

The subject of pruning is one of wide discussion. and it is doubtful if the methods and systems of any two growers are exactly alike. The subject has been studied definitely but little, but a few suggestions are offered. There are, however, certain rules that may be considered basic:

(1). Have a definite system of pruning and do not change without some good reason.

(2). Consider the variety and prune to suit its fruiting habits.

(3). Have good tools; both money and time are saved by them.

(4). Prune regularly.

The object of pruning:

(1). To modify the vigor of the tree.

(2). To construct a framework, make the tree shapely, and keep it within bounds.

(3). To open the tree top so as to admit air and sunshine.

(4). To remove branches that are adding nothing to the economy of the trees.

(5) To aid in stimulating the development and proper distribution of fruit buds.

(6). To facilitate the harvesting of the fruit.

Heading.—For the past ten years about 75 per cent. of the orchards planted have been low-headed; to-day, a few growers are returning to the medium height. With the low-headed trees, spraying, pruning, and harvesting are more easily accomplished; with the medium high-headed tree cultivation can possibly be carried on more readily. However, with the extension disk and other modern orchard implements, the principal objection to the low-head is overcome. A tree that is too low is possibly objectionable, and one that is too high is a hindrance to the efficiency of labor. Fifteen to twenty inches, with a maximum of twenty-four inches to the first branch, is a good convenient height.

Pruning After First Year.—Trees are pruned ordinarily in late winter or early spring. Pruning for the first year consists of selecting the branches which are to form the framework of the tree and removing all others. Care must be taken to have these branches so spaced that they all have separate unions with the trunk. A tree that has all its branches radiating from one common union is usually weak, and often the weight of foliage and fruit causes splitting.

Having selected the branches that are to form the main limbs of the tree, cut these back to within eight or nine inches of the trunk, then remove the other branches entirely. Cut back to a bud that points outward.

Fig. 2. A typical tree before pruning.

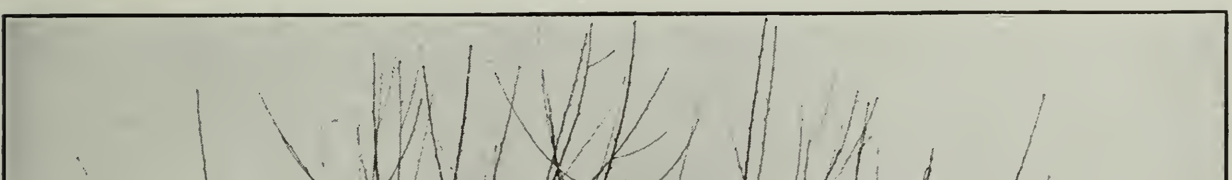


Fig. 3. Same tree as Fig. 2, thinned out, but not cut back or headed in.

Fig. 4. Another good type of tree, thinned out, but not cut back. The branches all come out at one height on the trunk.

Fig. 5. Tree showing a very heavy wood growth.

After Second Year.—This year pruning simply consists in thinning out the tree, choosing the main branches, and cutting out the others. Cut out all central leaders that appear at this period.

After Third Year.—By the end of the third year the tree will be setting a few fruit buds. The main limbs and branches are already formed and pruning consists largely of cutting back and thinning out growth.

Pruning Old Orchards.—Orchards that are yielding crops annually require regular and careful pruning. The system most practical is to thin out the tree, then cut back the remainder to twigs which show fruit buds. This is the most popular system.

Another plan that is followed by some is that of thinning out and not cutting back at all. Both large and small limbs are removed. It is maintained that whenever a tree is cut back, especially at the top, new growth is forced out and color on the fruit is sacrificed to some extent. Those who follow this latter system sacrifice ease of picking in order to obtain color. The regular cutting back or heading in undoubtedly keeps the fruit nearer the ground.

Fig. 6. A low-headed tree fairly pruned. It is both thinned out and headed in or cut back.

Fruiting Habits.—The fruit buds of the peach are normally axillary, and only very rarely is one found terminating a twig. They are borne always on one-year-old branches and short twigs, the latter sometimes very much resembling true fruit spurs. These buds open and produce a single flower but no leaves. They are borne singly in the axils of single leaves or in pairs, one on either side of a leaf bud, the three buds being borne in the axils of as many leaves.

The first type of flowering is found in trees very lightly pruned or on weak shoots in well-pruned trees, with certain variations, depending on the variety. Some of our best varieties bear a large percentage of their buds singly. Fig. 7 shows the two types of buds, the single buds on the smallest and weakest grown shoot, and a majority in the three bud formation on the strongest shoots. The stronger type with the triple buds is most desirable. However, some of the best varieties bear their fruit buds mostly single, even on strong twigs, as a reference to Fig. 8 shows.

Fig. 7. Greensboro.

Fig. 8. St. John.

In Fig. 8 most of the buds are leaf buds, and the fruit buds may be noted as being more rounded at the apex and a little stouter throughout. In most varieties shoots that do not make a growth of over ten or twelve inches bear their fruit singly. The triple buds are found on the stronger one-year-old wood.

In reference to Fig. 9, it will be seen that the centre shoot, which is the strongest, bears far more of its buds in the triple formation than the laterals, which are shorter and weaker and have most of their buds borne singly. Fig. 10 shows a branch in which all buds are single and but few of which are fruit buds.

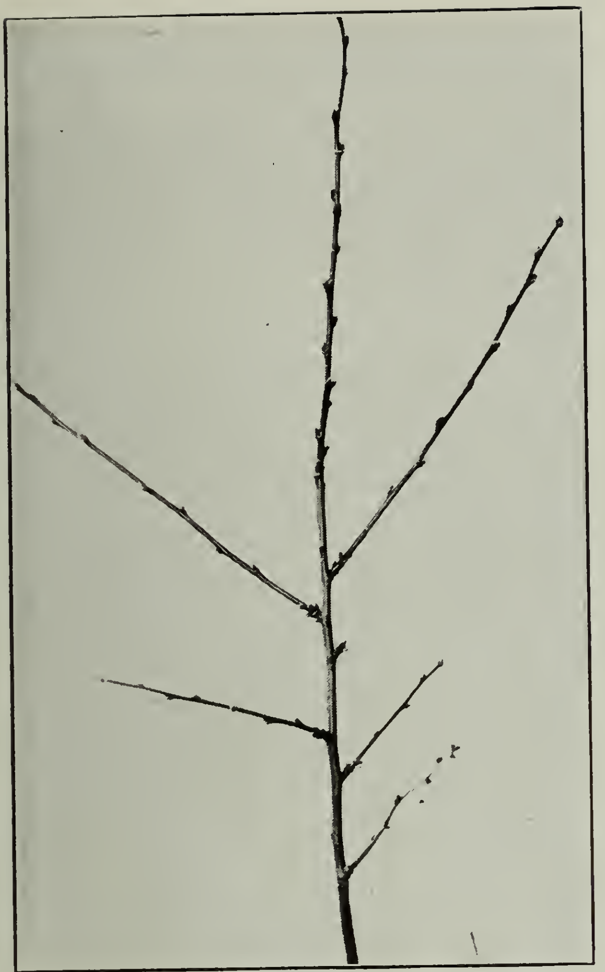


Fig. 9. Greensboro.

Fig. 10. Crawford.

Fig. 11. Greensboro.

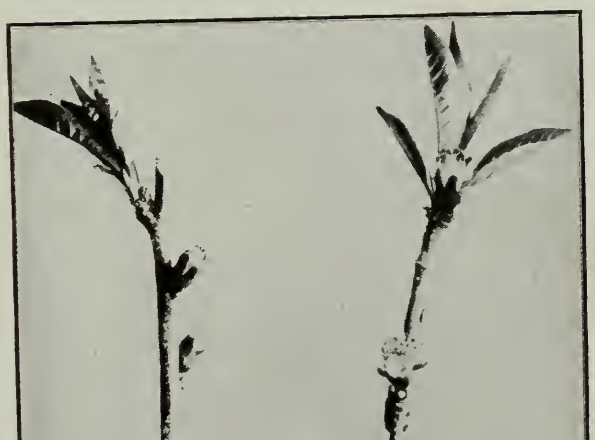


Fig. 12. St. John.

Figs. 11 and 12 show the buds of the two types at the opening stage. Fig. 11 is triple bud formation, in which the centre is a leaf bud supported by the fruit buds on either side. This is the large flowering type of peach, while Fig. 12 is of the small flowering type. The latter shows the single buds opening and the uneven distribution of leaf surface, while there is a good percentage of fruit buds. This point is well to remember, as it has considerable significance in "heading-in" fruiting wood for the purpose of thinning the fruit.

Fig. 13 shows the triple bud flowering type—two blossoms, one leaf bud—where there is an abundance of bloom and an even distribution of foliage, also even bloom on short laterals or spurs on two-year-old wood. In this illustration the branch at the right was cut from the branch at the left, and all parts are one-year-old wood except the heavy portion of the branch on the left. Fig. 14 shows the type with the

Fig. 13. Greensboro.

Fig. 14. Crawford.

single bud formation, and consequently the scarcity of leaves along that portion of the branch where most of the fruit is borne. The petals of the flowers have fallen. In this latter case it is inadvisable to thin the fruit by heading-in the fruiting wood because a large percentage of leaf surface is lost, with the consequent poor nourishment of the fruit. Where the tree has made poor growth and where the fruit buds are borne singly, pruning can be employed as a means of thinning the fruit only in so far as whole branches can be spared. With the triple bud formation heading-in may be resorted to for fruit thinning purposes without fear of loss of leaf surface. The fruiting wood, with its fruit buds in pairs with a branch bud between—that is, the triple bud formation—may be cut back to even its last pair of fruit buds. The branch bud will continue the growth of the twig. Such a type of fruiting wood can only be developed by severe pruning. Some of these strong twigs will grow in the tops of poorly pruned trees, but to grow them in the centre of the tree the top must be pruned back severely. It is almost impossible to maintain a fruiting depth of more than four to six feet. Little is gained by growing a peach tree fifteen feet in height when the bottom seven feet is barren. It is better to keep the trees down to a height of ten feet with fruiting wood within three feet of the ground. A well pruned tree will grow thirty inches or more of new top each year, but if the tree is to continue productive, a very large portion of this must be removed each year. It is safe to say that in a well pruned peach tree from one-

Fig. 15. Greensboro.

Fig. 16. Crawford.

third to three-quarters of the one-year-old growth is removed at each pruning season.

Figs. 15 and 16 show the two types of bud-bearing wood in fruit. Fig. 15 is that of the triple bud formation, and shows that while it bears an abundance of blossoms very close together the fruit that sets has ample room and will develop normally, although some of them are very close and may require thinning. Fig. 16 shows the fruit well scattered from the single bud formation.

CULTIVATION.

To give a method of cultivation that will suit every condition is impossible.

The objects of cultivation are:

(1). To improve the physical condition of the soil.

(2). To check evaporation and also increase the water-holding capacity of the soil.

(3). To hasten the decomposition of organic matter and free plant food in the soil.

The usual method of cultivation is to plow as soon as the ground is dry in the spring. Whether to plow up to or away from the tree must be left to the discretion of the grower. It is usual to plow up to the trees in the fall and away in the spring, but circumstances alter cases, and it is often advisable to plow up to the trees in the spring.

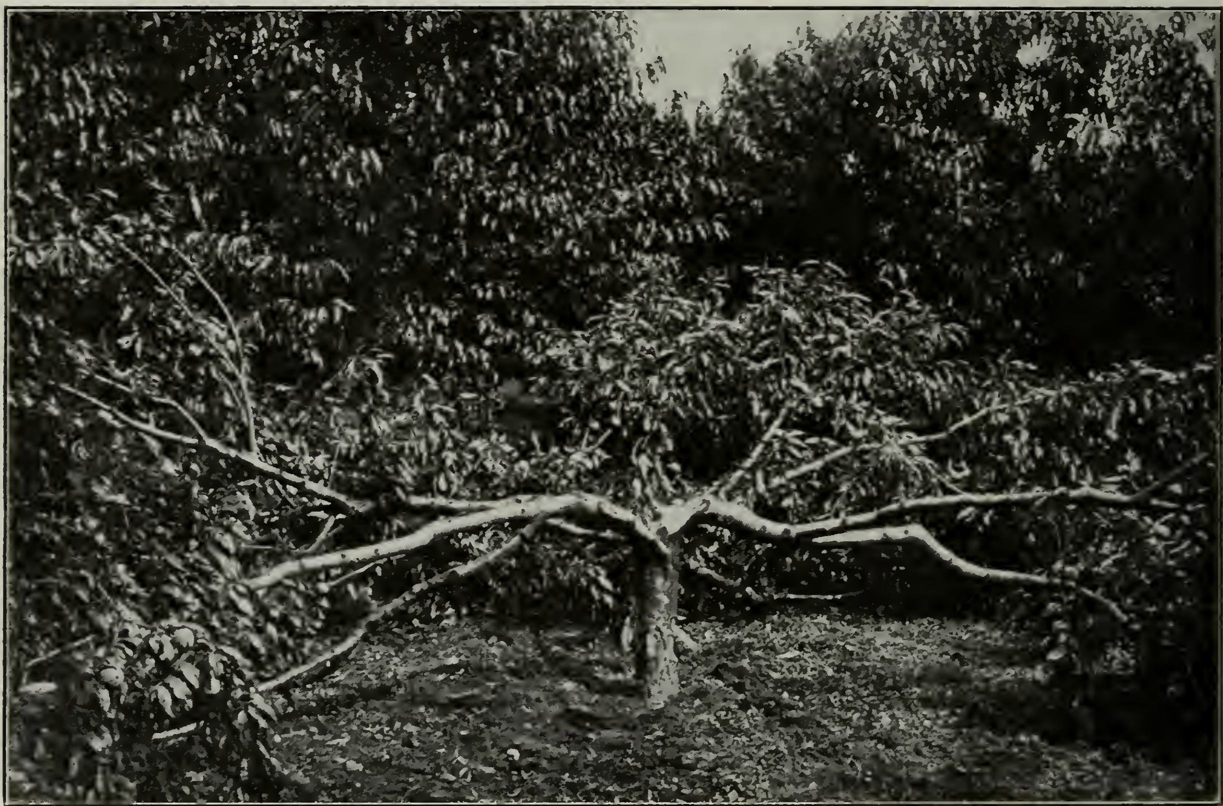


Fig. 17. A bad crotch, attacked by canker, unable to carry its load.

Cultivation throughout the season consists of keeping the soil well worked and free from weeds. To do this properly, it is necessary to cultivate about every ten days and as soon after rains as possible.

Before winter sets in the trees should be well ridged up with the plow or banked up by hand. This prevents surface water from damaging the roots.

Cover Crops.—The uses of cover crops are:

(1). To prevent washing.

(2). T check fall growth.

(3). To add humus.

(4.) To add nitrogen.

(5). To hold the snow and leaves.

(6.) To prevent deep freezing, and consequently winter injury to the roots.

Cover crops may generally be classed under two heads—leguminous and non-leguminous. Of the former the most common are red and crimson clover, vetch and cow peas. Of the non-leguminous, the more common are oats, buckwheat, rye, rape and turnips. Very often "chickweed" (*Stellaria media*) is encouraged to grow in a peach orchard to serve as cover crop.

The cover crop is sown when the orchard is given its last cultivation for the season, usually the second or third week in July, although the exact time is regulated by the weather conditions:

Leguminous	Amt. per Acre	Cost per Acre
Red Clover	12 lbs.	$ 3.00
Crimson Clover	15 "	1.50
Hairy Vetch	1 bu.	6.00
Cow Peas	1.5 "	4.50
NON-LEGUMINOUS		
Oats	1 bu.	.50
Buckwheat	3 pecks	1.20
Rye	1.5 bu.	2.47
Turnip	6 lbs.	2.10
Rape	6 "	.48

Seed prices vary a great deal; the above prices are only comparative.

Leguminous Crops.—*Vetch* has not proven an attractive cover crop at the Experiment Station. It grows very slowly in the fall and must of necessity be left quite late in the spring before plowing in order to get the necessary quantity of material to plow under. Once it becomes thick and matted it is very difficult to plow under. When well grown, it adds both nitrogen and organic matter in quantity to the soil.

Cow Peas.—This crop has been used to some extent in the apple orchards of Ontario, but is not recommended for extensive use.

Crimson Clover.—This crop grows very readily and will make a fairly good stand in the fall. The main objection to it is that it kills out very easily in the winter. It is recommended for positions that are not windswept and are likely to hold the snow. When it does not winter-kill, it is one of the very best of the legumes.

Red Clover.—This crop is well known to all and is excellent when a good stand can be obtained. The main objection to it is the high price per pound and the chance that a catch may not be obtained at that season of the year.

Non-Leguminous.—*Oats.*—This is a cover crop that is not used extensively but has proven to be one of the best at the Experiment Station. When sown at the rate of a bushel and one-half per acre or at the rate of one bushel per acre with ten pounds of red clover, it makes excellent growth, holds the snow, and adds organic matter to the soil. The objection to it lies in the fact that it winter-kills. It is never difficult to obtain a good stand of this crop.

Buckwheat.—This is important as a cover crop as it will grow on almost any soil and leaves the land in good condition. It is also used to smother weeds, particularly in the case of twitch grass. It holds snow well, but may attract mice and rabbits.

Rye.—Rye is a very good cover crop, and will grow almost anywhere. It makes a good covering for the land, prevents drifting of the snow, furnishes a good supply of organic matter, and retains soluble plant food. The disadvantage lies in the fact that it must be plowed early in the spring or will become tall and difficult to plow under.

Turnips and Rape.—Either of these is a cheap cover crop. They will grow anywhere. Their main disadvantage lies in the fact that the leaves and tops retain moisture and consequently are disagreeable to work among. Rape is an especially good crop when carefully handled.

Interplanted Crops.—Very few growers can afford to let the trees come into bearing without intercropping for at least two years. The practice is of no advantage to the tree, and cannot be compared with thorough tillage, but if interplanted crops are wisely selected and the interest of the tree always remembered, no serious injury results.

A crop for interplanting ought to be one which requires the same tillage as the peach, and care should also be taken to plant crops that will not require cultivation late in the season. Early potatoes are very good, but late potatoes are objectionable.

Corn is quite often used, but if planted close to the trees is harmful because it shades them.

Whatever crop is planted a strip of three to four feet should be left on either side of the tree.

Protection from Mice and Rabbits.—In a few localities mice and rabbits do damage by girdling. One method that has been proved to be quite practicable but expensive is the wrapping of the trunks of the trees with tarred paper up to a height of 18 to 24 inches, depending on the length of the trunk of the tree and the depth of snow common in the locality. Tie the paper loosely with a piece of twine. In most cases it is much easier to bank up the tree with earth to a height of eight inches to one foot. This requires time, but is generally effective.

Manures.—*Manure and Cover Crops.*—Cultivation is the cheapest and most valuable fertilizer at the disposal of the fruit-grower. Orchards on sandy loam soil have been known to produce good crops for six or seven years in succession without farmyard manure or commercial fertilizer, but they have always had a good supply of humus and thorough cultivation. The best cover crops are largely the same composition as farmyard manure, and with the exception of being unable to seed the soil with the organisms of decay, can take their place in every particular. The following is the chemical analysis of the three most prominent cover crops compared to farmyard manure. The figures show the average percentages:

	Nitrogen	Phosphorus	Potash	Water
Vetch	.65	.146	.457	79.15
Red Clover	.41	.13	.45	.80
Rye (green)	.33	1.5	7.5	
Manure	.5 to .75	.5 to .75	.25 to .375	

Vetch and red clover are legumes, and consequently take a large supply of their nitrogen from the air, and when they decay give it to the soil. Rye is not a legume, but has the power of breaking up, absorbing, and making available a large quantity of potash. It supplies a large quantity of the much needed organic matter. Rye when left too long before plowing becomes tough and fibrous, and does not decay readily, but if handled at the proper time it is in no way objectionable.

As the table shows, any one of the three crops mentioned gives, when plowed under green, almost as much plant food ton for ton as farmyard manure.

Commercial Fertilizer.—Commercial fertilizers without humus have no place in orchard management, and therefore must be used in conjunction with a cover crop or farmyard manure. Nitrate of soda is the only fertilizer that can be readily absorbed without humus. Others require the action of humus to bring about the chemical changes which are necessary before the fertilizer can be absorbed. Potash is applied either as the muriate of sulphate, the former being in most general use. Phosphorus is applied in a number of forms, such as Kainite, ground bone, superphosphate, etc. The very fine ground bone and acid phosphate are used for quick returns.

The following methods of fertilizing are submitted for reference:

(1) 10 tons farmyard manure at	$1.50	$15.00	$15.00
(2) 6 " " " "	1.50	9.00	
200 lbs. bone meal "	1.50 per cwt.	3.00	
100 " muriate "	2.15	2.15	14.15
(3) 30 " vetch "	6.00 per bu.	3.00	
200 " bone meal "	1.50 per cwt,	3.00	
100 " muriate "	2.15	2.15	8.15
(4) 20 " red clover "	9.00 per ton	3.00	
200 " bone meal "	1.50 per cwt.	3.00	
100 " muriate "	2.15	2.15	8.15
(5) 1 bu. rye "	.95 per bu.	95	
20 lbs. vetch "	6.00 " "	2.00	
200 " bone meal "	1.50 per cwt.	3.00	
100 " muriate "	2.15 " "	2.15	8.10

Thinning.—Thinning by hand is not practiced extensively. It is desired if possible to thin the fruit by heavy cutting back and by the removal of unnecessary small twigs and branches. The desired end cannot, however, always be accomplished by pruning. The better practice would undoubtedly be to thin by hand, but very often help is not available and the expense is considered too high.

The following is the result of an experiment concluded on fifteen St. John trees in the summer of 1910: The trees were healthy, of average size, nine years of age, and headed and pruned rather high. The previous year they had borne no fruit at all—the first time they had ever failed—and at the time of thinning they were very heavily loaded. These trees were chosen because they gave a chance to observe the greatest extremes. The thinning was done on June 25th and 27th. It required approximately two days to do the work. Distances in thinning can only be guessed at, and a statement of distance must necessarily convey widely different ideas to different persons.

Natural means that the tree was left with what fruit, in the opinion of the experimenter, it could mature properly.

	Firsts	Seconds	Culls
Unthinned	32½ lbs.	194¼ lbs.	328 lbs.
1 to 3	201½ "	404½ "	62¼ "
3 to 5	245¾ "	295½ "	9 "
5 to 7	252 "	183½ "	5¼ "
Natural	253¼ "	219½ "	30 "

Unthinned	6,392 peaches,	weighing	555.25 lbs.,	worth	$ 7.75
1 to 3	4,503 "	"	667.75 "	"	22.01
3 to 5	3,466 "	"	550.25 "	"	20.76
5 to 7	2,595 "	"	446.25 "	"	17.55
Natural	3,209 "	"	502.75 "	"	18.73

It will be noticed that the returns from the unthinned trees are very low. This is accounted for by the fact that the trees were extremely heavily loaded. The trees thinned from one to three inches, or just so two peaches when fully developed or ripe would not touch each other, as nearly as could be judged, in the early part of the season, gave the highest gross returns. Thinned the greatest distance or so, not more than one peach was left on each twig, unless it was exceptionally large, gave the lowest returns. This, however, would not have been the case if the fancy fruits had been graded as such and sold at the price for fancy. Also, it was a year in which there was a good demand for almost any grade of fruit. The value is reckoned at seventy-five cents a basket for firsts and fifty cents for seconds. Some of the best sold for one dollar, but as the exact amount is not known no account is taken of it here.

Rather than thin to a set distance, it is much better to thin to the tree—that is, leave on the tree just what it can ripen nicely. This requires much judgment on the part of the grower. It is very seldom that two trees, even of the same age, are alike in growth and vigor. A tree at the end of the fourth summer should produce a basket of fruit. Some produce more, some less. At the end of the next summer it should produce two baskets, at the end of the next summer four baskets, and at the end of the eighth year ten baskets, or an increase of two baskets a year up to eight years of age. This would be a maximum average, and is given only as a guide, not as a rule, to follow when thinning. Small areas have been known to produce much heavier than this for one season, but the increase cannot be expected to be so great when the trees have once reached maturity. The idea is to remove when small all fruit that the tree is not likely to ripen properly. You know the health and vigor of the tree, and how, what and how much you fed it. The tree can draw just a certain amount of food from the soil, and the question is how many fruits is this food to be divided up among. The pits always claim first attention, and it is only after they have been satisfied that the flesh and next year's fruit buds are developed. You have it within your power to say how much shall be left for flesh and buds. Ripen as few pits as possible consistent with quantity.

Winter Injury.—This is a form of loss that is very difficult to eliminate. Three forms are very common—killing of the fruit buds, killing of the branches and twigs, and killing of the roots.

The first form is most noticeable because it is marked by a small crop or the total absence of fruit. This form of injury is caused most largely by a very sudden drop in temperature following a warm spell in winter, such as occurred in January, 1914, or sometimes the first warm days of spring having opened the buds the blossoms are exposed to frost or cold adverse weather conditions late in the spring. Cultured methods are of little avail in such cases except in so far as good cultured methods tend to keep the tree thrifty. A site for the orchard that is not subject to these conditions is the best insurance against loss.

The second form, i.e., the killing of branches or twigs and possibly the blackening of the hearts of the main limbs and trunks, is more readily guarded against. This injury is most common in over-cultivated orchards, over-pruned trees or under any conditions where soft, sappy growth has been produced. The remedy lies in more judicious cultural methods that will tend to keep the tree vigorous and healthy but not overgrowthy. The slower growing and slower maturing trees are the most resistant to cold.

The third form, root injury, may be due to a number of causes. Peach roots cannot withstand excessive moisture. Roots in a poor soil lacking in humus suffer from deep freezing and are themselves weak from want of food. This form of injury can be detected by the behavior of the tree in early spring. It may begin to leaf out and even open its blossoms, but in a few days begins to lose color, and in a time ranging from a few days to midsummer gradually but surely dies. It is expected that the trees are budded on the most hardy roots obtainable because beyond this there is no insurance against loss except the removal of surplus moisture by ridging up with the plow in the fall and the prevention of deep freezing by mulching with farmyard manure. A cover crop that holds the snow is an insurance against deep freezing. Judicious cultural methods are again the best form of insurance.

WHY IT PAYS TO PRODUCE HIGH-GRADE FRUIT.

The accompanying table is intended to show why it pays to produce high-grade fruit. All calculations are made from returns to growers except the cost of picking and packing one basket of fruit, which has been calculated at ten cents per eleven quart basket.

Note particularly the column headed "Per cent. of wholesale price used in marketing." Notice how rapidly it declines as the wholesale price rises. It is impossible to state any overhead expense which will apply outside of a particular case. Data from a reliable grower seems to indicate that overhead expense is about fifteen cents per basket. Taking this as an average and combining it with the data given in the table, it will be seen that it is necessary to receive a wholesale price of between thirty cents and thirty-five cents to defray the total expenses:

				11 qt. bkts. fruit picked and packed.				Fruit on tree.	
Retail price.	Wholesale price.	Price which growers received.	% of retail price which growers receive.	% of wholesale price which growers receive.	% of wholesale price used in marketing.	Price which growers receive.	% of retail price which growers receive.	% of wholesale price which growers receive.	% of wholesale price used in marketing
.20	.15	.06½	32.5	43.3	56.7	.03½	0.0	0.0	100.0
.25	.20	.11	44.0	55.0	45.0	.01	.4	5.0	95.0
.30	.25	.15½	51.6	62.0	38.0	.05½	11.6	22.0	78.0
.40	.30	.20	50.0	66.6	33.4	.10	25.0	33.3	66.6
.50	.35	.24½	49.0	70.0	30.0	.14½	29.0	41.4	58.6
.50	.40	.29	58.0	72.5	27.5	.19	38.0	47.5	52.5
.60	.45	.33½	55.8	74.4	25.6	.23½	39.1	52.2	47.8
.60	.50	.38	63.3	76.0	24.0	.28	46.6	56.0	44.0
.70	.55	.42½	60.7	77.2	22.8	.32½	46.4	59.0	41.0
.75	.60	.47	62.7	78.3	21.7	.37	49.3	61.6	38.4
.80	.65	.51½	64.4	79.2	20.8	.41½	51.8	63.8	36.2
.90	.70	.56	62.2	80.0	20.0	.46	51.1	65.7	34.3
.90	.75	.60½	67.2	80.6	19.4	.50½	56.1	66.0	34.0
1.00	.80	.65	65.0	81.2	18.8	.55	55.0	66.7	33.3
1.10	.85	.69½	63.2	81.7	18.3	.59½	54.0	70.0	30.0
1.15	.90	.74	64.3	82.2	17.8	.64	55.6	71.1	28.9
1.20	.95	.78½	65.4	82.6	17.4	.68½	57.0	72.1	27.9
1.25	1.00	.83	66.4	83.0	17.0	.73	58.4	73.0	27.0

Picking.—The time of picking depends on the maturity of the fruit. The degree of maturity at which the fruit should be picked depends on the market to which it is to be shipped. These are points that must be learned from experience.

Picked below a certain degree of maturity, peaches shrivel and decay before ripening. Picked above a certain degree of maturity the fruit bruises badly and will spoil before it reaches its destination. The eye is almost the sole judge for maturity in market fruits. Size and color are the deciding factors. Size is easily judged, but color is deceiving. The beginning of the development of a red cheek and the changing of the ground color from green to yellow are indications of approaching maturity. The ease with which the stem frees from the fruit and without tearing or doing damage to the tender skin is another indication of approaching maturity.

The trees are always picked over at least twice; more usually three times, and very often four or five times. In a few cases trees have been picked over eight and

Fig. 18. Heaped leno-covered baskets in Woolverton case.

ten times in order that very uniform grades of fruit for maturity might be obtained. The question of labor is, however, very often the deciding factor.

Sun very rapidly hastens ripening or maturity. As soon as a basket is filled it should be placed in the shade for immediate delivery to the packing house. Moisture is favorable to the development of fungus growth and decay. Consequently, fruit should not be put in the basket while it shows signs of moisture.

Packing and Grading.—Peaches are ordinarily divided into three grades—Firsts, Seconds, and Culls. Quite often a grade of fancy is made. There are no standard sizes for Fancy, Firsts or Seconds, and consequently the Firsts in a shipment from a number of growers may vary quite as much as the Firsts and Seconds of any one grower. The size of the fruit in the grade is often also determined by the variety. The Shipping Associations are gradually developing standards, but really only a start has been made in uniform grading and packing.

The work of packing should be done in a packing house or other suitable building, and the fruit handled as quickly and carefully as possible.

No attempt is made to discuss here the methods of packing, as that is the work of a demonstrator. The most serious complaint, however, that comes back from the consumer is the fact that very often the baskets are slack, but more often have been filled too full with three layer peaches, and every peach is bruised. A basket should be level full when a patent cover is to be used.

Fig. 19. Peach Box.

Fig. 20. Georgia 6-basket carrier.

Packages.—There are various sized baskets in use. The dimensions of these are fixed by law, but apparently inaccuracies of manufacture creep in and many variations are noticed.

(*a*). *Six-Quart.*—This is the standard grape basket, but is used also for fancy peaches—those grades that will fill the basket even full with two layers. The dimensions of this basket are fixed by law, as follows: "Four and one-half inches deep perpendicularly, fifteen and three-eighths inches in length and seven inches in width at the top of the basket, thirteen and one-half inches in length, and five and seven-eighths inches in width at the bottom of the basket, as nearly exactly as practicable, all measurements to be inside of the veneer proper and not to include the top band."

(*b*). *Eleven-Quart.*—This is the basket in which is shipped the great bulk of the peach crop. It has been severely criticized as being too large, and by some too small; for others it is quite satisfactory. At any rate, with possibly certain modifications, it might be made an ideal basket.

The legal standard says: "Be five and three-fourths inches deep perpendicularly, eighteen and three-fourths inches in length, and eight inches in width at the top of the basket, sixteen and three-fourths inches in length, and six and seven-eighths inches in width at the bottom of the basket, as nearly exactly as practicable, all measurements to be inside of the veneer proper and not to include the top band."

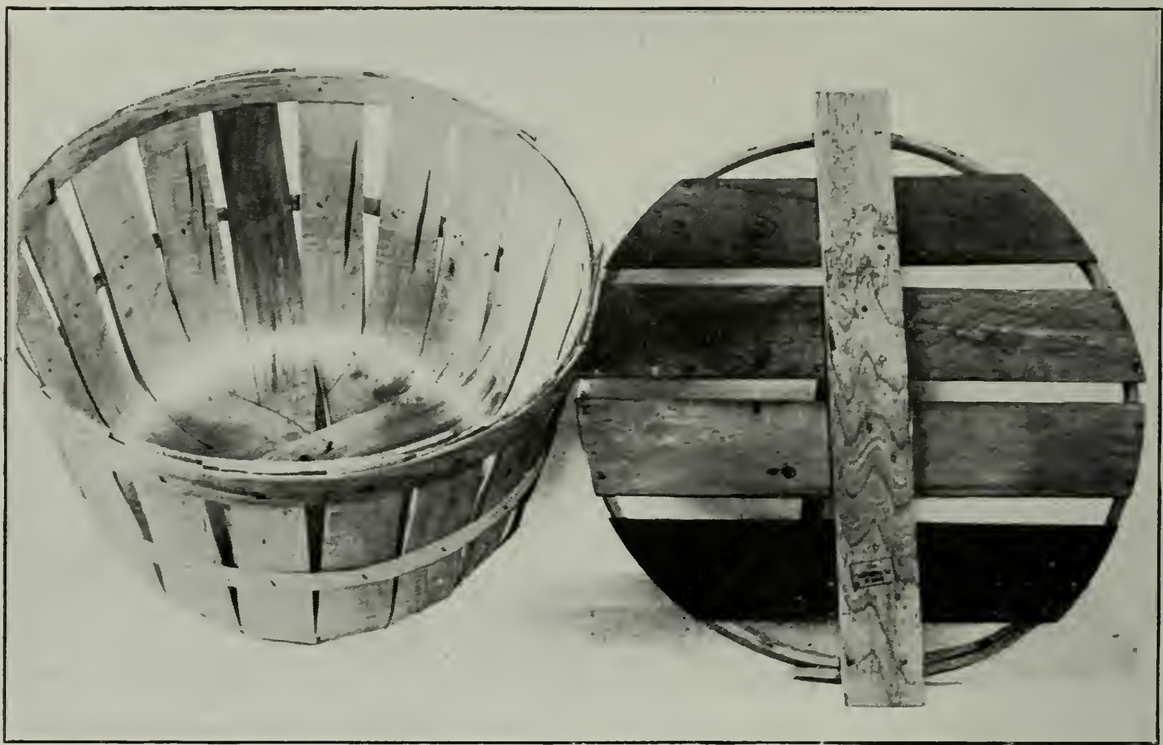


Fig 21. Good type of bushel basket, but cover weak.

(*c*). *Deep Eleven* is the name applied to a basket holding approximately the same as the eleven described under "b," but made a little deeper and a little smaller at the bottom. This is used to some extent to accommodate three layers of peaches a little larger than will ordinarily pack conveniently into a common eleven. The dimensions of this basket are not fixed by law.

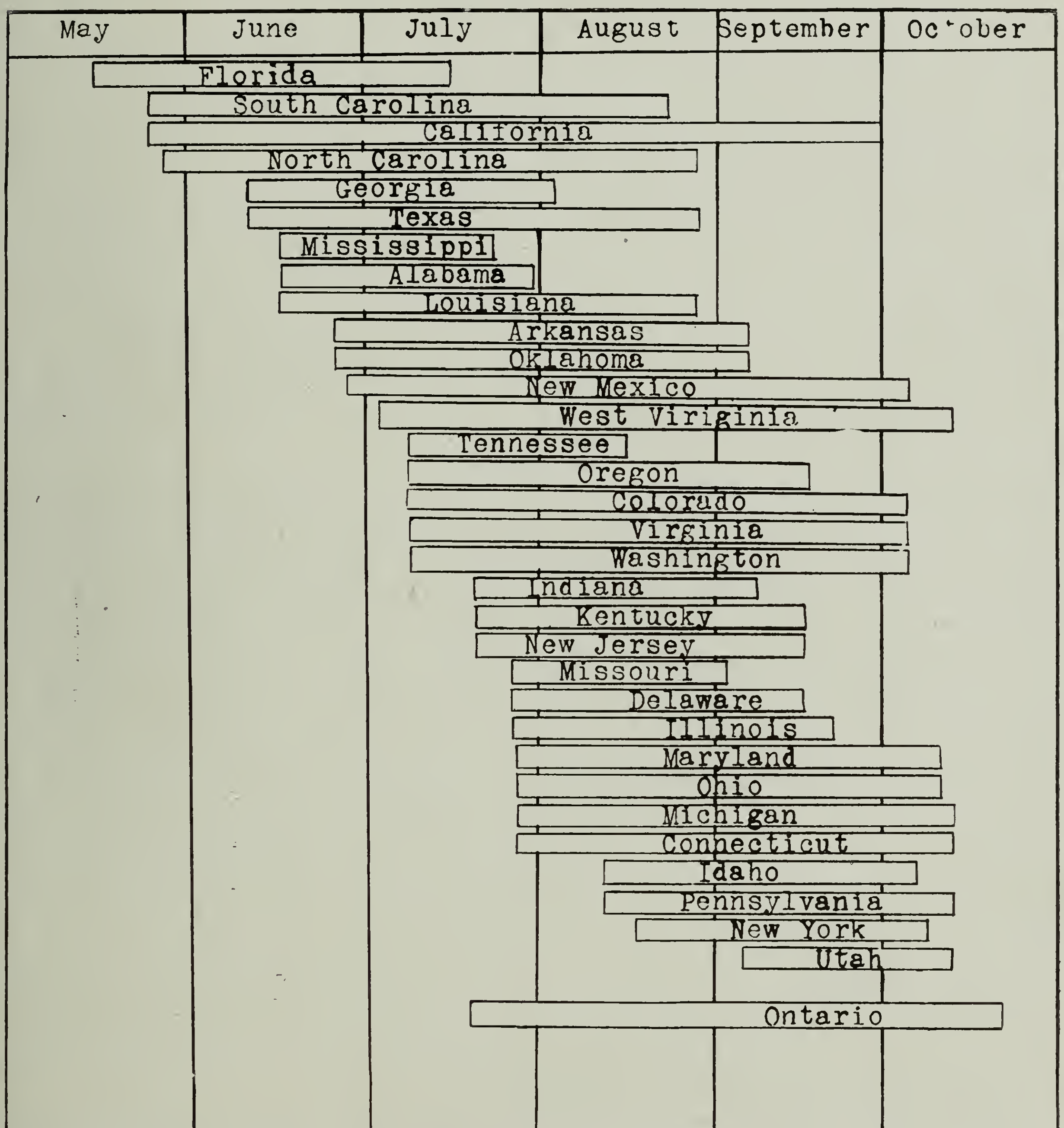
(*d*). *"Shallow Nines."*—This is a basket made from eleven-quart bottoms and six-quart sides, i.e., the bottom is the same as the common eleven-quart and the sides are the same as the common six-quart. This accommodates very readily two layers of Fancy fruit of most varieties. It is a legal package only when "stamped on the side plainly in black letters at least three-quarters of an inch deep and wide, with the word 'Quart' in full, preceded with the minimum number of quarts, omitting fractions, which the basket will hold when level-full."

(*e*). *The Leno Cover* (Fig. 18).—This package is becoming ever more popular. It is very attractive to the consuming public. The only objection to it lies in the fact that it is not readily accommodated to present facilities for shipment by rail.

Special facilities have been provided for this package for shipment by boat from Queenston and Niagara.

(*f*). *The Peach Box* is not yet used extensively. It is 18.5 x 11 x 4½ or 5 inches deep, and holds approximately twenty pounds net. (Fig. 19.)

(*g*). *The Georgia Peach Carrier* (Fig. 20) is an excellent package for fancy fruit, but is not popular in Canada except for fruit stand trade. This particular carrier was made with the handle additional.



(*h*). *The Bushel Basket,* holding approximately forty-five pounds net, is not used very extensively. It is an excellent package for long-distance shipment, especially if the fruit is firm. It is a very popular package in some of the States of the United States. (Fig. 21.)

SPRAYING.

Peaches are usually sprayed but once in Ontario. Any sprayings other than this are in the nature of special treatments for certain insects or diseases. A thorough application of lime sulphur, winter strength, just when the buds are swelling, and before they show signs of bursting, is all that is necessary ordinarily. Commercial concentrated lime sulphur, home-made concentrated lime sulphur, and the old home-boiled lime sulphur all are used by various growers for the same purpose. Any one is efficient if applied thoroughly at the proper time. For other sprayings, look up under the heads of "Insects and Diseases."

THE SHIPPING SEASON.

The chart on page 35, with the exception of Ontario, is taken from U. S. Bulletin No. 298. The peach season, when considered for the United States, extends from the middle of May, when shipments begin in Florida, to the latter part of October, when they end in the Northern States.

California, with its diversified climate and great number of varieties of peaches, probably has the longest season, i.e., from the middle of May to the end of September.

The chart shows in detail the comparative seasons of the different States, and incidentally those that compete with Ontario during her shipping season.

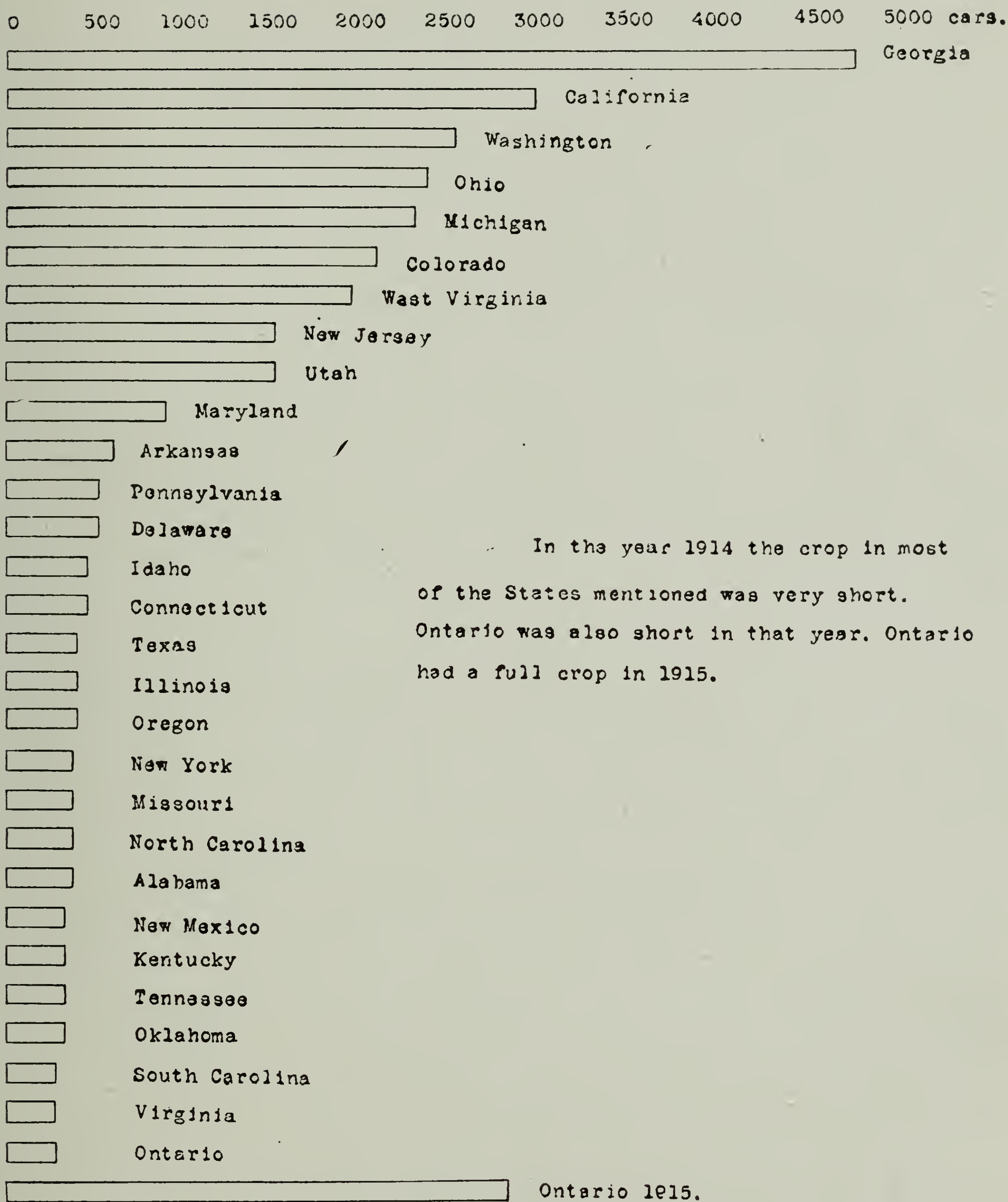
Ontario shipments are light up to approximately August 20th. They again fall off very quickly about the end of September. It can readily be seen then that the heavy shipping season is about six weeks.

Production and Shipments.—The 1910 census of the United States credits that country with 94,507,000 bearing and 42,266,000 non-bearing trees, peaches and nectarines, a total of 136,773,000 trees, or approximately 1 1-3 trees for each individual. The number of nectarines is comparatively very small. The 1911 census of Canada (there is no 1910 census) credits this country with 839,288 bearing and 1,056,359 non-bearing, a total of 1,895,647 trees, or approximately one-quarter of a tree to each individual in Canada. We have every reason to believe that the average production of fruit per tree is as heavy or heavier in the United States than in Canada. With these figures before us, then, well might we ask the question: If only during the last few years have the growers in the United States begun to feel the pinch in marketing where the production is comparatively four or five times as great as our own for each consumer, should the Canadian grower not still be in a position to plant heavily and sell to good advantage if the markets were properly developed and kept supplied at all times.

The home market is undoubtedly the most attractive market for Ontario peaches. Shipments to the Provinces east and west are increasing rapidly, but the great bulk of the shipments stay within our own Province. Ontario has a population of 2,523,274, of whom 1,194,785 are classified as rural. A very large part of this population has not yet been reached.

The following chart is from U. S. Bulletin No. 298, "Peach Supply and Distribution in 1914." To it has been added the shipments from Ontario. The figures going to make up the total for Ontario were carefully collected, and though they are not absolute, they are approximately so. The United States figures are for 1914, the Ontario figure for 1915. The Ontario figure represents total tonnage freight and express. The number of cars was obtained by dividing by 10. The United States figures are comparatively low, 1914 being a year of poor yield the same as in Ontario. The 1914 Ontario crop could be measured by tens, not hundreds, of cars. Two hundred cars would possibly cover Ontario's shipments for that year.

This chart, taken from U. S. Bulletin No. 298, shows the comparative volume of shipments from the leading areas as compared with Ontario:



PEACH PRECOOLING.

Edwin Smith, Dominion Precooling Plant, Grimsby.

The experience of horticulturists with tender fruits has been that the peach is one of the most difficult fruits to ship long distances. The difference in keeping qualities of the varieties, the frequence of crushing, the short period for harvesting, the danger of picking too green or too ripe, the carelessness of packers in grading and packing, the roughness of help in carloading, the chance for refrigerator cars to get side-tracked or left without ice, the sluggishness of the trade in distributing, and the ignorance of the consumer as to the handling and serving of the different kinds of peaches, have all combined to give the peach grower an immense task, and one which would not be attempted without the promise of goodly returns.

The peach, being a fruit which will grow in many climates, yet one that will only thrive and produce profitably in a few favored districts, often makes large returns. In years past this has resulted in ebb and flood tides of peach plantings. The phenomenally large prices and net returns received by the Ontario peach grower during the ten years previous to 1913 resulted in very high priced lands and large plantings. These plantings are now bearing fruit, making a surplus of peaches for the old markets, so that it is being a serious question with many growers as to whether they can afford to grow peaches longer.

To meet these conditions new markets are required, and for the most part these must be sought for at greater distances from home. The Canadian West offers this field.

To market peaches on the Canadian prairies requires from seven to fourteen days from the time the fruit is picked till it reaches the consumer. To hold the peach successfully this length of time it must be placed under refrigeration. It has been found that ordinary refrigerator cars do not offer enough refrigeration for the length of time in transit, since so slow is the process of cooling that the peaches become over-ripe and show evidence of decay before they actually reach a temperature of 45 degrees. This situation has demanded that the fruit be precooled.

Results of Precooling.—During 1914 the peach crop in the Niagara District was so light that the Grimsby Plant was not afforded an opportunity to demonstrate or even experiment with the precooling of peaches. However, the work during the past season was not entered upon as an untried undertaking, since the field of precooling and cold storage of peaches had been worked upon ten years ago by the United States Department of Agriculture, so that the Dairy and Cold Storage Branch felt sure of their way in the undertakings.

First Shipment a Success.—The first shipment of peaches was made to Boissevain, Man., and consisted of the Yellow St. John variety, which is one of the more tender shippers of the yellow fleshed peaches. The fruit was packed in the Northwest Standard box by the Department's staff for Mr. Thos. Liddle. The shipment required eight days, arrived at its destination in splendid condition, and was sold profitably without the loss of a peach. Other shipments followed to Winnipeg, Brandon, Saskatoon. The farthest Western shipment was made to Prince Albert, Sask. On all shipments where the peaches were brought to the plant in a satisfactory condition the best results followed, the peaches arriving in very good condition.

Successful Shipment to Glasgow.—On the 29th of September the Grimsby Fruit Growers were making a precooling shipment of pears to Glasgow. Upon suggestion from the Department they furnished Elberta peaches sufficient for the Department's staff to pack in the ordinary commercial manner fifteen boxes. These were included in the shipment and arrived in Glasgow in good condition fourteen days afterward, the peaches selling at retail for 4d. and 6d. each.

Several Eastern shipments were made as far as St. John, N.B., including some peaches that were becoming well advanced toward ripeness.

Experimental Cars.—The Department purchased fruit for two experimental cars to test and demonstrate packages and also precooling. One of these cars included 855 boxes of Early Crawford peaches. These peaches were becoming well advanced towards ripeness at the time of picking, and in order to make up the carload part were held under refrigeration eight days before shipping, and were five days in transit to Winnipeg. The shipment gave perfect satisfaction, as reported by Mr. A. H. Flack, Chief Fruit Inspector for Prairie Provinces. The other experimental car shipped to Winnipeg contained Elberta peaches in four different packages, the Michigan bushel, Woolverton crate, Hunter crate (both 6-quart and 11-quart baskets), and the Northwest box. The test showed conclusively that if peaches are picked properly and precooled that they may be shipped in any of these packages, although other shipments have shown that unless the fruit is well packed the results will not be satisfactory.

Precooling for Brine Tank Cars.—Brine tank cars were used in both experimental shipments of peaches. The ordinary practice has been to place block ice without salt in these cars. The results have been disastrous, even when the fruit has been precooled; however, in connection with some investigational work that the Department has been carrying on with this type of car arrangements were made with the transportation companies to have crushed ice and 5 per cent. salt placed in the tanks. Thermographs were placed near the tanks and in the centre of the car to get the highest and lowest temperatures during shipment.

The results were most satisfactory. The temperatures ranged between 30 degrees and 40 degrees, thus giving better temperatures than are ordinarily secured in block-ice cars. Inspector Flack found no evidence of damage whatever from the low temperatures near the tanks. The cars required a very small amount of ice during transit.

Degree of Maturity of Peaches for Precooling.—For successful shipment of precooled peaches the fruit must be picked when "medium-ripe," i.e., when the fruit is mature yet not ripe. With the Elberta peach this stage is reached when the ground color is turning yellow and the blush is advancing to a good splash of red, yet when the fruit is perfectly firm. This is usually two or three days before the peach would be ripe if left on the tree.

The peach is not truly a cold storage fruit, so that particular care must be used in handling it at the ripe stage. If allowed to be placed under refrigeration when ripe, contrary to common opinion, its quality becomes mealy, dry and worthless. On the other hand, if picked too green it will never advance in color, quality or flavor. Perhaps no fruit loses its flavor so quickly under refrigeration as the peach, and although it is possible to hold certain varieties of peaches for several weeks, as far as firmness is concerned, it is impossible to conserve the flavor this length of time. This is important in making peach shipments in order that as much dispatch as possible will be secured in their shipment and distribution.

The Peach in Cold Storage.—Refrigeration may be used to great advantage in marketing the peach other than in their precooling and shipment in refrigerator cars. By means of cold storage peaches may be held several days, or even weeks in the case of some varieties, and still be handled in marketable condition. By placing peaches in cold storage gluts may be avoided. As is well known to peach growers, a few warm, hot days coming after a period of cool, slow-maturing weather ripens a variety of peaches all at once, so that the bulk have to be picked within a space of three days instead of a week or ten days. In such cases local markets receive an over-abundance of fruit and then are bare. It has been found that with cold storage facilities at hand fruit may be handled more rapidly at these periods, thus avoiding a waste from over-ripeness on the trees and at the same time bringing greater returns for the peaches by holding them till the market strengthens after the bulk of the variety has moved. If cold storage were universally accessible to the peach grower and used at the time of gluts the tendency would be to strengthen the markets at that time by relieving them of a certain surplus.

The cold storage holds an unique place in the peach shipping industry by acting as a reserve medium. By keeping a certain amount of peaches in cold storage stock is always on hand to fill orders. By holding peaches at the latter end of the peach season many late orders are in this way taken care of that would otherwise have to be lost.

Temperature for Storing Peaches.—Peaches store best at a temperature of 32 degrees. Less decay is found to follow and peaches may be held longer at this temperature than at higher temperatures.

Varieties.—The Triumph, Graves, Admiral Dewey, Champion, Mountain Rose and varieties of a soft nature should not be used for storage but should be shipped or used at once. Such varieties as the Belle of Georgia, Arp Beauty and Early Crawford may be held for a week under refrigeration, or may be precooled and safely shipped in refrigerator cars for several days. The Elberta is one of the best storage varieties, and if picked at the proper maturity may be stored at 32 degrees for two weeks, or longer in some cases.

THE MORE IMPORTANT INSECTS AND DISEASES ATTACKING PEACH TREES

L. Caesar and J. E. Howitt.

INSECTS.

The San José Scale (*Aspidiotus perniciosus*).—This great pest of fruit trees will thrive wherever the peach thrives, and is so destructive that if it gets on a peach tree it will in many cases, if left untreated, increase so rapidly as to kill the tree in a couple of years. The adult female scales are circular in outline, nearly flat, ashy brown in color, with usually a yellowish central area. The diameter of the scale is about that of the head of a pin. Numerous very small, immature scales are nearly always found along with these adults and serve as a better means of iden-

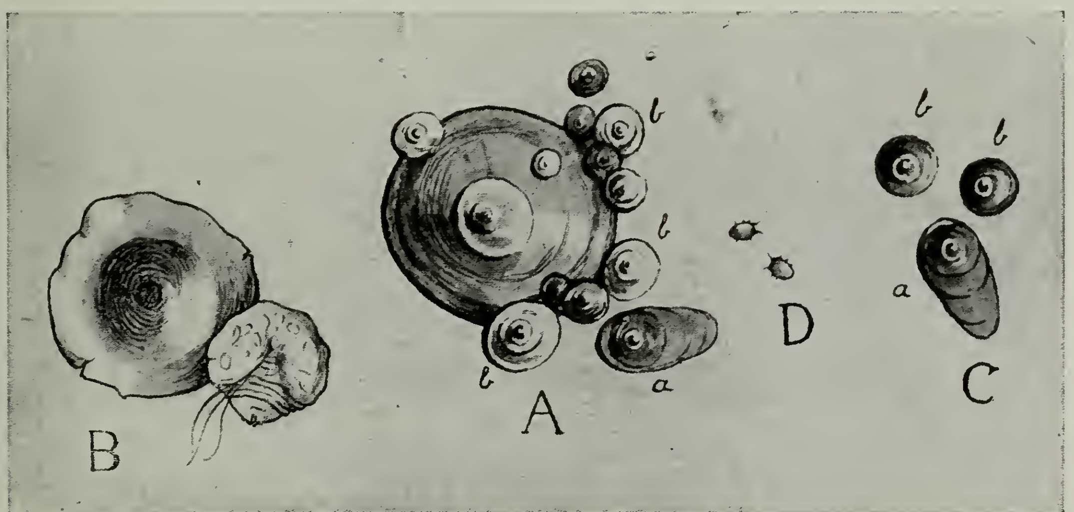


Fig. 22. Various stages of San José Scale, all enlarged about fifteen times: A. Adult female scale with immature young of various stages settled down around or upon it; *a*, an adult male scale; *b*, *b*, *b*, three small black scales, winter stage. B. An adult female scale turned over, revealing the insect herself beneath with bristle-like mouth parts exposed. C. *a*, an adult male scale; *b*, *b*, two immature black winter stage scales. D. Young active larvae soon after birth. Note the nipples and little grooves around them in A *b*, *b*, *b*, and in *C b*, *b*. (B redrawn from Alwood, the remainder original drawings by Miss A. Hearle.)

tification. They are mere dots in size as seen by the naked eye, but under a hand lens are seen to be circular and black, and have a little central nipple with a ring or groove around it. No other scale with all these characteristics is likely to be found on the peach. There are several broods of this scale each year, and so prolific is it that there may be more than 1,000,000 offspring from a single female by the end of the season. All parts of the tree above ground, including trunk, branches, leaves and fruit, are attacked.

Means of Control.—A single, thorough application of lime-sulphur, strength 1.035 sp. gr. (1 gallon of commercial lime-sulphur to about 7 gallons of water) will kill the scale. It should be applied early in spring before the buds have begun to swell so that it may control the leaf curl disease at the same time. In some cases late fall applications on warm days after the leaves are off have given good results. Soluble-sulphur, 12½ lbs. to 40 gallons of water, has also proven a good remedy. In the United States barium-sulphur crystals have given satisfaction, but have not been tested yet in Ontario.

THE PEACH-TREE BORER (*Sanninoidea exitiosa*).—This is the most common and next to the San José Scale the most destructive insect enemy of the peach. The injury is done by the larvæ which bore in the sapwood of the trunk, usually at or below the ground. We have removed as many as twenty of these borers from a single four-year-old tree. Badly infested trees like these become sickly and not infrequently die either as a direct result of the work of the borers or because they have in their weakened state attracted Fruit-tree Bark-beetles, or have become too weak to stand the winter. The adult insects are pretty, clear-winged moths, bluish black in color, and not unlike certain common kinds of wasps. The female has around her abdomen a broad orange band, which is absent from the male. The moths begin to appear about the middle of July in Ontario and are to be seen up to the middle of September. Egg laying takes place over much of this period. Eggs

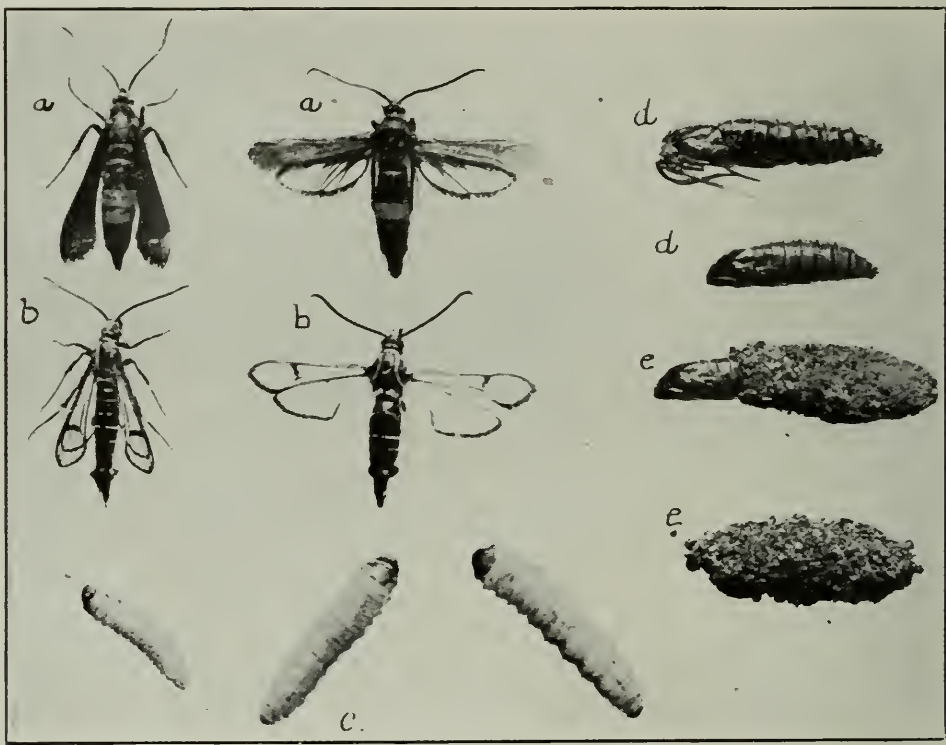


Fig. 23. The Peach-tree Borer: *a. a.* adult females; *b. b.* adult males; *c*, full-grown or nearly full-grown larvae; *d. d.* pupae, the upper one being empty; *e. e.* cocoons or pupa cases, the pupa protruding from the upper one; all natural size. (Original.)

are laid on the trunk, branches, leaves and occasionally in the ground near the tree. On hatching the little larvæ work their way to the base of the trunk and gradually eat through the bark. Some of them are still very small by winter; others are almost full grown. The larvæ are whitish with brown heads. During the winter they remain dormant either in their burrows or in little shelters constructed on the bark. Next spring feeding commences again and in June the largest larvæ begin to pupate, smaller ones doing so later. There is only one brood a year.

Means of Control.—The customary method, and one which has given fairly good satisfaction, is to examine each tree twice a year, once in October and once at the end of May or in early June, and with a sharp knife dig out and kill all larvæ found. In searching for them the earth should first be removed from around the trunk to the depth of three or four inches because they often work below the surface. Their presence can nearly always be determined by the masses of gum that exude from the wounds. This should first be removed with the knife or trowel, and then by cutting along with the grain of the bark so as to do as little damage to the tree as possible, the larvæ should be sought out and killed. If earth to a height of 6 or 8 inches is heaped up around the trees at the end of June it forces the larvæ to work higher up on the trunk, and thus, when it is removed, they can be more easily found and destroyed. The earth should be put back for winter. Recently in the United States tree protectors, made by the Scott Tree Protector Co., Baltimore, Md., have been used with success. These are stout discs fitted closely around the base of the tree and fastened there firmly by a sticky substance. They are put on before the eggs are laid and prevent the larvæ from crawling down to the crown.

The Lesser Peach-tree Borer (*Sesia pictipes*).—Both in the adult and in the larval stage this borer closely resembles the one just discussed. It is, however, a little smaller, and the female has not the broad orange band around the abdomen. Moreover, the habits of the larvæ are different in that it prefers to work in or alongside wounds not only on the trunk, but anywhere on the larger branches or at the

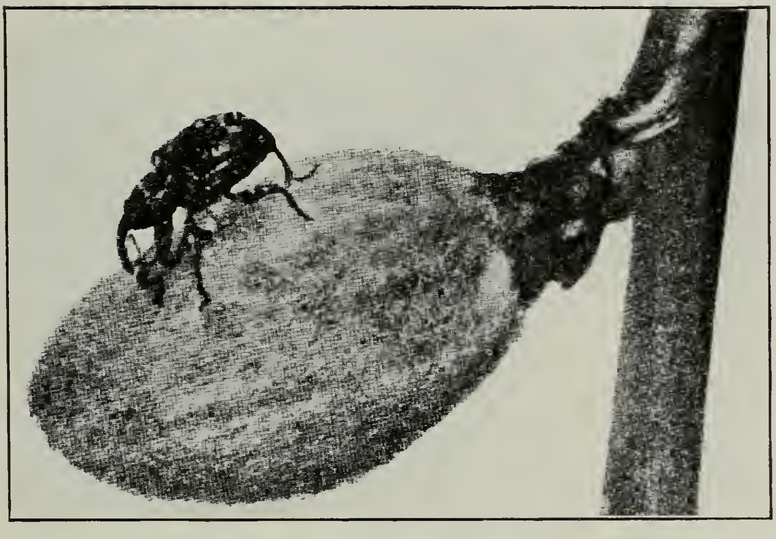


Fig. 24. The Plum Curculio on a peach fruit; enlarged about 3 times. (After Quaintance and Jenne.)

crotch. In many parts of the Niagara district there is a considerable amount of the so-called "Peach Canker" which causes wounds that afford almost ideal breeding places for these borers. Trees with smooth uninjured bark are very seldom attacked. The life history of the insect is, with these exceptions, almost the same as that of the Peach-tree Borer.

Means of Control.—From what has been said, it is clear that the best method of control would be to keep the trees free from injuries, but this cannot always be done. In cases where there are many cankers, much can be gained when pruning by cutting off any cankered branches which may be spared and burning them. The remaining wounds should be inspected about the end of May and as many of them as possible cleaned out with a draw-knife and ordinary stout sharp knife. All borers found should be killed and the wounds covered over with white lead or grafting wax.

The Plum Curculio (*Conotrachelus nenuphar*).—This Curculio attacks peaches as well as plums, cherries, pears, apples, apricots and some other fruits. It is regularly worst in the vicinity of woods or waste lands where there is an accumulation of rubbish of any kind. Well cultivated and cared for orchards with clean surroundings are seldom troubled by it. The losses from it are caused first by the premature falling of infested fruit; and, secondly, by the Brown Rot disease which gets admission to the fruit, especially in autumn, through the wounds made in the skin by the beetles when feeding. The adults are stout, grayish black beetles about ¼ inch long, with rough wing covers and a long snout. The winter is passed in the adult stage under any good shelter such as is found in long grass and rubbish along fence corners or in the borders of woods or thickets. About the time the blossoms on the peach have fallen the beetles come out and begin laying eggs. These continue to be laid for more than a month. Each egg has a crescent-like slit made about it which serves to distinguish it from those of any other insect. The larvæ on hatching work their way to the pit and feed alongside it. Full grown larvæ are about one-third inch long, dirty white in color, curved, legless, and have a brown head. They are full grown in two or three weeks and then enter the soil a short distance to pupate. Late in July new adults begin to appear and continue to do so for some time. These do not lay eggs but feed on the surface of the fruit for some time, eating out small areas from which gum soon exudes. Later in the fall they all go into winter quarters.

Means of Control.—(1) Clean up the surroundings, leaving as little rubbish as possible in or near the orchard to serve as winter quarters. (2) Cultivate well up to as late as is desirable for the welfare of the trees. This kills the pupæ in the ground. (3) If, in spite of these steps, owing to the presence of woods or other causes, the beetles still cause trouble, spray once each year with 2 or 3 lbs. arsenate of lead to 40 gallons of water soon after the fruit is well set and the calyces are off, so that the spray material can get all over the surface. A pound or so of freshly slaked lime added to each barrel will help to insure immunity from burning of foliage.

The Fruit-tree Bark-beetle, or Shot-hole Borer (*Eccoptogaster rugulosus*).—In many peach, cherry or plum orchards a tree or two here or there will be found with numerous small gum masses exuding from the bark of the trunk and branches. If with a knife one cuts the outer bark off these places and finds a little hole it is a proof that the gum was caused by the work of this pest. The adult insect is a tiny, reddish-black beetle, about 1/10 inch long. It attacks most commonly sickly, dying, or dead trees, infesting healthy trees only when these others are absent. If a dead tree is examined the bark will often be seen to have many little holes like shot-holes in it. If it is removed the wood underneath will be seen to be engraved with numerous little tunnels running in various directions. These are the work of the larvæ, which are stout, little white grubs without any legs. The winter is passed in the larval stage in these burrows under the bark. In June they have become full grown, pupated, and begun to change into adult beetles. These soon seek the sick, dying, or dead trees, bore holes through the bark and make tunnels nearly an inch long underneath it. In these they lay their eggs. The young larvæ on hatching feed on the wood and under part of the bark, making many little tunnels in doing so, and thus give the engraved surface to the wood. There is a second brood of adults in August. These may be seen on the trees for many weeks, but they all perish before winter and only their larvæ survive.

Means of Control.—Owing to the fact that this insect can breed only in dead or dying wood, there will very seldom be any damage done by it if all dead or dying fruit trees or branches are removed and burned each spring before the end of May.

No brush heaps, or even piles of cordwood made up of the larger branches and trunks of fruit trees should be left. If the latter are desired for fuel they should be stored in a woodshed or cut in the fall, dried and burned before the above date. Healthy trees that have been attacked and become covered with gum should not be cut down because the gum drives out the beetles and so no eggs are laid in them. They should instead be severely pruned, and the soil well fertilized and cultivated to stimulate growth. In such cases they usually completely recover.

If beetles are found attacking an individual tree, they may be kept off by covering the tree at once with a coating of thick whitewash containing ¼ lb. of salt to each pailful.

DISEASES.

Peach Yellows and Little Peach.—These two diseases are so closely related that they may be discussed together. They have caused a great deal of alarm to peach-growers, and a few years ago were so prevalent and destructive throughout the Niagara peninsula that several otherwise excellent orchards had to be destroyed and many growers believed that the peach industry would soon be ruined. All efforts to discover the cause of either disease have resulted in failure. Moreover, we are still to a very large extent ignorant of how and when they are spread from tree to tree. We do know, however, both from our own experiments and those of others that if buds are taken from diseased trees and inserted into healthy ones the latter will in all, or nearly all cases, become diseased. It is also clear that either disease will spread to other trees from infected trees that are allowed to remain long in an orchard. The spread may be very slow, and it is quite possible that weather conditions may some years almost totally prevent it. Our experiments prove that even where diseased buds are inserted into healthy trees, the disease seldom shows up for two years, so one can understand that it will take considerable time, except under very favorable conditions, for Yellows or Little Peach to travel through a whole orchard. We have, however, seen entire orchards perish by the time they were eight years old. It has been claimed that pits from diseased trees will not grow, but we have demonstrated that as high as eight per cent. under favorable conditions may do so, but there is little or no proof yet in our experiments that the seedlings from these will develop into diseased trees.

Symptoms of Yellows.—On a diseased tree some of the fruit will usually be seen to ripen prematurely, be more highly colored than normal, blotched outside with red, streaked inside with this color, and the flesh around the pit redder than usual. Sometimes only one branch will show these symptoms and all the rest of the tree bear quite normal fruit. The foliage on at least some of the branches soon begins to assume a yellowish color, and in many cases the leaves begin to curl and cluster as if they were affected by Little Peach. This is especially true when the disease is far advanced. On such trees we sometimes also find arising from the main branches little upright growths of slender, much-branched twigs with narrow, yellowish leaves.

Symptoms of Little Peach.—The fruit on a typical diseased tree or part of a tree ripens later than usual, is smaller than normal, but has no unusual color markings. In many cases, however, we find diseased trees in which the fruit ripens at the usual time and is about normal in size, but the foliage shows clearly that the trees are diseased. The symptoms on the foliage are the curling and clustering of the leaves, especially on the inner parts of the tree, and the sickly yellowish or reddish yellow color that they assume. In younger trees the leaves on the outer branches will usually remain quite green for a long time after those in the centre of the tree have clearly begun to show the disease. If the centre of the tree looks healthy but the outer branches, because of their reddish yellow color, look diseased, it will nearly always be found that such trees are not attacked by Little Peach, but are merely in need of better nourishment.

Means of Control for Both Diseases.—There is only one means of control, namely, to inspect the orchard in early August and again in September, mark all diseased trees and remove and burn them, root and branch, promptly. Inspection need not begin before the last week in July or August 1st, because it is very diffi-

Fig. 25. Branch of Little Peach tree just beginning to show the clustering and curling of leaves near the base. (Original.)

cult to detect the disease any earlier than this. No tree that gives clear symptoms of either disease, even in a single branch, can be cured by cutting off such branch or in any other known way. All diseased trees are useless after the first year. It is illegal to sell diseased fruit. Every tree left standing for any length of time in the orchard after it has begun to show the disease is a menace to all the other trees. Therefore, common sense should lead every man to get rid of such trees quickly and to help the local inspectors in their work. That good inspection and prompt removal will control the disease has been well demonstrated by the fact that in 1911 nearly 60,000 trees had to be marked and destroyed, and by 1914 this number was reduced to 3,000. Japanese plums are also subject to both diseases and should be inspected with equal care. When diseased trees are removed it has been found safe to replant in the same place the next spring.

Peach Leaf Curl (*Exoascus deformans* (Berk.) Fuckel).—This is the most common and most injurious fungus disease of peaches in Ontario. It is familiar to every peach-grower, and very frequently seriously impairs the vitality of his trees.

It affects the leaves as they expand in the spring and they become distorted, curled, thickened, and yellowish white, pinkish or purblish in color. A little later in the season they turn brown and fall. The disease may spread into the shoots and destroy them. In severe attacks of Peach Leaf Curl the trees are almost completely defoliated, the fruit is stunted or drops to the ground, and the vitality of the trees is so impaired that they are very likely to be severely injured by the cold the following winter. It is also probable that proper development of fruit buds is prevented. Young trees may be killed the first year they are set out if they are defoliated before they have recovered from the shock of transplanting. Peach Leaf Curl is always most severe in cold, wet springs.

Fig. 26. Peach Leaf-curl.

Life History.—The fungus which causes Peach Leaf Curl is carried over the winter as spores adhering on or between the bud scales. In the spring, when the buds begin to swell with warmth and moisture, the spores germinate and infect the unfolding leaves; hence the necessity for early and thorough spraying. In cold, wet springs the opening of the buds is retarded, while the germination of the spores and the development of the fungus is favored by the excessive moisture and not retarded by the cold. Thus the fungus has plenty of time to get established in the tender tissues of the developing leaf. This explains why Peach Leaf Curl is always worse in cold, wet springs.

Means of Control.—Spray with lime-sulphur, using the strength recommended for San José Scale, viz.: Concentrated lime-sulphur, strength, 1.035 specific gravity, which equals one gallon commercial lime-sulphur to seven gallons of water. The spraying must be done early in the spring before the buds have started to swell, and care must be taken to see that every bud is thoroughly covered. Success depends upon early and thorough spraying, as can be understood from a consideration of the life history of the fungus. Somewhat weaker solutions of lime-sulphur or Bordeaux mixture will prevent the Leaf Curl but will not kill San José Scale, which is apt to be found wherever peaches are grown, and therefore it is advisable to use the strong solution of concentrated lime-sulphur as recommended above.

Brown Rot (*Sclerotinia fructigena* (Pers.) Schroet).—This disease, which is so common on plums and cherries, also destroys peaches. Certain varieties, such as the Triumph, are particularly susceptible to it.

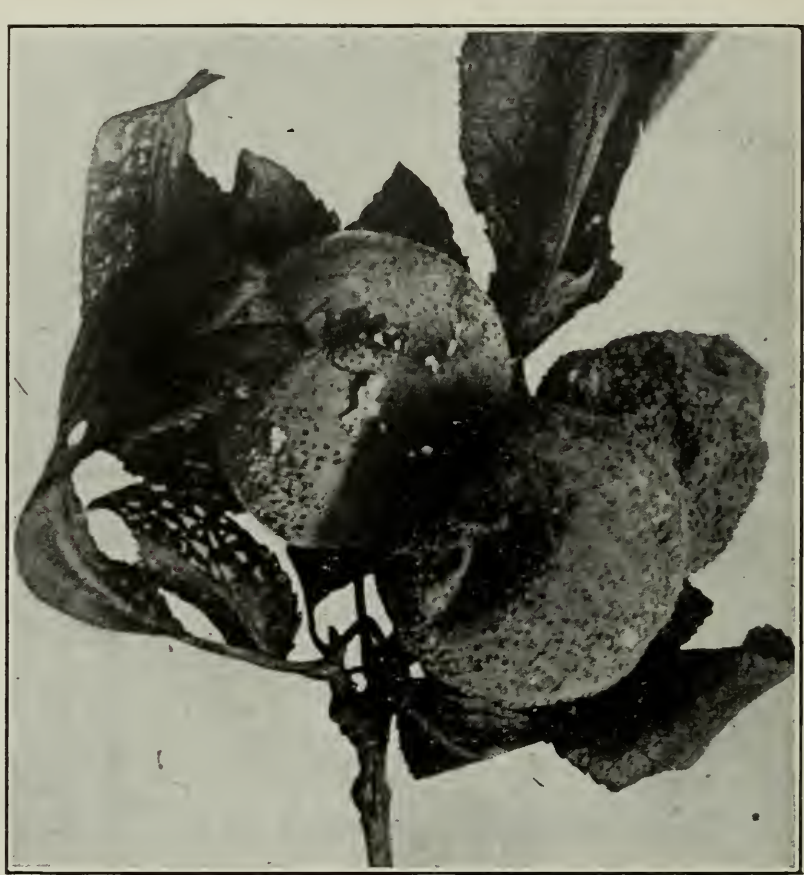


Fig. 27. Brown Rot Disease. (After Duggar).

It attacks the blossoms, twigs and fruits. It is to the fruit, however, that the disease does most damage. On this a small, dark brown spot first appears. This spot increases in size until the whole fruit becomes soft, brown, and rotten. The surface of the fruit becomes covered with ashy-colored, spore pustules. For awhile affected fruits retain their form, but gradually they shrivel up and become hard, dry mummies. These are frequently seen hanging on the trees, or lying on the ground beneath them.

The fungus which causes the Brown Rot may spread into the twigs and small branches on which the affected fruit is borne. These are girdled by the fungus near the point of attachment of the fruit and the portion of the twig above this point is killed. These blighted twigs are common in an orchard after the fruit has been destroyed by the rot.

Life History.—The disease is spread during the summer months by means of spores produced on the surface of the rotting fruits. It spreads very rapidly during warm, muggy weather, especially when the fruits are close together and the foliage is so thick as to keep out the sunlight and prevent the free circulation of the air. It is carried over the winter by means of spores adhering to the bark, bud scales and mummied fruits, and by dormant fungus threads (mycelium) in the mummied fruits.

Means of Control.—1. Prune the trees so as to let in light and air.

2. Destroy the mummied fruits. Knock them off the trees in the fall, and either gather and burn them or plough them under early in the spring.

3. Thin peaches so that they do not touch each other.

4. Spray with concentrated lime-sulphur, strength specific gravity 1.035, early in the spring before the buds begin to swell. Spray with self boiled lime-sulphur about a month after the fruit is set and again about a month before the fruit ripens.

Peach Scab or Black Spot (*Cladosporium carpophilum*, Thum.).—This disease is seldom destructive in Ontario. It is, however, very frequently seen on low grade peaches, especially the white-fleshed varieties.

It produces small, circular, sooty black spots on the surface of the fruit. These may be scattered all over the surface or may be more or less confined to certain areas. In severe attacks the spots may be so numerous as to badly disfigure the fruit and occasionally, as a result of the injury, cracking of the fruit may occur. Twigs and leaves are also sometimes affected, but seldom to a noticeable extent here in Ontario.

Life History.—The fungus which causes the Scab is thought to winter over in the twigs and produce fresh crops of spores in the spring.

Means of Control.—Give the early spraying with lime-sulphur as directed for Peach Leaf Curl, and in addition spray with self boiled lime-sulphur about a month after the fruit is set.

Powdery Mildew (*Sphaerotheca pannosa* (Wallr.) Lev.)—This mildew attacks both the rose and the peach. It is most commonly seen on young peach trees which have not yet come into bearing. It frequently severely injures nursery stock. It does, however, sometimes occur on older trees. Certain varieties are said to be particularly susceptible to it.

It attacks the leaves, young shoots, and rarely the fruit. The leaves become distorted, stunted, curled, pale, sickly, more or less folded lengthwise and covered with a dense powdery white substance which extends over the twigs on which the leaves are borne. The mildew is easily recognized by this dense, white, powdery covering on the affected leaves and shoots. It develops most vigorously in warm, moist weather, and is usually worst in late summer and autumn.

Means of Control.—At the first sign of the mildew dust with flour of sulphur and repeat at intervals of ten days as often as may be required to hold the disease in check. Spraying with self-boiled lime-sulphur is also recommended. It is often advisable to discard very susceptible varieties.

Crown Gall (*Pseudomonas tumefaciens* (Erw. Smith & Townsend.—This is a bacterial disease which affects many other trees and plants besides peach trees. It is easily recognized by the woody, knot-like swellings it causes on the trunk and roots. These galls vary in shape and size; some are not as large as a walnut, while some may be as large or larger than a man's fist. When these galls are on the trunk they are usually just below the ground. The extent of injury done to the trees by the Crown Gall is an open question. Many affected trees continue to grow and appear to thrive normally. There is no doubt, however, that some trees are weakened and stunted, if not killed, by the presence of the galls.

Prevention.—In order to be on the safe side, do not plant any trees showing any indication of Crown Gall. Such trees should be returned to the nurseryman with a request for healthy trees to take their place. It is not advisable to plant peach trees where raspberries have grown, as raspberries are very subject to this disease.

CANKER OR GUMMOSIS OF PEACH TREES.—In certain localities in the Niagara district, especially at Queenston, Niagara-on-the-Lake, St. Catharines, and in a few orchards at Winona, it is a common thing to see large, black, gum-covered cankers, chiefly on the upper side of large branches. These cankers do not heal over but

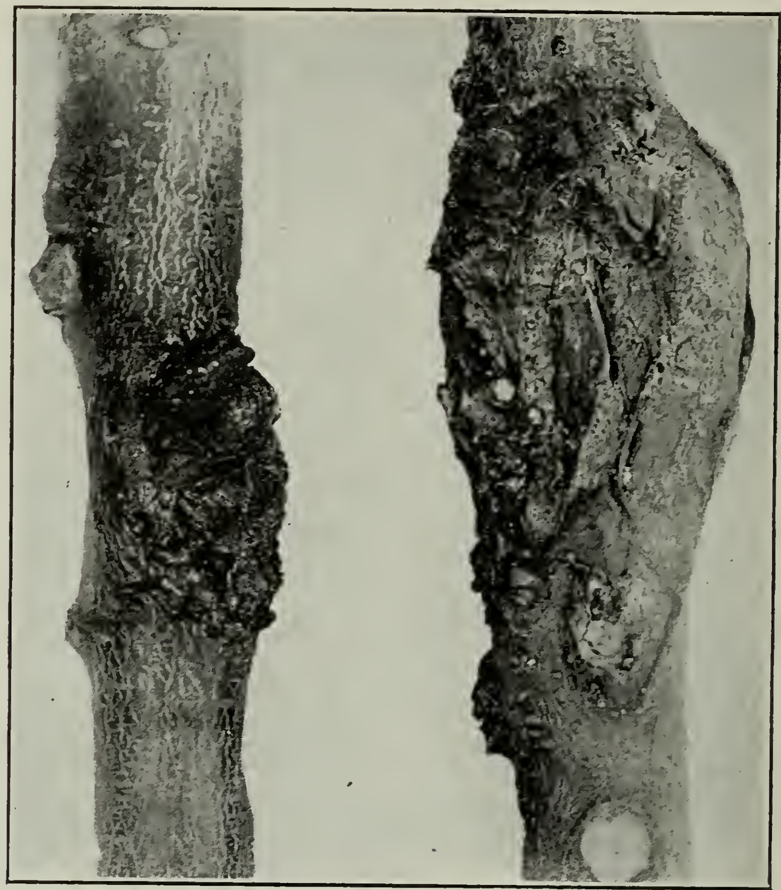


Fig. 28. Small Cankers on peach branches; natural size. (Original.)

continue to widen out and enlarge until finally the whole branch dies. This usually takes several years.

The cankers have been attributed to various causes. Mr. W. A. McCubbin, of the Dominion Laboratory, who has made a special study of Peach Cankers, writes as follows concerning their origin:—

*" 1. A very small percentage arise from holes made by borer larvæ.

" 2. They may come as an after-effect from small cracks in the trunks or limbs. The percentage thus formed is also very small.

" 3. A small number start from gum blisters under the bark.

" 4. A few arise at the bases of twigs killed by Brown Rot. The Brown Rot fungus works back from the rotten fruit into the twig and then starts a canker in the larger limb.

" 5. Wounds made by scraping the limbs, etc., are accountable for a small number.

"6. Quite a few cankers start at pruning wounds.

"7. By far the greatest proportion of cankers are formed on the limbs at the bases of dead twigs. There is presumably a fungus concerned here which, after establishing itself in the dead twig, runs back into the larger limb and there starts a canker."

Field observations, however, made by the writers incline them to think that heavy pruning and heavy fertilizing, in combination with wet weather early in the growing season, may also have much effect in inducing the formation of cankers.

Means of Control.—Mr. W. A. McCubbin, after conducting many experiments on the healing of Peach Cankers, makes the following recommendation in regard to their prevention and control: Removal of the dead twigs from the main limbs, since it is found that these twigs are the starting points of the disease in such a large number of cases; destruction of Brown Rot mummies; painting of all the larger pruning wounds; removal of small limbs showing cankers, and the treatment of cankers on trunk or large limbs by cleaning out the cankers immediately after rain when the bark and gum are soft, and disinfecting the wounds with formalin diluted one to ten, or corrosive sublimate, one in a thousand, and coating them with lead paint free from turpentine.

The field observations of the writers recorded above indicate that care should be taken not to over prune or over fertilize peach trees, as such treatment apparently tends to induce the formation of cankers.

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*Bull. 24, Dominion Department of Agriculture. "Fruit Tree Diseases of Southern Ontario."

BULLETIN 242 DECEMBER, 1916

Ontario Department of Agriculture

WOMEN'S INSTITUTES BRANCH

Written for the Oral Hygiene Committee of the Ontario Dental Soc

Diseased Mouths a Cause of Ill-health

ARTHUR DAY, D.D.S.

The importance of hygiene and personal cleanliness is becoming more and more generally recognized by all civilized nations. This recognition must be on an ever-increasing scale if disease is to be stamped out, and the health of the public improved. The Provincial Board of Health looks after scientific sanitation, protecting the public from the injurious effects of impure water and impure food, sewage, and overcrowded living conditions, and isolating all persons afflicted with contagious diseases.

Of all hygiene, however, not the least important is the hygiene of the mouth.

Dr. Mayo, the celebrated United States surgeon, says that the next great forward movement to be undertaken in the prevention of disease is the procuring of clean mouths among the people. Now that we know so many diseases are communicable, it is a duty to society, for each one of us to have as healthy and germ-free a mouth as possible.

Probably the majority of the population forget that the mouth, which should be the cleanest part of the body, becomes the filthiest when neglected. There is nothing more disgusting than a mouth that is a stranger to the tooth-brush, or one that is treated only occasionally to a half-hearted scrubbing with this highly necessary toilet article. A person with such a mouth, when sneezing or coughing, forces into the air disease germs, which immediately become attached to dust particles, poisoning the air which others must breathe, with myriads of disease-producing germs—such as pulmonary tuberculosis, pneumonia, diphtheria, tonsilitis, la grippe, the common cold, and many others. Imagine also, if you will, a person with a dirty mouth swallowing this filth with every mouthful of food.

Medical authorities state that fully seventy-five per cent. of disease either originates in the mouth, or enters the system through it.

Unsightly teeth and foul breath create anything but a favorable impression in business and social circles, counting much against success in every walk of life. But the value of sound teeth and a healthy mouth must not be judged solely by appearances. There is a more serious result arising from a disease-infected mouth, and that is THE EFFECT UPON THE GENERAL HEALTH.

Probably few people have any idea of the enormous number of germs (i.e., bacteria) to be found in the human mouth. Authorities differ as to the exact number, but a conservative estimate is, that the ordinary varieties which are to be found in a diseased mouth number about fifteen. However, bacteria multiply so rapidly that tens become millions in a few hours if the condition of the mouth is favorable to their reproduction.

A noted bacteriologist has estimated that in a certain very unclean mouth there were not less than one billion one hundred and forty million bacteria. Think of the atmosphere of a room inhabited by a person with such a mouth! Some of these germs are more poisonous or disease-producing than others, but it is a fact that the human mouth when in a diseased condition contains many of the most virulent germs known. This is particularly true of germs associated with decayed teeth having abscesses at their roots, and those associated with pus which may be pressed out from around the necks of the teeth. These conditions are exceedingly common, and it is an accepted fact that dental disorders are the most wide-spread that afflict the human race, and that many obscure ailments affecting the general system—such as chronic dyspepsia, gastritis, certain nervous affections, and general diseased conditions of the blood, as pernicious anæmia—may be traced to a diseased mouth. This kind of mouth is the result of failure to make proper use of the tooth-brush, and of failing to consult a dentist when decayed teeth, or red and swollen gums are first noticed.

It seems hard to impress the public with the seriousness of these facts. The subject is one of great importance from the standpoint of public health. It is second to none that concern the physical and mental welfare of the people, as it affects the entire community. These mouth troubles are alarmingly frequent in the children of the public schools, and in most localities no adequate measures have been adopted, up to the present, to cure the evil or to arrest its progress. Great efforts are being made to stamp out tuberculosis; much has been done to prevent cholera, diphtheria, rabies, yellow fever, typhoid, meningitis, and other preventable diseases; but how little has been done in most places to rescue the school-children from the dangers of mouth bacteria. Statistics show that over ninety per cent. of the children in public schools have decayed teeth; or abscessed teeth, the pus from which is being constantly swallowed.

In this province, Toronto is one of the few places where the mouths of the children, rich and poor, are systematically cared for. In other places the rich are privileged to have healthy mouths, and even in such cases neglect is frequently the rule.

Without a doubt, the spread of such infectious diseases as diphtheria, influenza, pneumonia, bronchitis and tuberculosis, in the public schools, is greatly increased by the unsanitary condition of the mouths of many of the children. The campaign against the spread of tuberculosis meets with many obstacles that are hard to overcome; but in a campaign against mouth infection all that is needed is regular inspection of the school children's mouths, instruction to the children in the proper preventive treatment, and a dental clinic maintained by the municipality, where the mouths of the children whose parents cannot afford to pay for the work, will be put in a condition of health.

As to the effects of an ill-kept mouth on the mouth itself: probably the most common is toothache. Toothache is too well known to require any discussion; the more serious conditions are those that follow the ache. Toothache is succeeded frequently by a swollen jaw, the swelling being caused by pus at the end of the root of the tooth. Generally the pus discharges into the mouth through a so-called gum-boil. Though there may be no discharge into the mouth, the pus is absorbed by the blood and carried to all parts of the body, and sets up many diseases, of which mention will be made later. Swollen glands in the necks are very often caused by pus which travels down to them from the abscessed tooth. The tubercular germ is more or less constant in the mouth, and often becomes mixed with this pus, and when it enters the glands of the neck it is apt to travel through the entire system, perhaps lodging in a joint, or in the lungs.

The tongue is sometimes the seat of ulcers due to the mechanical irritation of decayed teeth having sharp edges, and to masses of tartar. Ulcers of this kind, when neglected, are often the starting point of cancer. Cancer is much more prevalent than tuberculosis in those above forty years of age, so that it is important to attend to any ragged edges or points of irritation to the tongue.

On account of its close proximity, the throat may be infected from a diseased mouth. It is a fact that periodic attacks of tonsilitis are often a result of an unsanitary mouth. A number of diseases come from infected tonsils, and in many cases the tonsils are infected from the mouth. The spread of diphtheria is much more rapid, and its virulence greater among children with neglected and diseased mouths, than among those whose mouths are in a fairly hygienic condition.

The mouth is never entirely free from bacteria, because they are in the open air, in street cars, on the floors, and in every place. When a mouth is in a neglected and unsanitary condition, it is a veritable hotbed of infection, swarming with organisms which infect the tonsils, the ears, the throat, the bronchial tubes, the lungs, the stomach, and the intestines.

The long-continued ingestion of myriads of disease germs by swallowing them with the food, and during the intervals between meals, cannot but retard the process of digestion. Besides, the constant presence of those poisons in the stomach and intestines will sooner or later infect the lining of these organs, setting up an inflammation in the stomach and the intestines, increasing the danger of appendicitis. The gastric juice of the stomach is not a barrier to the passage of bacteria from the stomach to the intestine. Smithies, an English authority, in an examination of 2,406 people with stomach trouble (indigestion, etc.) found bacteria in 87 per cent.

The bronchial tubes and the lungs are subject to infection from an unsanitary mouth. Pneumonia very often follows the taking of an anæsthetic, due to the passage of bacteria from the mouth to the lungs during the heavy breathing while under the anæsthetic, and at a time when the patient's power of resistance to disease is lowered.

The diseases which may arise by indirect infection through the absorption of bacteria in the mouth into the blood are exceedingly numerous; in fact this possibility covers almost all germ diseases, including those that are considered contagious and infectious and those that are not. Among the more serious of these might be mentioned inflammation of the inner part of the bone, heart disease, kidney disease, pus in any cavity of the body such as in the chest, meningitis, a slow and general poisoning of the blood, erysipelas, diabetes, etc.

Dr. R. Ackerly, of London, England, in a lecture before the Royal Society of Medicine upon "Observations of the Mouth in One Thousand Consecutive Cases of Chronic Diseases," said that he found that 36 per cent. had less than half their natural chewing powers owing to a loss of tooth tissue, and that 22 per cent. had mouths containing pus (which is necessarily disease-laden). He says, "If careful mastication is necessary for those whom we call healthy . . . . . surely it is more obviously necessary for those who are failing in health and whose nutrition is imperfect, especially in the large groups of chronic diseases in which are marked dyspeptic symptoms . . . . . diseases of the stomach, bowels and liver, and directly and indirectly most heart complaints, the condition described as gouty and rheumatic, and all those in which there is wasting, or a tendency to waste.

Quite apart from the definite evils following the swallowing of lumps of food, or food imperfectly mixed with saliva, is it not obvious in these cases that, whatever else we do, it is only by attention to mastication that we can hope to improve impaired nutrition? It is quite common for patients to be supplied with a list of articles of food that they must or must not eat, but I find it necessary to tell them, 'It is far less important what you eat than how you eat it.'"

The following case is taken from the *Medical Record,* and is reported by Dr. Brandon:—

"Mrs. S. J. W., age 34 years, had always enjoyed the best of health previous to her present trouble. Was suffering almost continually with neuralgia (facial), also dyspepsia, and, as she termed it, sick-headache, nervous prostration, loss of sleep, irregularity of the bowels, etc., etc., so bad that she was compelled to keep her bed for days at a time. She had employed many physicians, with only temporary relief. Upon examination, could detect no constitutional disturbance that could be attributed as the cause of her trouble. But noticing her foul breath, requested to examine her teeth, which were found in a bad condition, several broken down, others with the gums falling away, and so on. Requested her to have the offending members removed. She objected, as it would hurt, and went to another physician for treatment, but finally returned, when, upon assuring her that it would be a great help, she consented to the operation. All the irritated and irritating teeth were extracted. When asked if I was not going to prescribe for her, informed her I was not. Three months later she informed me that she had enjoyed splendid health since the operation."

Wallis, of London, England, who was one of the original investigators of the conditions of school children's mouths, is of the opinion that diseased mouths in children have a most detrimental effect upon the health. *The British Journal of Dental Science* quoted him as follows:—

"He had considerable opportunity in the last few years of watching the effects of oral sepsis in London County Council school children. In certain schools there were dental charts showing the weights and the average ages of the children, and these clearly showed that the children with the most septic (diseased) mouths were not only below the average weight of their class, but were below the average intellectual status of their age. Those with the most highly septic mouths were frequently two standards below what they ought to be in accordance with their age. With regard to oral (mouth) sepsis, it has been his plan at the hospital to have the patients weighed weekly after wholesale extractions of teeth, and, in spite of their being left unable to masticate their food, they progressively increased in weight, and at the end of a few months they had in nearly all cases gained several pounds. That seemed to show that the really serious matter was not so much the want of mastication as the fact that they were constantly swallowing the products of decomposition and the micro-organisms of disease."

Swallowing food before it is properly masticated is generally supposed to be a habit only, and, while it does become a habit, it is frequently necessitated by a tooth which has a large cavity, and which is tender, or an inflamed tooth which has a swelling at the root, and which also is tender. It is impossible to masticate the food properly if too many teeth have been extracted, or if the teeth are decayed away, leaving only the roots. If the food is not masticated a sufficient length of time the proper amount of saliva is not mixed with it, which is necessary to digest certain elements in the food. When food, imperfectly masticated and improperly mixed with saliva, is swallowed, fermentation is soon established, with the formation of gases, which cause discomfort or pain. Proper mastication cannot be accomplished without good teeth. Normal digestion is impossible without proper mastication. Perfect assimilation is impossible without normal digestion, and without proper assimilation there cannot be sufficient nutrition. True, there are a great many who are strong and healthy, and who have few teeth or none at all, but these persons are exceptions. A popular slogan runs thus: "Chew your food, your stomach has no teeth."

Mr. Peter Danial, the well-known surgeon of London, England, in speaking of his experience with diabetic patients, says that, in his opinion, this disease occurs most frequently in people who neglect the care of the mouth.

It is also recognized that a great many nervous affections, some of which last for years, are due to unsanitary mouths. In patients about to undergo an operation, the part to be operated on is made thoroughly clean, and the surgeon has all his instruments disinfected, but if the patient's blood is infected from a diseased condition of the mouth, that infection being carried to all parts of the body, may, and very often does, infect the wound of the operation and cause blood-poisoning. Operations, especially upon the stomach or intestines, including the appendix, should not be undertaken until the mouth has been put in a thoroughly healthy condition, when there is time for it, otherwise the patient is apt to be infected by the swallowing of the disease germs which are in the mouth.

There is another condition of the mouth which is almost entirely unknown to the general public—a condition which, while not common, has far-reaching effects when it does present itself. It is a result of impacted teeth. An impacted tooth, instead of growing into the mouth in the regular way, is lodged entirely in the jaw-bone. It is often caused by the teeth growing sideways in the jaw instead of growing into the mouth. It does not appear through the gum at all. The tooth, by taking up a position and occupying space which was not intended by nature, causes a pressure on the nerves, resulting in a severe nervous irritation. The results of this irritation in various parts of the body are very many; there may be pain around the tooth or pain elsewhere, as in the eye, the ear, etc., or the trouble may manifest itself in the form of insomnia, melancholy, or insanity. Prof. H. N. Upson, in the investigations into the relationship of dental diseases to moral aberration, found that irritations of practically a painless character were frequently responsible for moral deficiencies, just as they were for mental deficiencies.

"In the course of an investigation into the subject of impacted teeth as a cause of insanity," says the Professor, "I examined eighteen of the younger inmates of the Cleveland Workhouse with the special view to the impaction of teeth. Of the eighteen cases, ranging from eighteen to twenty-five years of age, twelve showed multiple impactions (of teeth)."

He reports the following cases:—

"A robust mechanic, age 28 years, three weeks before being seen had been moodily accosted by his wife, who said that she believed she was losing her mind. It immediately occurred to him that he might be losing *his* mind. He slept little that night or the succeeding nights, gave up his work, and spent his days in fear of the asylum. Tonics and assurances were of no avail. The only lesion that could be discovered was dental caries. The filling of a deep cavity extending into the pulp of the tooth was followed by prompt recovery, and he returned to work. At no time had there been toothache or other pain, but dizziness and sweating had been noted."

"An unmarried woman, aged 27 years, a teacher, for a year had been profoundly melancholy, with intractable insomnia, delusions of various deadly sins, and entire hopelessness of recovery. Restlessness was extreme; tonics and local uterine treatment were of no avail. As a last resource the teeth were examined. They were apparently in good condition. An X-ray showed, however, an impacted right upper third molar tooth pressing against the second molar—a condition obviously capable of causing irritation. The tooth was removed, and in about a week the symptoms began to improve. Recovery was complete in six or eight weeks, and has persisted for six months."

He says, further: "The inference is warranted that the teeth in melancholics, neurasthenics, and those afflicted with insomnia should share the honors of a medical examination equally with the contents of the chest, abdomen and pelvis, and, when diseased, should be cured."

Another case, ". . . . . one of insomnia and mild melancholia in a merchant of 40 years of age. Trouble began four or five years ago in occasional attacks of sleeplessness and mental depression. Two years ago depression and insomnia became persistent and annoying. At times depression was followed by elation, also attended by insomnia. These conditions were improved by rest, and became worse by work and worry. Had no headache, no neuralgia and no toothache, except occasionally from an ulcerated tooth, which was relieved by evacuating the pus. Had parted with three molars during the last four years on account of abscess at the roots. An X-ray showed left upper third molar was impacted against the roots of the second molar, high in the jawbone. The second molar was dead, but showed no evidences of abscess. Both teeth were extracted. The patient made a progressive recovery. Sleep was better two nights after the operation. Depression has disappeared, and the patient has made a practical return to health."

A fourth case, ". . . . . is one of severe delusional and suicidal melancholia in a teacher of 27 years old. When first seen she had been profoundly melancholy for more than a year. Had persistent insomnia and many delusions that her mind was gone, had never been quite sane, and that she had committed various dreadful sins. Treatment by tonics, by suggestion, change of scene, and other treatment were of no avail. After a year of useless effort the teeth were examined, and found in apparently normal condition. X-ray showed an impacted upper third molar, which was removed. Patient had never in her life suffered from toothache or any other disease of the teeth or the jaws. She began to sleep well within a week or ten days after the extraction of the tooth. Her return to normal health was steady, and was typical in the fact that the delusions persisted longer than the melancholy. In such patients it is practically invariable that the emotional health is recovered first and the delusions are got rid of after. The only physical disease in this case was the impacted tooth, the other viscera throughout being healthy. The recovery has been complete."

The same results, only not to such a serious extent, may be caused by irregular or crooked teeth.

If unsanitary mouths are so common, and if they contain so many disease germs, it may seem strange that we are not infected with more diseases than we are. And so we should be but for the forces in our bodies which combat disease and render the germs harmless. These forces are spoken of as our powers of resistance, or our immunity from disease. A person may consume typhoid-infected milk or water for years, and finally, owing to a lowered resistance due to some cause, lose his immunity and fall a victim to typhoid. It is the same with many other diseases, the germs of which are found in the mouth. The person with a germ-laden mouth is taking the chance of getting almost any disease when his system is run down and his power of resistance is lowered. Also, he might carry the germs in his mouth, and, while not taking the disease himself, might transmit it to others through his breath or sputum. This was shown to be the case lately in this province when fifteen meningitis "carriers" were isolated from the rest of the soldiers at the Toronto camp during the outbreak of that disease there. Though some people might live a long life with the germs of a great many diseases constantly in the mouth, it would be extremely unwise for the rest of us to take such a chance. The germs of pneumonia are to be found in the mouths of one-third of us, but in order to contract pneumonia there must be a properly balanced relation between the virulence of the infection and our power of resistance.

With our present knowledge of the specific organisms of so many diseases, is it too much to suppose that each disease may have specific bacteria as its cause (with the exception, of course, of inherited defects and injuries)? Whether they all have or not, we know of a great many that have, and almost all of these may enter the system through the mouth, especially if that organ is not kept in a hygienic condition. As to the number of mouths that are unhygienic, Dr. Gilmore, of Chicago, an authority on this subject, says that 25 per cent. of the population are suffering from pus at the roots of one or more teeth. This pus may find its way into the stomach or intestines by being swallowed, or may be absorbed into the blood and circulated to all parts of the body. The health of any person with an unclean mouth is ALWAYS in danger. The time is sure to come, sooner or later, when, owing to a cold or other cause, the individual is "run down," and his power of resistance is lowered, and some serious illness is contracted, the infection of which came from the mouth.

To prevent as much as possible therefore, the contracting of disease, two rules must be observed. First, keep the mouth as free from bacteria as possible. This condition can best be obtained by the proper and regular use of the tooth-brush, using it in such a manner as to brush every part of the mouth, the spaces between the teeth, and the top of the tongue. Second, keep at a distance from those suspected of having unclean mouths, especially if they are in the habit of coughing or clearing their throats. The power of resistance can best be maintained by proper mastication of the food with a good set of teeth, and by closely observing the proper laws of living.

BULLETIN 243] [DECEMBER, 1916

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

[A Revised Edition of No. 124]

NATURE STUDY

PRESIDENT GEORGE C. CREELMAN.

"Father," said a country boy of twelve years, "I made five dollars to-day."

"Why, how was that, my son."

"Why, I took first prize in the Nature Study competition at the fall fair."

"Is that so? Tell me all about it."

"Well, you see, the Agricultural Society offers prizes now for what is called Nature Study work, and all of the schools in the county are allowed to try."

"And how many pupils entered the competition?"

"Twenty-three," said the boy, and he smiled as he said it.

"Well, what did you have to do?"

A School Garden.

"Oh, not much. Just picked out a lot of common things and called them by their right names."

"What do you mean?"

"Well, 'Dad,' this is just what we had to do exactly. First, one of the judges went into the main building and brought out a basketful of apples, all different kinds. He had taken one from each plate on exhibition there. Then he stuck a pin in each with a number attached and gave us a sheet of paper with corresponding numbers and told us to fill in the names of the different varieties."

"And did you all do it?"

"Not quite, but the ripe ones were easy. Some of the winter varieties had not colored up, and you had to distinguish them by their shape."

"And did you get them all right?"

"No, 'Dad,' I didn't. I missed the Ontario; I called it a Spy."

"How was that?"

"The color fooled me; but then, you know that Ontario is half Spy, anyhow, and this one must have looked more like his dad than his brothers."

"What are you talking about? Brothers and fathers among apples."

"Sure; don't you know the Ontario is a cross between the Wagner and the Spy?"

"Is that so?"

"Of course, I thought everybody knew that."

"Well, was that all you had to do?"

"No, sir, we started in next on the insects."

"Oh, bugs, eh?"

"Yes, bugs and other insects."

"Other insects? Aren't all insects bugs?"

"Why, 'Dad,' where did you go to school? Of course bugs are insects, but they are only one of the many orders. Beetles are not bugs, and grasshoppers are not bugs; and butterflies are not bugs; and we had specimens of all the orders. We had to pick them out and arrange them in groups, according to their mouth parts."

"Mouth parts? What do you mean?"

"Well, you see, all insects either bite or suck their food. Cabbage-grubs and grasshoppers and potato beetles eat right along like we do, but plant lice and the San José Scale and bed-bugs and ticks have a long snout, and they pierce the skin and suck the juice of the plants or animals."

"Well, what difference does it make how they eat?"

"Why, don't you see? The reason we study these insects is so as to know how to kill those that are injurious. If they eat the leaves, then by putting Paris green or some such poison on the foliage where they are feeding you kill them as they come along. But if they are 'suckers' they can stick their snouts right through the poison and get the juice from the inside."

"Well, how are you going to get at them?"

"By throwing something right on them, like dust, or pyrethrum, or kerosene emulsion, or lime and sulphur, and simply cover them with it and so fill up their lungs or breathing pores and they suffocate."

"And did you get all the insects classified?"

"No, sir, I missed one or two, but I'll know them next time, as the teacher went over all of them with us afterwards."

"And was your teacher at the fair?"

"Sure. He went through all the cattle sheds and horse stables and experimental plots and everywhere with us, and we picked out the different breeds, and he got several of the judges to tell us why they placed the prizes as they did. Our teacher says a boy may get just as much useful knowledge outside of school as he can in it, if he keeps his eyes open and gets a little help sometimes."

"And so you won the prize?"

"Yes, but I haven't told you all yet. We had to identify the bad weeds and the wild flowers and the different kinds of wood."

"All of them?"

"Oh, no, just about forty or fifty of each. Say, 'Dad,' how many kinds of trees can you name?"

"Who? Me? Oh, I guess I know all the common ones."

"How many, 'Dad'?"

"Oh, I don't know, not more than fifty, I suppose. Let's see. There's maple and beech and ash and oak and elm and birch and pine and spruce and hemlock and walnut and butternut. How many does that make?"

"Eleven."

"Is that all? Well, those are all the common varieties."

"Hardly. Why, we have seventy-eight different species in Ontario alone, and there are more kinds of native maples in Canada than you have named altogether."

And so the father's eyes were opened to the possibilities of the New Education, and he thought he could see now why his son was busy all of the time—morning, noon and night—and all day Saturday, making discoveries, adding to his knowledge, and seeking after truth. Only twelve years old, and already finding "Tongues in trees, books in the running brooks, sermons in stones, and good in everything." Such is Nature Study.

This bulletin is intended to stimulate an interest in the common things about us, and we send it out with that object only in view.

THE STORY OF A GRAIN OF WHEAT

DR. C. A. ZAVITZ.

A grain of wheat is very small. It is much smaller than the smallest clay marble that I ever made or that I ever saw. In fact it is so small that a little ant is able to carry it from one place to another. Boys and girls greatly enjoy making clay marbles. They can become very much interested also in trying to make grains of wheat out of clay and water. Even with the greatest of care and the best of success, however, only artificial grains of wheat can be made in this way. No

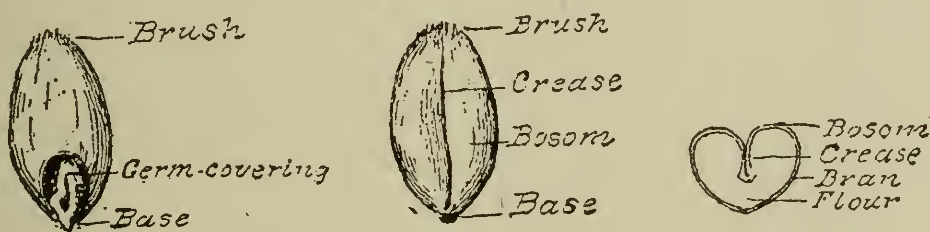


Fig. 1. Back view Front view. Cross section.

person, either young or old, can make a real grain of wheat; yet a real wheat grain is of much greater value and is of far greater interest for the boys and the girls to examine and to study than even the prettiest artificial grain of wheat which was ever made. Allow me to tell you a few of the many interesting things about a genuine living grain of wheat.

An average grain of wheat is about one-quarter of an inch in length, and one-half as wide as it is long. The hairy end is known as the brush, and the opposite end is usually called the base. Along the front side is a well-defined crease or furrow extending the entire length of the grain. This crease should be narrow and not very deep. The portion on either side of the crease is called the bosom, which should be large, plump, and rather smooth. The backs of some grains are curved and those of others are actually humped. Most grains have a slightly wavy appearance along the central part of the back, but some are so plump that the wavy appearance is scarcely noticeable. There is still another part to be mentioned, and that is the rough portion near the base and at the back of the grain. This is the cover-

Side view. Back view.

Fig. 2. Grain of wheat sprouting; four days in ground.

ing to the embryo, or germ, or seed proper. The embryo itself can be readily examined if you first soak the grain of wheat in water for about a day, and then carefully remove this covering. A grain of wheat is made up of three principal parts—the bran, or skin; the endosperm, or flour; and the embryo, or germ. The grain should be plump, the skin thin and nearly smooth, and the germ fairly prominent.

The great difference between a grain of wheat and a marble of clay lies in the fact that the former has life, and the latter has no life. Nothing can be done to induce a marble to grow. This is not so with a grain of wheat. As long as it is kept in a dry condition, it is simply sleeping. When it is placed in the ground at the right season of the year and surrounded with the proper amount of moisture, heat and air, it soon awakens. A great change takes place in a very short time. The grain absorbs water, the embryo swells and begins to grow, and in a few days a young plant is produced.

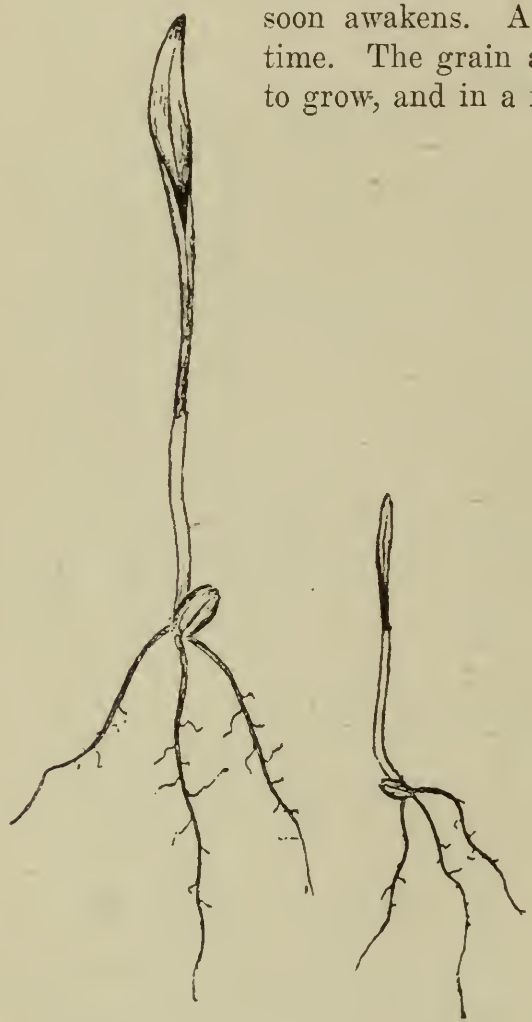


Fig. 3. Plants produced from grains of wheat of different sizes, nine days after planting.

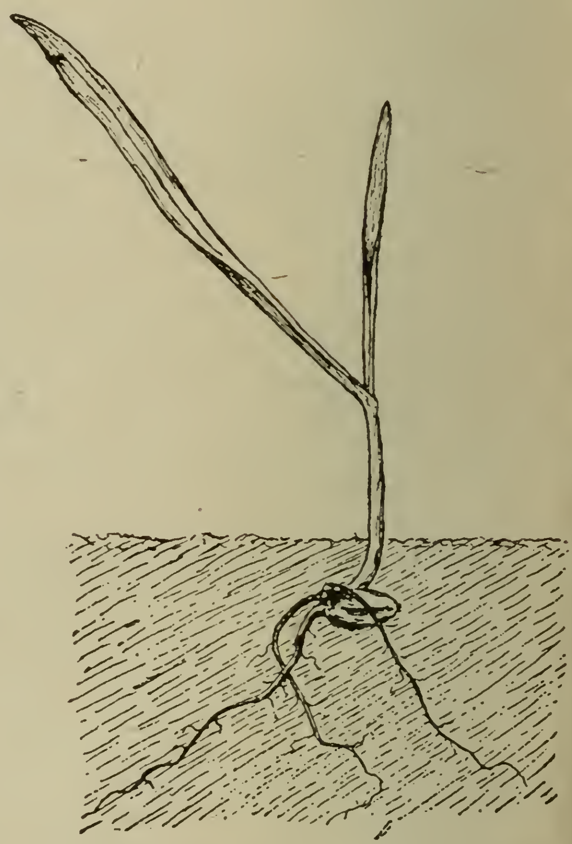


Fig. 4. Young plant of wheat thirteen days after planting.

The little plant at first obtains its food from the starchy part of the grain. As soon, however, as it sends its roots into the soil and its leaves into the air, it obtains its food from outside sources. The little, fibrous roots get food from the soil in the form of liquids, and the green leaves get food from the air in the form of gases. With the proper conditions, the plant makes a wonderful growth; and, as time passes, we observe the formation of several long, slender, upright stems, with a very interesting and peculiarly arranged head on the top of each.

Front view. Side view.

Fig. 5. Head of wheat, natural size.

An average head of wheat is about three and a half inches in length. It is made up of a large number of spikelets which are arranged alternately along the stalk. Each spikelet usually contains three flowers. The flower is small and is enclosed by two glumes, which afterwards form the

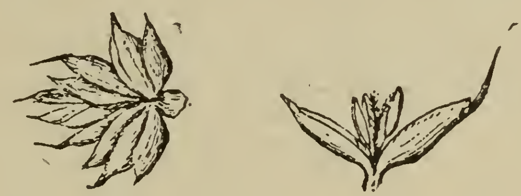


Fig 6. Spikelet of wheat. Wheat flower.

chaff. These glumes are sometimes blunt and sometimes elongated into awns or beards. The very interesting little flower, therefore, cannot be seen except by opening up the glumes, which can be readily done by means of a sharp knife or a pin. A small magnifying glass will greatly help in examining the various parts of the flower. The flower produces the seed, which at first is very small, but which grows rapidly and ripens in three or four weeks after the formation of the flower.

As the grain ripens the leaves turn brown and wither, the stems or straws change to a green or lightish yellow color, and the glumes become dry and harsh. From one seed which was planted we have obtained a well ripened plant, which is ready to be cut, harvested, and threshed, and will furnish us with straw, chaff and grain, all of which are useful.

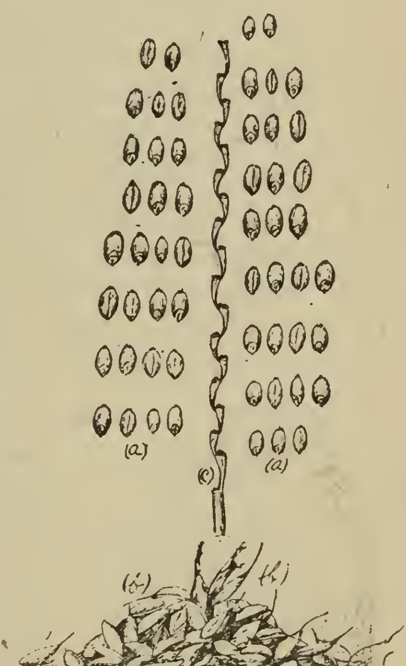


Fig 7. A head of wheat divided into three parts: (a) the grains; (b) the chaff, and (c) the centre stem.

I have touched on only a few of the points in connection with the life history of the wheat. The germination of the seed; the feeding of the plant; the growth of the leaf, the stem, and the head; the arrangement of the flower; the production of the grain—are all subjects which are very interesting and worthy of a person's close attention and careful study.

In view of the importance of the wheat crop, a large amount of experimental work has been done at the Ontario Agricultural College in order to glean information which may be of value in increasing both the yield and the quality of the wheat in Ontario. The results of these experiments have been published in bulletins which have been distributed among the farmers from time to time. Upwards of 300 varieties of wheat have been grown side by side on the College plots. These varieties possess many variations, and may be classified according to the time of sowing, as fall and spring; according to the structure of the chaff, as bearded and bald; according to the composition of the grain, as hard and soft; and according to the color of the grain, as red and white. There are other classifications also, but the ones here mentioned are the most common. Certain varieties of wheat are particularly well adapted for special purposes; some for the production of bread, others for macaroni, and still others for pastry, biscuits, breakfast foods, etc. For making flour, both the red wheats and the white wheats are used; but for the other three purposes, the white wheats are used almost entirely.

For the very best results in crop production, a selection of the most desirable plants from a field of the best variety of wheat should be made. From the grain obtained from these plants, none but the fully-developed, well matured, plump, sound grains should be used for sowing, with the object of producing grain of high quality to be used for seed in the following year.

As we grasp the meaning of the little verse,

> "Little drops of water,
> Little grains of sand,
> Make the mighty ocean
> And the beauteous land."

we can better realize how it is that little grains of wheat make up the world's production of about two and a half billion bushels, or of Ontario's production of about twenty-five million bushels annually.

Let no one despise the little grain of wheat, but rather let everyone give honor where honor is due, and gladly acknowledge its high position in the vegetable world.

THE STORY OF A LOAF OF BREAD

Professor Robert Harcourt.

Every one has seen and handled a grain of wheat. Each little grain is a store-house filled as full as it can be. In each of these little store-houses is everything that is needed to make our bodies grow. Some parts are useful in making bone, some in forming flesh, and some in forming fat, while others are useful in keeping up the heat of the body, and in giving us power to walk and run. Each grain of wheat contains everything that is necessary for all these different purposes. This is one reason why wheat is worth so much money and why we grow so much of it. The people over in England do not grow enough wheat for their own use; so we grow some for them and send it across the ocean in big shiploads.

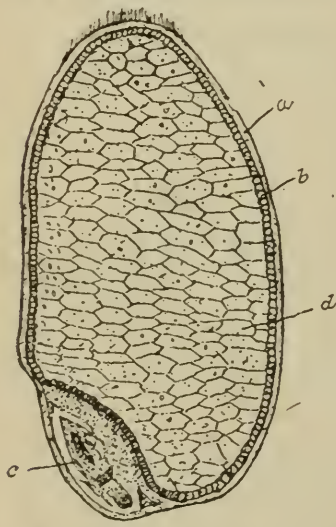


Fig. 1. Longitudinal section of wheat grain; (a) outer coverings; (b) aleurone cells; (c) germ; (d) endosperm, the part of the wheat from which the flour is made.

While we use a large amount of wheat, we do not like to eat it until it has been ground and made into flour. Long ago, when people first began to grind wheat, they crushed it between any two flat stones that happened to be near at hand. A little later they kept two flat stones specially for the purpose, one of which was fixed in the ground while the other was turned on it. Methods of grinding in pioneer days are illustrated in Fig. 7. When treadmills, windmills, and, later, water-wheels came into use, the grinding was done at mills by men who understood how it should be done. But in all these ways of grinding, all the different parts of the wheat were left together in the flour. Later the millers found a method of sifting out the coarser parts.

The grinding of the grain and the sifting of the flour have gradually been improved, until to-day we have mills covering acres of ground, and making thousands of barrels of flour each day. In these mills they are able to separate the different parts of the wheat, and can make ever so many different grades of flour.

You naturally ask: What is the difference between their various grades of flour? Are they not all made from the same wheat? Yes, they are; but to understand the difference we shall have to learn something about the different parts of a wheat grain. If we cut a wheat grain through from end to end, and place it, properly prepared, under a microscope, which is a wonderful instrument that makes things look larger than they really are, we shall see something like that shown in Fig. 1. If we were to cut the wheat crosswise, it would appear as in Fig. 2.

Around the outside of the grain, as you see in the picture, there are several thin coverings. Underneath these there is a row of cells tightly packed together, called the *aleurone* cells. These outer layers and the row of cells taken together form the greater part of the bran. The little egg-shaped part at the bottom of the first picture is the germ from which the sprout starts when the grain commences to grow. The remainer of the grain, known as the *endosperm,* is made up largely of starch and gluten. From a miller's standpoint, this part of the grain is by far the most important; for the object of milling is to separate the endosperm from the rest of the grain and grind it to flour.

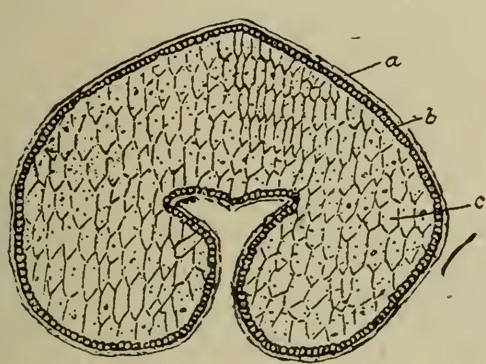
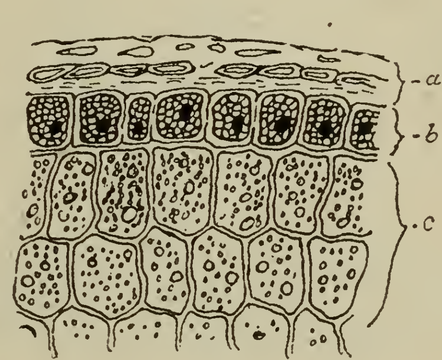


Fig. 2. Cross section of a grain of wheat; (a) outer coverings; (b) aleurone cells; (c) endosperm, the part of the wheat from which the flour is made.



A part of the section more highly magnified.

In the roller-process mills of to-day the wheat usually passes through six pairs of rollers before the grinding is complete. In the first, the miller seeks just to break the grain into pieces. After sifting, the coarse parts, called the "tailings," are passed on to the next pair of rollers, where they are flattened, and some of the floury substance ground off of them. This is also sifted, and the tailings passed on to the next rollers, where the flour is removed. After the wheat has passed through all the rollers in this way, the flattened pieces are almost entirely free from flour, and are classed as bran. Fig. 26 is a picture of a piece or "*scale*" *of bran.* In all such methods of grinding wheat the centre part is rubbed off first; and, being free from bran particles, it makes very white flour. This forms the grade of flour known as "patent." That got by grinding closer to the bran is known as the "baker's" grades. Still closer grinding forms the low grades of flour. Generally speaking, the more bran particles there are in the flour, the lower it is graded. The outer

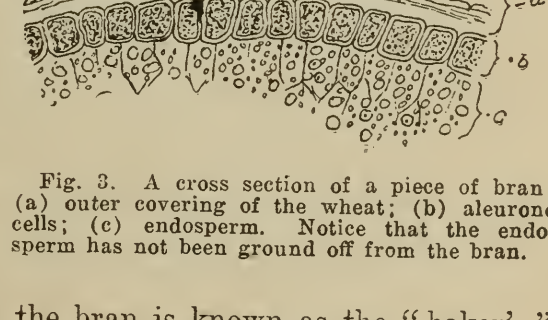


Fig. 3. A cross section of a piece of bran: (a) outer covering of the wheat; (b) aleurone cells; (c) endosperm. Notice that the endosperm has not been ground off from the bran.

part of the wheat, nearly all of which goes into the bran, contains much more bone-making material than the flour. Because of this some say that the "patent" and "baker's" grades of flour are not so good as the flour made by the old stone process. The Graham flour is supposed to be all of the wheat ground into flour; but it is hard to grind the bran so fine that it will not have a bad effect on man's digestive system. To overcome this there has been invented a machine which peels off the outer coat of the wheat grain. The remainder is ground, and is known as "entire wheat flour." Such flour is always dark in color, because the germ is ground with it; but it contains more bone and fat-producing material than flour made in any other way.

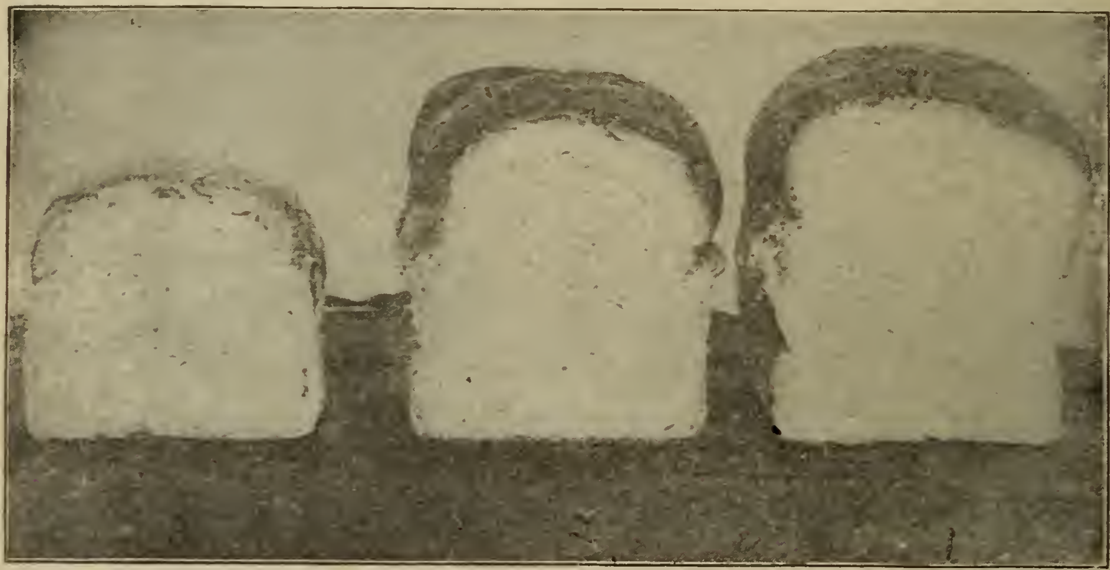


Fig. 4. Loaves of bread made from equal weights of flour: 1. From Manitoba wheat; 2. From Wild Goose wheat; 3. From Michigan Amber wheat.

It is very difficult to determine the exact quality of a flour; but there are certain general rules by which a good bread flour may be judged quickly. It should be white with a faint yellow tinge, and it should fall loosely apart in the hand after being pressed. When put between the teeth, it should "crunch" a little; or when rubbed between the fingers it should be slightly gritty. As flour is prepared, possibly there is no one point which determines its quality so much as the amount of gluten it contains. Some one asks: "What is gluten?" Have you ever made gum by chewing wheat? Nearly all children in the country have. The gummy part is gluten. If you have ever tried to make gum from oats, barley, or corn, you have failed; because these grains do not contain gluten. It is because wheat contains this substance that it is so much used for bread baking. If you take a little flour and add enough water to make it into a stiff dough, and allow it to stand for an hour, and then take it between your fingers and knead it in water, you will see the water get white with the starch part that is separating from the dough. Continue the washing until the starch is all removed. What remains is gluten. Notice how tough and elastic it is.

Some varieties of wheat contain more gluten than others. There is also a great difference in the quality of glutens: some are tough and can be pulled out like a piece of rubber; others are soft and break when pulled. The wheat which

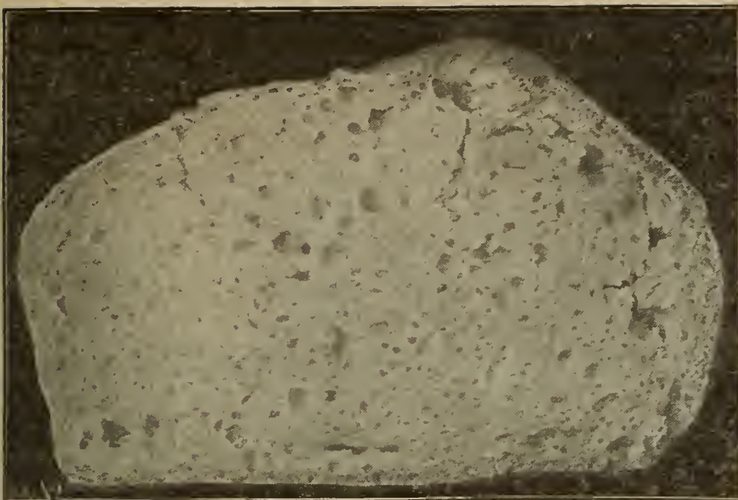


Fig. 5. Loaf of bread made from normal flour from which part of the gluten has been removed. Note the big cracks up through the loaf, from which the gases escaped without causing the dough to rise.

contains the most gluten of a good, tough elastic quality will make the best flour for bread-making. For this reason, what are known as Spring Wheats are usually better than those known as Fall Wheats. To illustrate this point, flour was made from three kinds of wheat—Michigan Amber, one of our best winter varieties; Wild Goose, a very hard Spring variety; and Manitoba No. 1 hard. These flours were made into bread and a loaf of each lot was photographed. The same weight of flour was used for each loaf. Fig. 4 shows the difference in size of the loaves. Manitoba flour made the largest loaf, one reason being because it contained more and better gluten than the others. Millers call a flour which contains good gluten "strong," and one that contains poor gluten, "weak."

Now that we have learned something about flour, let us see if we can learn something about the changes that take place when it is made into bread. If you have ever tried to wet flour with water you will have noticed how hard it is to get the flour all wet. That is because the flour is so very fine. One of the main objects of making the flour into bread before it is eaten is to separate these fine particles, so that the digestive fluids of the stomach may more easily mix with them. The baker commences by mixing the flour with water. He also puts in yeast or something that will produce the same effects, and mixes it all together so thoroughly that the water and yeast come into contact with each little particle of flour. When the paste, or dough, containing yeast, is set in a warm place, the yeast begins to "work," as we say, and the dough to "rise." The yeast causes changes, one of the principal results of which is the production of a gas. This gas, in trying to force its way through the dough, comes into contact with the tough elastic gluten which spreads out and holds the gas in so as to form little bubbles, and thuse causes the dough to rise. In this way the fine particles of flour are separated from one another. The tougher and more elastic the gluten, the better the dough will rise, and the lighter the bread will be. This is where good gluten is valuable.

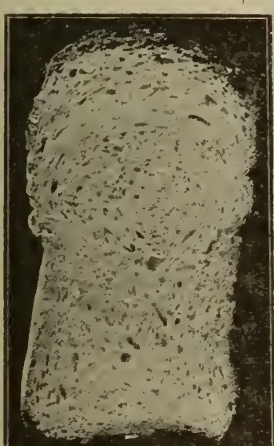


Fig. 6. Loaf of bread made from normal flour.

Take a slice of bread and examine it carefully. Notice the little openings or holes in it. These little holes were formed by the gas being held in by the gluten as just described.

If too much yeast is added to the flour too much gas may be formed, and, if improperly handled, the openings will be very large, or the gas may even spread out the gluten so far that the walls of the bubbles may break.

If the gluten is all or partly removed from the flour, the dough will not rise, because there is nothing to keep the gas in, and we shall have a loaf like that shown in Fig. 5.

After the yeast has worked enough, the dough is put into a hot oven. Here the heat kills the yeast, and causes the gas to expand and stretch out the walls of the little bubbles, or pockets, which it formed between the particles of dough, and changes some of the water into steam, thus raising the loaf still more. The heat on the outside of the loaf converts some of the starch into *dextrin,* a gummy substance with a sweetish taste. This is why the crust is sweeter and tougher than the centre of the loaf. The harder the loaf is baked, the darker the color, through the changing of some of this dextrin into caramel, which is a form of sugar. Some bakers moisten the top of the loaf with water, or water containing a little sugar, to

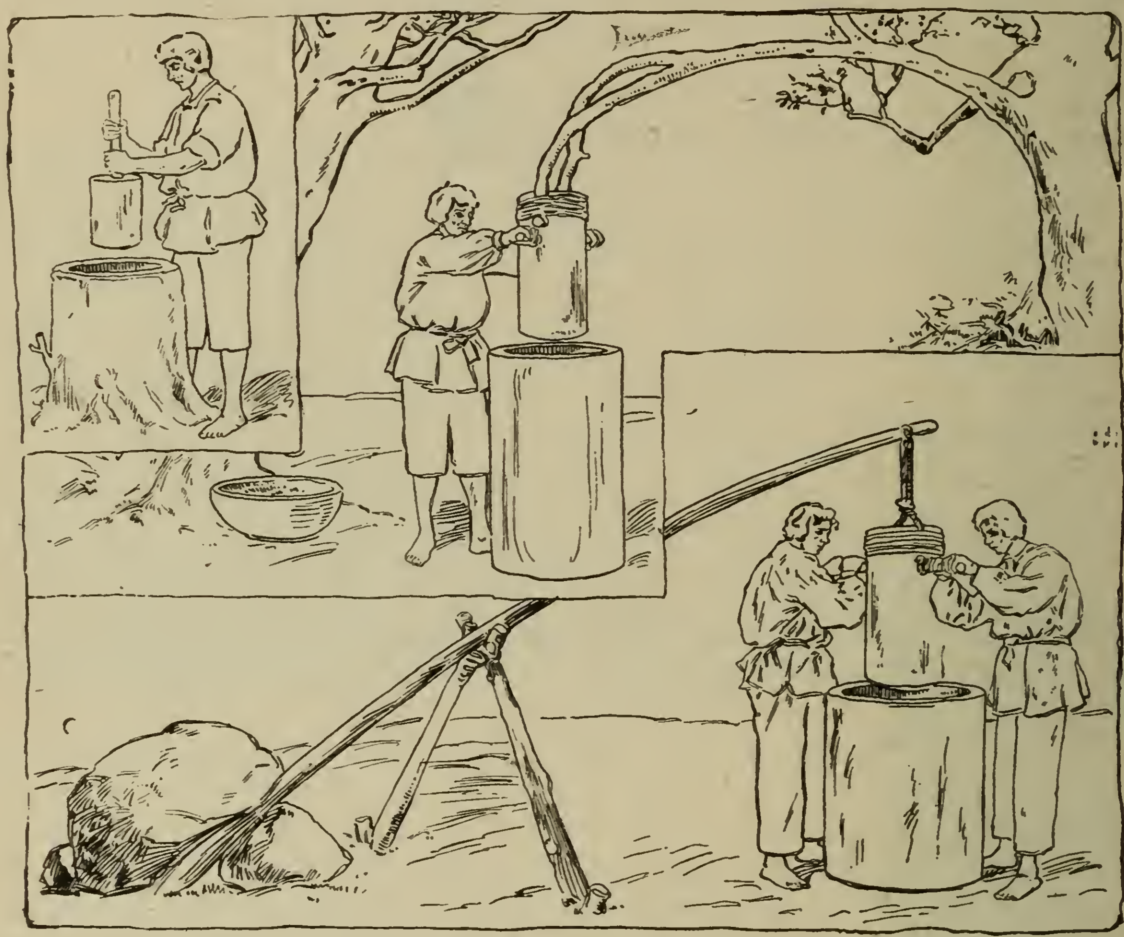


Fig. 7. In pioneer days.

develop caramel, and to give the loaf a darker and richer color. Both dextrin and caramel are soluble in water; and, therefore, they are easily digested. This explains why the crust of bread and toast are sweeter than the soft interior of the loaf, and also why they are more easily digested.

DAIRY STORIES

PROFESSOR H. H. DEAN.

A QUART OF MILK.

Milk is a complete human food, especially for children. Grown-ups might use milk more largely than they do. Instead of putting a small amount on porridge for breakfast, or in tea or coffee, and using little otherwise, it may form a part of every meal. A quart of milk is equal in food value to about one pound of meat or eight eggs, each of which cost from 20 to 25 cents, whereas the milk costs but 8 to 10 cents. Milk is not only a complete food, but it is a cheap food.

Cows' milk is most generally used for feeding boys and girls, because cows' milk is most nearly like human milk and because the cow gives a large flow of milk —much larger than any other animal, hence it is profitable to produce milk for sale from cows.

We do not know exactly how milk is made, but it is probably made from blood by the action of nervous force; hence a good cow has a plentiful supply of blood, and is always more or less nervous. She should be treated kindly at all times if she is expected to give plenty of milk.

Blood is made from food and water, therefore the cow giving milk must be supplied with plenty of pure food and pure water. The best foods for milk production are grass, corn silage, clover hay, roots, wheat bran, oats and oil-cake. The cow should receive all the grass she can eat in summer, and all the corn silage, clover hay and roots, preferably mangels or sugar beets, she requires in winter. In addition, she may be fed from four to eight or more, pounds, daily, of bran, oats and oil-cake, mixing these in proportions of about three parts each of bran and oats, and one or two parts of oil-cake.

The manger and watering place of the cow should be kept clean. The best arrangement for winter feeding and watering is a combined manger and water trough made of cement, and having temporary divisions made of steel to keep the feed for each cow separate. These divisions are easily swung up while the manger is cleaned.

The cow, stable, feed, water, milker and all utensils must be clean, in order to produce milk fit for humans to drink.

The cow and all persons handling the milk must be free from disease germs of all kinds, as milk is an excellent place in which disease bacteria may grow.

As soon as milk is drawn from the cow it should be strained and cooled to 50°F. or lower, to prevent souring.

There are three grades of milk commonly offered for sale—Raw, Pasteurized and Certified.

Ordinary raw milk is most commonly bought, because it is cheapest. However, this is not always a "safe" milk, hence the modern method of pasteurizing, in which milk is heated to about 140°F., held for twenty minutes at this temperature, then cooled to 45°F., and kept cold until delivered. This is the *safest* kind of milk which can be purchased by the ordinary consumer.

Certified milk is the highest grade of raw milk. It is produced from cows free of tuberculosis, and under conditions which are especially sanitary. Usually, however, this class of milk is high in price.

Milk should be exposed to the light and air as little as possible, as it was never intended to see daylight or mix with air. Nature intended it to pass directly from the cow's udder to the calf's stomach.

Milk and cream are best kept, so far as possible, in a tightly-closed milk bottle and in a cold place—in a refrigerator or cellar. No more milk or cream should be emptied into a pitcher for table use than is likely to be used at one meal. If any be left over this should not be emptied into the milk bottle, as it will likely sour the whole supply.

Glass milk bottles should be washed as soon as empty and be promptly returned to the milkman. These bottles should not be used for any other purpose.

The mono-service, or one-service bottle, made of sterilized paper, coated on the inside with wax, is the best form of milk bottle. It is destroyed as soon as empty. In this way there are no bottles to break or wash, and little danger of spreading disease from infected stables or houses, by means of the milk supply.

Boys and girls should drink plenty of pure milk, as this tends to build strong bodies and make active minds.

A POUND OF BUTTER.

The oil of butter is especially well adapted for oiling the brain. Brain-workers should use plenty of good butter and never any of the substitutes for cow's butter, such as "oleo," "peanut-butter," etc.

Butter is "concentrated sunshine," hence good butter tends to make people more "sunshiny" in disposition. It is also a "heat producer," and may be used more largely in winter when the weather is cold. It furnishes energy to do physical and mental work.

Butter consists of the tiny milk-fat globules (so small that it requires about ten thousand of them lying side by side to make a line an inch long) which are massed, or packed together, by means of a churn. After massing the fat globules, the butter-milk is removed, the butter is washed with clean cold water, salt is added to taste, then the butter is worked to mix the salt through the butter, expel the surplus moisture and to make it compact for printing or packing.

The finest flavored butter is made from sweet cream, and the butter is salted very lightly. Such butter has the true "creamy," natural flavor of fine butter. Ordinarily, however, after the cream is separated from the milk by setting it for twenty-four to thirty-six hours in shallow pans, or deep cans, or by running the milk through a cream separator, the cream is soured or ripened, making what is known as ripened or sour cream butter.

Butter for local markets and home use is best made into prints weighing one pound. All farm dairy butter, put up in prints or boxes must be branded with the word "Dairy," and such butter may not have the word "Creamery" on the wrapper or package.

Butter made during the summer may be packed solidly in an air-tight package (crock, tub, or box), and if kept in a cool place this will be quite palatable in winter, when butter is scarce and dear. The months of June and September are usually the best months for packing butter.

Good butter is a wholesome food, and should be used largely on the tables of Canadians. Butter substitutes should find no place in Canada.

A POUND OF CHEESE.

Cheese is a very rich, concentrated, muscle-forming food. It is similar in composition to meat, and may be used instead of meat, which is usually high in price. Cheese may be eaten once a day with profit. It may be eaten uncooked, or be cooked in a variety of ways. A pound of cheese is equal in food value to about two pounds of meat, and costs only about half as much. Fruit should always be eaten with cheese.

Cheese is made largely from the casein, fat and water of milk by coagulating (curdling) the milk with rennet or pepsin. Any person can easily make cheese for home needs, with simple utensils, which are nearly all found on farms. Rennet may be made from a calf's stomach, by soaking it two or three days in salt water. A hoop for moulding the cheese can be made by a tinsmith, or be made out of wood—square, oblong, or circular in form. The cheese may be pressed with a scantling, having a weight at one end.

To make a cheese, weighing from eight to ten pounds, use eight or ten gallons of sweet milk. Heat this in a clean boiler to 86°F. Then add about six tea-spoonfuls of strong rennet and stir it well through the milk. Then allow it to stand until it thickens, when it should be carefully cut into small cubes with a long knife; or with a regular curd knife or knives. Next heat to 96°F. by placing a can of hot water in the curd and whey, or heat slowly over a fire. Allow to stand for about three hours, then remove the curd from the whey and place on a slanting table covered with a clean cotton cloth for draining. When the curd feels firm apply two to four ounces of salt, mix through the curd, then put into the hoop or mould and press gently at first. When firm, cover with a clean cotton cloth, and place in a cool place, turning the cheese daily for two weeks. When about a month old the cheese will be ready to use. If the cheese moulds, wash with salt brine or spray with formalin. Dipping in, or coating the cheese with, hot wax prevents drying and moulding.

Cheese may also be made from skimmilk, buttermilk and cream. These are usually classed as "soft" cheese. The ordinary cheese is known as a "hard" variety.

THE STORY OF AN EGG

Professor W. R. Graham.

Every one is familiar with the size and shape of an egg; but very few of us stop to think how wonderfully it is made. We all know that the contents of the egg are enclosed in a shell. This shell appears to be hard and solid, but this is not the case. True, it has much strength; but we find upon examination that it is full of little holes. These small holes allow the air next to the shell to get into the egg. Thus it will be seen that we should keep the egg in a clean place, away from dirty straw, such as we often see in the nest; also away from strong smelling substances, such as onions; otherwise these strong odors, passing through the shell, will affect the taste of the egg more or less.

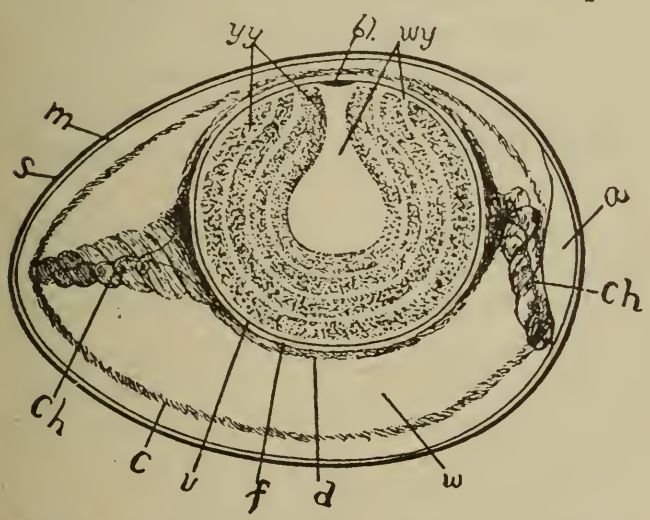


Fig. 1. Diagrammatic section of an unincubated fowl's egg (bl) germ spot; (wy) white yolk, consisting of central flask-shaped mass, and a number of layers concentrically arranged around it, the outer layer of white yolk lying immediately beneath the vitelline membrane, and connected with the central mass beneath the blastoderm; (yy) yellow yolk; (v) vitelline membrane; (f) layer of more fluid albumen surrounding the yolk; (ch) chalaze; (a) air chamber between the two layers of the shell membrane; (m) shell membranes, where they lie in contact over the greater portion of the egg; (s) shell; (d) denser albumen, which extends around the yolk, outside of the internal layer of more fluid albumen; (c) boundary between the outer and middle portion of the albumen.

Next to the shell is a thin tissue. This tissue is made of two layers all over the egg, except at the large end, where they separate, forming a small open space, called the air-space. This air-space increases in size as the egg evaporates or dries. The longer the egg is allowed to remain in the air, the more air will pass through the shell; and each little particle of air carries away with it some of the moisture of the egg and thus the contents dry up and the air-space increases in size. Sometimes eggs that have been left exposed to the air in a nice clean place for a year, are found to have very little content; and that which is left is dry and almost hard. These tissues may be pulled off the shell, especially in the case of a hard-boiled egg.

Now we come to the white of the eggs, or what is called the albumen. This is said by doctors to be a very good food: but we are particularly interested in its appearance. So let us break an egg in a saucer. Notice that the white on the outside is thin and watery; in a little farther, we see a grey or whitish streak that extends all the way around the yolk or yellow portion, but does not touch it. You will also notice that at each end of the yolk and extending from this whitish portion is a knotted portion, like a little piece of white string. We wonder what these are for, and observe that they are simply an extended portion of this first white streak as mentioned. Inside the white streak is another watery portion. This comes in touch with the yolk. We shall now look at the yolk. Take your finger, or a blunt pencil, and try to turn it over, and you will notice that the covering of the yolk goes into all sorts of wrinkles and folds. So we find that the yolk is separated from the white by a thin layer of tissues or skin.

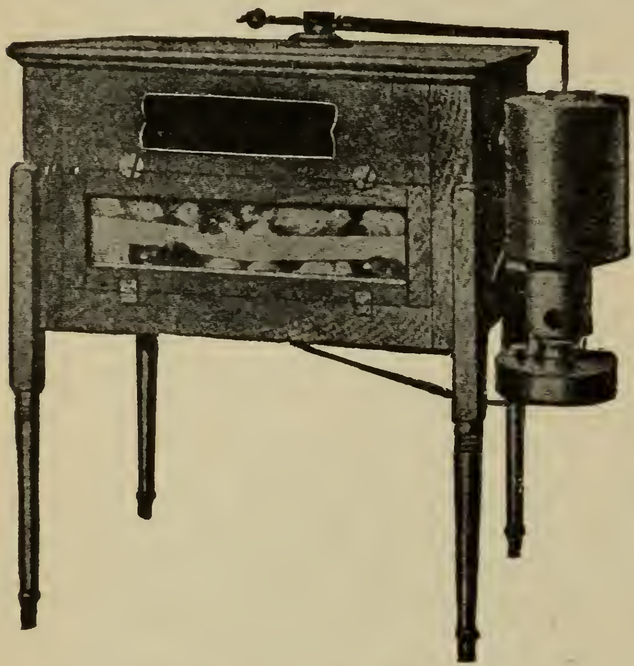


Fig. 2. An incubator.

If you have been careful in breaking the egg, you will notice a little round spot at the top of the yolk. This spot is about the size of a pea, and is called the germ spot; and it is from this that the chicken grows when heat and other conditions are properly applied.

To study further the structure of an egg, we will have one boiled hard, and, after removing the shell and lining tissues, we will tear loose a small piece of the white at the larger end of the egg. Now, by continuing to pull the torn portion from the left towards the right, you will notice that this white has a spiral arrangement. This is generally considered as giving strength to the egg.

We will next examine the yolk. Take the yolk out, cut through the centre, using a very sharp knife and you will notice a small, flask-shaped portion of the yolk, which is soft and light in color, and that the neck of the flask extends to the outer edge of the yolk. Upon this the germ rests. The hardened portion of the yolk, you will notice, is arranged in regular rings around this flask. This flask-shaped portion is lighter than the rest of the yolk, and is therefore always uppermost. No matter how you turn the egg, this spot will be on the upper surface.

Fig. 3.

Let us ponder for a few minutes over the many things we have found in the egg content. The germ, resting upon a nice soft cushion in the yolk, the yolk covered with a thin skin, adjoining this is a very thin portion of the white, and outside this a thicker portion. Now these two portions hold the yolk in position. If a sudden jar occurs, the yolk, or chiefly the germ, is protected by the skin of the yolk. The thin white portion acts as a pad or cushion, and the thick white portion holds it steady. Those extended cords of the thick layer of the white act as the axis of the yolk holding it in position; and, as you turn the egg around quickly, you twist the cords similar to twisting a string, with the result that, as soon as the egg is steady, these cords unwind, and help to right the germ spot on the upper surface again.

No doubt by this time you are wondering, if this germ spot and the portion of the yolk under it are so light, why the yolk does not come right up against the tissues lining the shell. But nature has guarded against this by the thick layer of albumen, which always tends to hold the yolk in position. Sometimes when the egg is left for weeks in the one position, the thick layer is overpowered, and the yolk touches the wall of the shell. If the yolk remains against the wall any length of time, it appears to become fastened to it, after which you cannot successfully hatch a chicken from the egg. Being fastened in one position, the germ cannot move properly in order to develop, the result being that the germ dies. You may say a hen sitting on eggs never moves them, but in this you are mistaken. The next hen you set put a large pencil mark on each of the eggs, and place the eggs under the hen with the pencil marks uppermost. Next day lift the hen, and you will see that she has altered the position of the eggs.

We have to imitate the hen in running an incubator, in that we turn the eggs twice a day. But some one asks, what is an incubator? Well, it is simply a well-built box, heated by a lamp, and the heat evenly distributed over all parts of the interior, so as to give the eggs the same temperature. This box is not exactly air-tight, for you know that if this little germ inside of the egg is going to develop into a chicken at the end of twenty-one days, it must have air. This air, you will remember, passes through those little holes in the shell, the good air going in, and the foul air coming off in much the same manner as you breathe. Now, you will see we have this incubator ventilated in order to supply the little germ with pure air. There is another point we nearly overlooked, that is the temperature.

If you will place a thermometer under a hen you will notice that it reads 103 degrees; so we try to run the incubator at that temperature.

If any of you would like to see that the germ-spot always stays next to the surface, you can readily do so by taking a lamp after dark and going to a hen that has been sitting four or five days. Wrap a black cloth around the lamp chimney, but first make a hole in the cloth, much the same shape as an egg, and have the hole exactly opposite the blaze of the lamp. Put the lamp on a little box, the hole facing you. Now very carefully remove an egg from under the hen, taking great care not to turn it over. Place your finger at the ends of the egg and hold the egg in front of the light coming from the hole in the cloth that is around the chimney. If the egg is fertile you will see a dark spot, and from this a number of little veins running in different directions. This is the germ, and it has started to grow. Now turn the egg slowly around, and you will observe that the germ moves as you turn the egg, always resting near the surface. It is best to take a white egg to see this as white eggs are clearer than brown ones and the germ is more readily seen through them. Should the egg appear clear, or no dark portion be seen, it is infertile, and will not hatch.

THE STORY OF THE RAINDROPS

Professor Wm. H. Day.

Little drops of water,
  Falling on the sand,
Make a bounteous harvest,
  In the beauteous land.

As the drops of water reached the ground consciousness returned, and one said to another, "Why, I have been here before." "And so have I—and I—and I," came in chorus from thousands of their companions. "Say," said the first, "let's have an experience meeting and each tell as nearly as he can remember what has happened to him since we last met here." A general clapping of hands as they danced upon the ground signified the great delight at the prospect.

"Well," said the first drop, "it is years since I was here last. On that occasion, the 20th of August, 1904, I was the first to reach the ground and as I approached I could see it was very dry and parched. It was three weeks since rain had fallen; and as the plants were beginning to show signs of wilting, I thought the supply of water in the upper portion of the soil was exhausted; and it would seem so from first impressions, for as soon as I touched the ground a thousand tiny specks of earth exerted an attraction upon me, and almost before I knew what was happening each was surrounded by a very thin coat or film of water, all made at my expense. But I noted that the grains of earth lying a trifle lower in the soil were more easily satisfied than those at the surface; and upon examination I found that the soil actually contained between seven and eight per cent. of water by weight."

While No. I had been talking he had been observing the various expressions on the faces of his comrades; and while many countenances had not yet brightened in the sympathy of common experience, still as he proceeded, many assenting nods did tell him that the majority of the meeting were with him, but as he mentioned the per cent. of water in the soil when the plants wilted, he could discern that his experience was no longer general, and he paused for discussion upon the point.

"The soil upon which I fell," said No. II, "was of a sandy nature, and contained only about 2 per cent. of water when the plants wilted. The soil referred to by No. I must have been a loam, *i.e.*, about half sand and half clay."

"It was," said the leader.

No. III had observed that in a heavy clay soil the wilting point was about 10 per cent. of water, while No. IV had fallen on a muck soil and was able to add that the wilting point in it was 30 per cent.

"No. I, No. I," was heard on various sides, and the leader proceeded:

"I only had time to observe the condition of the soil when the shower of drops became general. Thousands of them fell almost in the same place as I had, but they sank much more quickly into the soil."

"Yes," said No. V, "that's because water moves much more easily through damp than through dry soil; you had opened the way, so to speak, and we took advantage of it; but remember we too had our share of pioneer work, for we had to begin the moistening process where you left off."

"Being near the surface," said No. I, "I made an observation which may have escaped many of you who were carried lower down. The shower had not lasted long before I noticed that the rain was falling faster than it could find its way into the soil, and some of it began to move slowly down the gentle slope towards a small creek in the low-land meadow. At the same time I saw in some places small bubbles of air coming out through the layer of water on the surface. This seemed strange to me at first, but as I meditated a little I realized that it must be so where soil is not under-drained, the air that fills the spaces between the grains of soil must escape as the countless drops settled down and spread themselves over the surface of the grains, thus diminishing the free space between. Then it occurred to me to enquire what quantity of air the soil was capable of holding, when dry, and by careful investigation I found the loam to be almost exactly 50 per cent. pore space. I suppose you, who fell upon other soils found varying pore space?"

"Yes," said No. II, "the pore space in the sand was only a little over 40 per cent."

"Clay, 48," "Muck, 53," came from No. III and No. IV in succession.

"What a lot of air there must be in the soil when it is dry," said No. VI. "I was one of those drops that were unable to enter the soil and ran toward the creek. It had not occurred to me to enquire about the soil conditions. Does the water in the soil when saturated correspond with the amount of air when dry?"

"When the rain has just ceased it does," resumed No I, "but the soil is not capable of maintaining those conditions—some of the water being free, *i.e.*, not held in films on the soil grains, gradually settles down until it finds unsaturated soil and is absorbed thereby, or else finds some outlet either natural or artificial."

"I was one of those 'free' water drops," said No. VII, "but it was during the shower of August 25th that I fell. After lying almost motionless for several days, I felt myself moved slowly sidewise by some gentle influence until at last reaching the low land, I passed through a joint and found myself in a tile drain with thousands of others, some of whom entered with me, but others of whom entered farther up. I found the grade of this drain to be 2 inches in 100 feet, and it was interesting to see the current's action on the grains of sand that from time to time entered through a joint as we passed by. Try as they would, sometimes even placing themselves on their flattest, broadest side, these grains could not find a lodging place—the velocity of the water was always just sufficient to keep them slowly rolling. Then I thought to myself, this is the true test of safety in a tile drain—the grade must be steep enough to keep sand rolling; and as I watched more closely I came to the conclusion that anything less than 2 inches in 100 feet would hardly do, for sometimes the larger grains would rest a moment as if anchored at last, but only to be moved on again. Each tile was 13 inches long, and as I passed a joint every second I was travelling slightly faster than a foot a second. At this rate it didn't take us long to reach the creek, the same one that many of our surface comrades sought soon after the shower began. Once in the creek, my journey was more rapid, and in a few hours we reached the south branch of the River Speed. The current was sluggish at the point of junction, so we moved slowly for many days, often resting in a quiet pool shaded by the bushes of the southern bank, or basking in the sunshine on a northern shoal. In these spots we met many of those drops who had hurried away to the creek so long before us."

"Those must have been halcyon days," broke in No. I again; "but I must go back to my story. The rain began with a heavy shower in the afternoon, but soon it slackened to a moderate fall which continued throughout the night. I had been in many rains, but that seemed the heaviest of them all. I have often wondered just how much rain fell during the twelve hours of that wet night."

No. VIII was a modest drop, who up to this time had taken little interest in the narratives, but at this remark he brightened up. "Why, I can tell you," said he. "I, with many others, fell into the College rain-gauge, and as the depth was measured next morning I listened for the reading—2.13 inches—and I also overheard the remark that during nineteen years that was the greatest fall recorded in any single day at the College. After the measurement was taken we were all poured upon the ground. But, No. I, you were going to tell us the amount of water the soil can retain after the free water has drained away."

"Like other properties, this depends upon the kind of soil. The loam held 44 per cent. by volume, showing that of the 50 per cent. pore space all was then full of water but 6; hence the quantity of air in the soil was comparatively small. What about the sand, No. II?"

"It retained 27 per cent. by volume of water."

"Heavy clay, 43 per cent."

"Muck, 49 per cent."

"Those are astonishing figures," put in No. VI. "They mean that if loam, clay and muck were dry, it would take between five and six inches of rain to saturate them one foot deep. Why, in the first five feet of soil there must be fully two feet of water, if all the little water films could be taken off the grains and put in a vessel for measurement. I had no idea that the soil could retain so much. I wonder what becomes of it all. I remember No. I said that when we reached the ground on the 20th it was very dry."

"Oh, it's all needed during the growth of the next crop," resumed No. I. "You see, this shower of which we are now talking, fell after the harvest. There was much rain during the next few days, so that the soil was pretty well saturated by the 25th, when No. VII began his career down through the soil to the drain, creek and river. Many of us, however, remained in the soil throughout the autumn, winter and spring, hibernating, one would think, but not growing lean as does the bear through his long sleep. We were really very busy and useful though we do say it ourselves. To begin with, we set about the task of bringing into solution certain portions of the soil known as potash and phosphoric acid, with which to feed the plants during the following summer. While the work was going on, however, the weather grew colder, and on November 5th 'the ground froze up,' as I heard people say. It was a strange sensation to feel our warmth irresistibly stealing away, but by and by we seemed to reach a steady temperature and we thought the worst had come. It was only a delusion, however, for soon, without any further change in temperature, we felt ourselves passing through some transition stage, some new state almost insensibly creeping over us, which, while it did not change our temperature, was nevertheless robbing us of our heat. We were gradually changing to ice, and we learned afterward that in the simple change of state we lost 79 times as much heat as in cooling one degree."

"Isn't that strange?" said No. VI. "I spent that winter in Lake St. Clair, whither we had gone by way of the River Thames. I saw many pieces of ice, and they all seemed lighter than the water, for they always floated. Why was that?"

"Well, you see, as we changed to ice we increased in size, why I do not know, but it made us lighter, volume for volume than before. All through the long winter we lay there in the soil perfectly rigid, and useless as it would then seem. In the spring, as the snow disappeared and left the ground exposed to the sun's warm rays, we again became conscious of some subtle influence within, the heat seemed to be returning, though our temperature was just the same as when we changed to ice in the autumn. And when the 79 units of heat we had lost in congealing had been restored we felt our molecules slip past one another with indescribable ease, and we were again in our normal state. We noticed the soil was somewhat changed. As we expanded in freezing, its grains, or groups of particles, had been pushed farther apart, some of them had even been broken up, and now as we again assumed the liquid state and returned to our original volume we observed that the soil did not settle down as before. The grains remained a little farther apart, and many new ones were formed from the larger ones broken by the frost. Then we saw that our expansion, which had brought upon us freezing and long months of inactivity, had really fulfilled a great purpose—it had rendered the soil more granular, and thus made it capable of admitting more air and retaining more water for the use of the plants.

"When the last vestige of ice had disappeared and the free water had drained away we thought we would soon become warm again, but in this we were mistaken. We did not know then, but we afterwards learned, that water is harder to heat than any other known substance, and that therefore our presence in the soil in such large quantities was really keeping it cold. But making due allowance for our high specific heat, I felt that there was still some other great influence keeping the soil cold. I was several inches below the surface at the time, but by close observation I found that we were moving slowly upward against gravity. This seemed strange, for I had seen so many of our comrades disappear downward as the free water drained away. It was not my good fortune, however, to discover the cause of this upward movement nor the influence retarding the heating of the soil. I see by No. IX's countenance that he has some information on this point."

"I was quite close to the surface," began No. IX, "when the drainage ceased in the upper soil. Each morning as the sun rose higher and higher above the horizon we felt ourselves warmed somewhat, and then cooled again towards evening, but each day we were a little higher in the soil than the day before. At last I reached the surface. I felt warmer than on any previous day, my molecules vibrated more rapidly, and to my amazement I saw many of them break through my surface film and escape into the air. I exerted all my influence to bring them back, and some of them did return under compulsion, but many others were travelling so rapidly that my attraction for them was overcome, and they soared aloft and were borne away by the winds. They had been changed from liquid to vapor. As I realized that they were gone a sense of impending disaster seemed to crowd in upon me, similar to but much keener than what I had felt as I was being changed from water to ice. During the process of vaporization I observed that my temperature remained pretty nearly constant, although the sun's rays were beaming down upon me, and I could not help enquiring the cause. Then I thought how rapidly those wandering molecules were travelling as they left me, and of the amount of energy that must have been used in piercing my outer film and breaking away from my strong grasp. I found that the amount used by them at 60° F. was 588 times as much as would heat the same quantity of water one degree. With this great loss, I would soon have become quite cold, but the sun's rays furnished me with sufficient energy to replace that loss, and to raise my temperature a little besides. Had it not been for this great loss we would have been warmed up much more rapidly."

"What proportion of the sun's heat is actually used in this way?" queried several of the drops who had not had this experience.

"Well," continued No. IX, "that is somewhat difficult to determine, but as my last molecules soared away in the air they passed over the College grounds, where they saw an individual working with a strange instrument known as a pyrheliometer. It was in a sheltered spot, so they settled down in the lull to get warm and to see what he was doing—and he was actually working on this very problem. They overheard his soliloquy: 'At the equator evaporation from the ocean during the year uses from 60 to 70 per cent. of all the heat from the sun, leaving only the small balance to warm the water. What is the proportion here at Guelph? We know that evaporation from wet soil is fully as rapid as from water under similar conditions of temperature and exposure. The heat used here in evaporation must bear a similar ratio to the total energy received from the sun.'"

"I understand now," said No. I, "why so little warmth reached us lower down in the soil during those early days. And I also understand why we all moved slowly toward the surface—the water films near the surface were made thinner by evaporation and we were drawn up to supply the deficiency. I believe the tendency of the thicker films below to replenish the thinner ones above is called 'the force of capillarity.' But I observed that in a few days we began to get heat more rapidly."

"Yes," said No. X, "the workmen on 'The Model Farm' came along with the harrow just as soon as the soil was dry enough to till and loosened it thoroughly for a depth of two or three inches. I was in the compact soil just below the mulch, and I noted four things; first, the movement of water toward the surface slackened immediately; second, that the mulch became fairly dry in a day or two, for it was losing water rapidly by evaporation and gaining it only slowly by capillarity, for capillarity does not work so well in an over-loose granular soil as in that same soil a little more compact; third, the rate of evaporation was greatly checked after the mulch became somewhat dry; fourth, the mulch became warm as well as dry. And once it became warm we began to get more heat further down.

"After a few days I saw a large implement passing above, called a seed-drill, I think, consisting of many hoes, each closely followed by a tube through which peas were dropping on the damp compact earth in the bottom of the small trenches made by the hoes. As they passed on the earth rolled in and covered the seed, one grain of which had fallen very close to me. It had scarcely settled itself in its dark bed when it began to drink of the water of the compact soil below. One would hardly think its capacity so great, but that seed actually absorbed 5 per cent. more water than its own weight. This served a very useful purpose, however, of splitting the seed open and thus allowing it to 'sprout.'

"Soon the root began to develop, and by some strange force, osmosis, I think it is called, I felt myself impelled into its tissues. With me went the plant food which I had brought into solution long ago, and together we rose upward in the plant, and I sighed a sigh of relief to feel myself above ground again. In the leaves of the plant the raw food, with a small portion of water, was prepared for assimilation by the plant and returned to its various tissues. But most of the molecules of which I was composed passed through the leaf into the freedom of the air, in the vapor state already referred to by some of our number."

No. I took up the story again. "I could see the roots descending day by day, and great numbers of drops passing slowly into them, as already described. It was a long time before my turn came, and by constant watching I became impressed with the vast quantities of water that entered the roots, and decided to watch for information as to what amount was required to mature the crops that grew upon that land. I was still in one of the plants when the peas were 'pulled,' and while lying in the 'bunch' I heard a couple of the workmen discussing experimental results, and one said that if all the water that passed from the soil during the growth of the crop, both by evaporation from the soil and transpiration through the plant, were collected on the ground at one time it would be from eighteen inches to two feet deep. He also said that the rains during that time amounted to only ten or twelve inches, far less than the crop needed, and that that was the reason they were so anxious to have the soil in condition to hold a large store of water, and to check the loss from evaporation by mulching. Why, he said, that during the summer evaporation alone amounts to more than the current rains, and that most of the water used by the crops is derived from the stores held in the soil at seeding time.

"But I could not wait to hear more. The gentle wind and the sun's heat were drying the grain by the same great power of evaporation, and, like so many of you, I found myself silently floating away with the breeze. Not long after I felt myself impelled toward a cloudy mass and entered another shower, which was then passing over Lake Ontario, whence I made my way slowly toward the sea.

"You all have the same story now, out to the sea, carried hither and thither by ocean currents and ocean storms, evaporating at last down near the Tropic of Cancer, then entering one of those great periodic low-pressure areas, over the Gulf of Mexico and travelling northward and eastward, condensing into drops on the way and falling here again on the Model Farm in this warm April shower."

All nodded assent to this last portion of the story, and then realizing that already they had lingered too long, each hurried away to enter the cycle again, many no doubt wishing that in this round they might enrich their experience with some of the interesting features they had missed before.

THE STORY OF THE PLANE

Professor John Evans.

One Christmas afternoon not very long ago I visited some friends living a little way out on the gravel road. Gathered round the fire-stove was a merry party of children, each very happy in having received a Christmas gift from Santa Claus. Little Harry with his horn was making music for all. Pearl was chatting away to a tiny teddy bear. Mary was nursing a doll with the bluest of blue eyes. George was holding forth on the merits of his wonderful knife, while Tom, the eldest, was deeply occupied in examining the parts of a new plane. Why, Tom, this is a fine tool you've got—the latest pattern, too! What will you do with it? "Oh! I can make use of it for making grit-boxes, nests, and coops. I have to look after the poultry, you know! Only I wish I knew how to manage this one—it's so different from the wooden plane papa has. Will you please tell me about it?" That I will do with pleasure, Tom!

I dare say you have noticed how vast a difference there is in the character of the work done by tools differently formed and differently introduced to the work they have to do. The countless number of tools used in the arts and crafts of to-day are but slight changes of a few simple elements, just as this new plane differs from the wooden one. They differ more in variety than in kind and in the extent to which different kinds of tools are put into the same complete machine.

A tool may be considered to be any implement used for performing mechanical operations by which man is enabled to change the form of material.

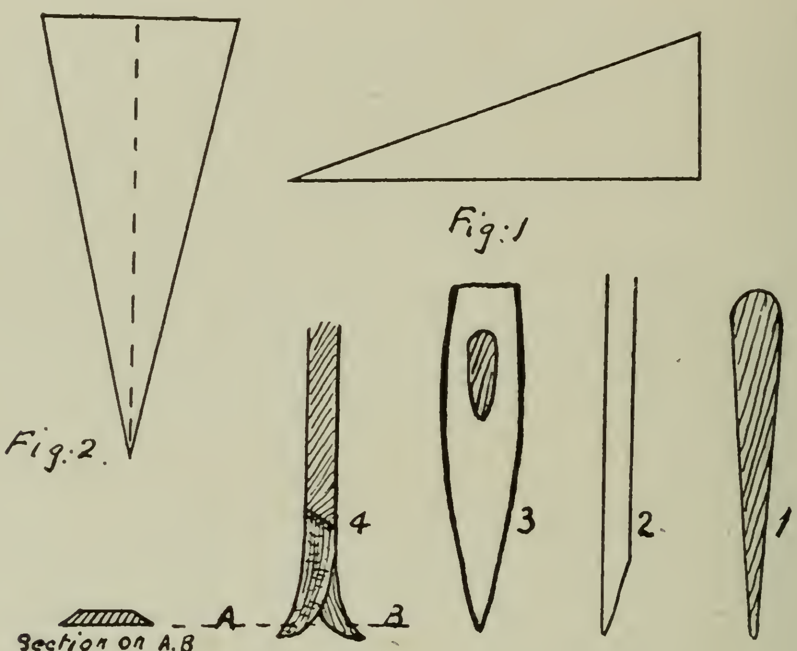
The tools in common use are scarcely more than half a dozen in number—the axe, the plane, the saw, the hammer, the square, and the chisel. It is hardly possible to draw a distinction between a tool and a machine. Whilst the former is more simple than the latter, they so merge into one another that it is difficult to determine where one ends and the other begins.

However complicated a machine may be, or however great its number of parts, all may be classed under the head of simple or elementary machines. These are the lever, the pulley, the inclined plane, the screw, the wedge. These have been termed the mechanical powers, and form, as it were, the basis of tool construction, or the alphabet out of which all combinations are made, in the same way as all English words are made up out of certain of the twenty-six letters. The modern machine shop is largely these simple elements brought together and made self-acting and driven by power.

Of these many contrivances for doing work, the inclined plane (Fig. 1) is the one that enters mostly into the construction of cutting tools and the most useful application of it is obtained by doubling it, that is, by placing two inclined planes, base to base, forming a wedge (Fig. 2).

If you will examine the forms of such tools as the axe, the knife, the chisel, the plane, and the saw, and compare their shapes with the wedge, you will find there exists considerable resemblance, not only in the shape of the tools, but in their mode of action as well (Fig. 3).

The axe, chisel, etc., are simply wedges with handles. The axe is driven into the material by means of the handle. The chisel is struck with a mallet just like the wedge. In short, the general form and character of these tools have undergone but little change since the period of the flint implements, and others are but slightly modified in construction to meet the demand for special application. The development of these tools has been along the line of some means to direct and limit the action of the tool, as well as to provide a wedge-shaped edge of adequate strength and hardness, either forming part of the cutting blade itself, as in the chisel, or



1. Section of Knife
2. Side View of Chisel
3. End View of Axe
4. Section of Saw Fig: 3.

independently of it, as in the plane. That is just what has taken place in this plane. It can be controlled better than the old one.

This is called a "jack" plane. You see, it is made of iron. Planes are made in a great variety of shapes and sizes in both iron and wood.

The wooden planes are much simpler in their construction than the iron ones. In its early stages the plane was just a chisel put at an angle in an oblong block of wood, called the "stock," with the cutting edge protruding slightly beyond the bottom and fastened in its place by a wedge (Fig. 4 A-22).

But the iron plane (Fig. 4 B) possesses many advantages over the wooden ones inasmuch as the sole, having once been made true, remains so always. It is *self-adjusting,* which removes most of the difficulty attending the setting of the wooden plane. The blade or cutting iron is secured in its place by means of the iron clamp (4) with a cam (4a) at its upper end. A screw (5) passing down into the iron bed piece below serves as a support (fulcrum) on which the clamp acts by pressing down the plane iron as the screw is tightened. The clamp may be put in position or removed at pleasure—it being properly slotted for this purpose—by releasing the cam as shown by the dotted line, 4a. The pressure required for the

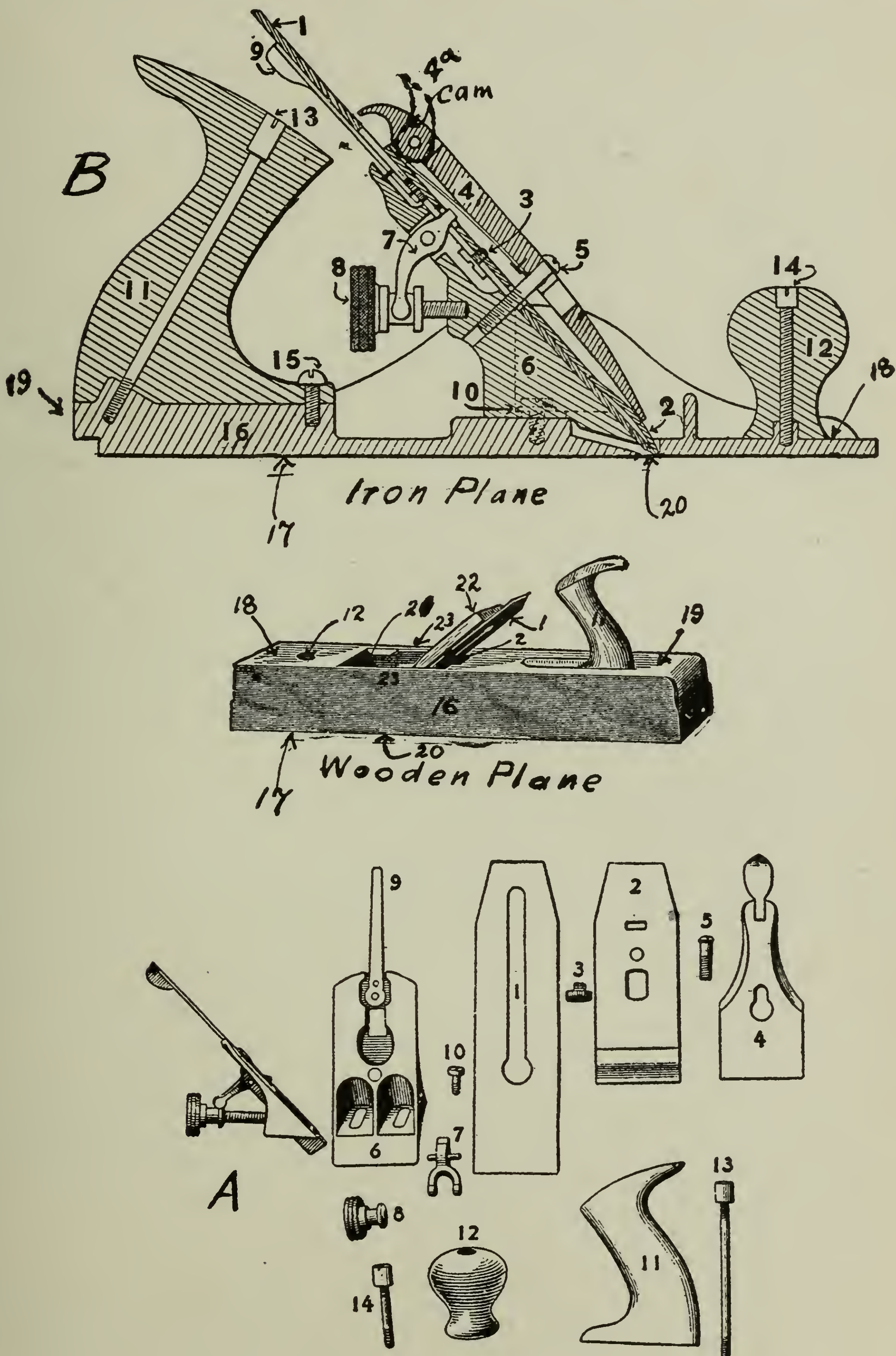


Fig. 4. The Jack Plane.

best working of the plane can be obtained at any time by tightening or slacking the central or cap screw (5) which acts upon the clamp. The thumb-screw (8) placed under the "frog" (6) and just in front of the handle works a simple device

(7) which enters an oblong slot in the blade and by means of which the blade can be easily set forward or withdrawn while it is still clamped down to the "frog" without removing the hands from the plane, or the plane from the work, and any desired thickness of shaving can be got with perfect accuracy. We'll take this plane to pieces for you to see the different parts and to learn their names.

The Jack Plane (Fig. 4).

1. The blade cutting or plane iron.	8. Brass adjusting nut.	16. Stock.
2. Top, cap or cover iron.	9. Lateral adjustment.	17. Sole or face.
3. Plane iron screw.	10. "Frog" screw.	18. Toe.
4. Clamp, 4a cam.	11. Handle.	19. Heel.
5. Clamp screw.	12. Knob.	20. Mouth.
6. "Frog."	13. Handle "bolt and nut."	21. Throat.
7. "Y" adjustment.	14. Knob "bolt and nut."	22. Wedge.
	15. Handle screw.	23. Cheeks.

The collection of parts marked A consist of Nos. 6, 7, 8 and 9, and form the "Frog complete."

Tell me, why was the chisel put into the block? Well, it was found that in certain grain of the wood the chisel caused the wood to split in front of the cutting edge and so spoil the work (Fig. 5). It was thought that this arrangement of putting the chisel in a case, as it were, would regulate the amount and direction of the cut made as well as to prevent splitting ahead of the tool. Though this method helped very much to stop the chisel following the lead of the fibres, it did not serve the purpose it was thought it would, for in progress of work whenever the grain of the wood was unfavorable the cutting edge caught the projecting ends of the layers of fibre, bending them back rather than cutting them, particularly so if the tool is blunt, the shaving running up the iron acquires a leverage drawing the chisel inwards in direction of the grain, causing much crushing of the fibres in the mouth of the plane and arresting the progress of the tool; to release it the worker by extra effort tears the fibres apart, leaving the surface very rough (Fig. 6). But this plane has two irons. You see, Tom, the tool did not work very well. It tore up the fibres and jammed up the mouth so that the next attempt to improve this tool was to prevent these defects. These faults, of course, might be partially avoided by narrowing the mouth, but this would make the amount of material it would take off so small that the tool would be of very little use, except for finishing work. But the tool, as already described, could not efficiently cross-cut the resisting fibres, and much ingenuity was exercised in devising a contrivance which would destroy the continuous connection of the fibres and so do away with any resistance from this cause. This led to the introduction of a second iron—one screwed down on the top of the other (Fig. 7), and almost every plane except those used for making mouldings has the blade stiffened by having the second iron screwed down on its flat upper surface. Henceforth the encased chisel loses its identity and must be regarded as a part of an independent tool.

The top-iron bears against the flat face of the cutting iron at its two ends (Fig. 7), and, being thin, presses against the edge with a yielding springy force. The pressure it exerts prevents, or very greatly deadens, "chattering," that is, the unsteady bending of the cutting edge before the always varying resistance of the material cut. This bending can take place only between the cutting edge and the top of the bevel on the cutting iron (Fig. 7 A), for at the latter point the iron is supported by resting on the stock; above this point it is firmly held by the wedge driven in to fasten it in its place in its stock in the wooden plane and by the clamp in the iron ones (Fig. 4). Besides this, the top iron serves another purpose: it breaks or cracks the shaving as soon as it is cut from the surface of the board. The distance at which the top iron is set back from the cutting edge must vary with the function of the plane and the class of work in hand.

There are three kinds of planes in common use—the jack, the smoothing, and the fore or jointer. For a jointer or a smoothing plane, 1-32 in. to 1-64 in. is frequently not too close, while for the jack ⅛ in. may not be too great a distance, as setting back the top iron conduces to splitting in front of the cutting edge.

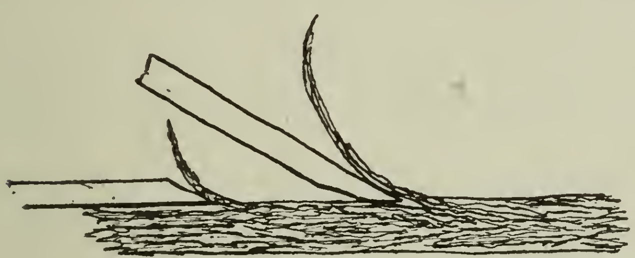


Fig: 5.

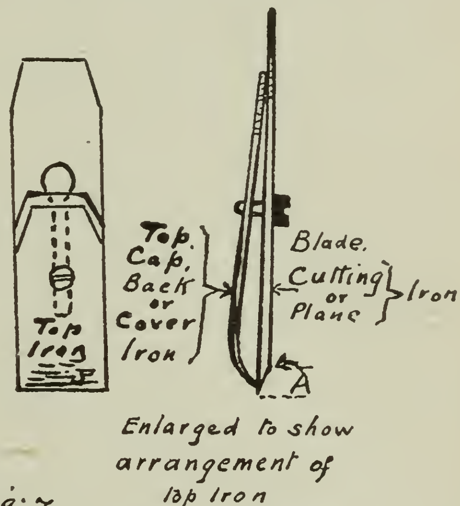


Fig: 7.

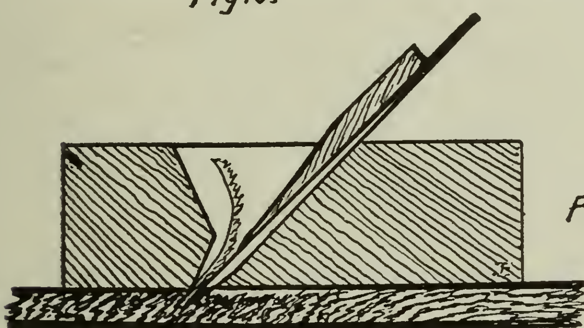


Fig: 6

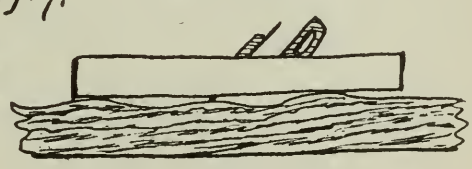


Fig: 9.

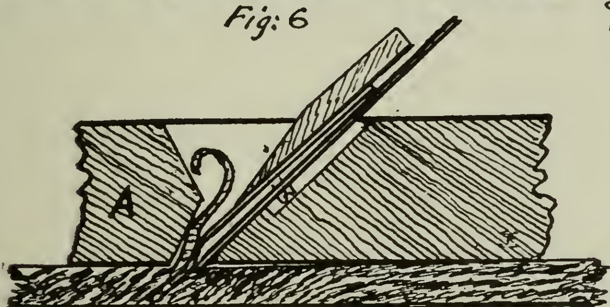


Fig: 8.

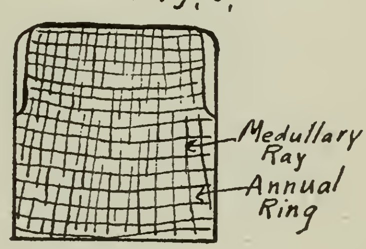
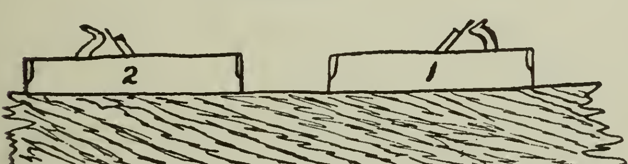
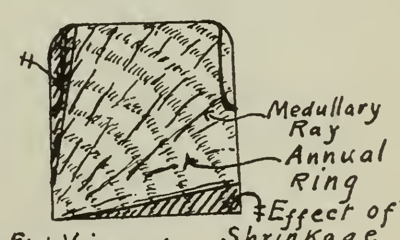


Fig: 11.



1. Planing with the grain
2. .. against.
Fig: 10.



End View of Wooden Plane
Fig: 12.

When there is considerable amount of material to come off the surface of a board this forms the easiest mode of removing it.

Examine this shaving, Tom, and notice that one side is quite smooth while the other is rough. Can you tell me how this is? No! Well, on the rough side you will see, on looking closely at it, little lines or cracks running parallel and cross-wise close to each other. These lines of half-breakage are made when the shaving slides up the edge of the back iron (Fig. 8).

If you'll bend the shaving over it will crack along one of these lines which are seen more easily on thick than on thin shavings. Notice, too, that the spacings between the lines are greater on the thicker shaving, agreeing more with the distance of the top-iron edge back from the cutting edge than with the width of the open mouth of the plane.

In a series of experiments it has been found that the main object in putting the top iron close down to the cutting edge is not so much the more immediate breaking of the shaving, as keeping the cutting edge of the blade perfectly steady, so that it may not yield more or less according as to whether it cuts over a high or a hollow place (Fig. 9).

Sometimes the mouth of the plane becomes clogged, and as a result the cutting ceases. This defect may be due to a variety of causes: A dull edge scraping off the fibres it cannot cut; too low a set of the top iron; a bad fit between top and cutting iron, allowing a shaving to find its way between them, obstructing the passage of other shavings; or, it may be due to the cutting edge being hollow, throwing up a double shaving, choking the plane.

In new wooden planes, the stoppage may be due to narrowness of the mouth, which will not allow a thick shaving to pass, but the opening should be no wider than is absolutely necessary, as it is one of the chief elements in the production of smooth work. If that portion of the stock in advance of the iron were wanting (Fig. 8A), the shaving, having nothing to hold it down, would rarely be broken notwithstanding the presence of the cover iron. A wide mouth would produce a similar effect. This being true, whatever other conditions there may be, the wider the mouth is the less frequently the shaving will be broken, and in obstinate grain, or in planing against the grain (Fig. 10-2), the rougher will be the face of the work.

Pressure on the material immediately in front of the cutting edge promotes clean cutting of the fibres and obviates splitting and tearing of the wood in advance of the tool. When a plane does become choked up, do not conclude that the mouth is too small and proceed to make it larger. It is quite possible that it is too large already. Knock out the wedge and try the iron to see if it beds firmly down without rocking; if it does, see if the wedge fits equally tight at all parts of its length. If this is right, too, examine the back iron and see if it touches evenly and closely on the face of the cutting iron throughout the entire width and that its edge is thin, so that the shavings can slide easily over it; or it may be that oil or dirt has gathered on the bevel of the back iron. Any or all of these causes will make a plane work badly or have a tendency to clog it up in use.

The stock, especially when new, gradually loses its perfect flatness of surface, either from atmospheric influence, as warping (Fig. 12); from unequal wear in different parts; or from scoring, that is, being grooved by accidentally driving over nailheads or benchtops. Should a plane refuse to "bite," although an abundance of iron projects beyond the face; or, if it persists in biting where it should not, and refuses to do so where it should, test the face to see if it is twisted, or if it is hollow across near the mouth or lengthways. It will probably have all these faults, and before it will work properly it must be "shot," that is, planed straight and true in all ways. When freshly "shot," or when new, a plane must have a plentiful supply of linseed oil on the face and periodically rubbed all over to preserve the plane and to prevent shrinkage. To facilitate the movement of the plane over the surface of the work, to reduce the wear from friction and keep the shavings from sticking in the mouth, a few drops of lubricating oil should be frequently applied to the sole. When a plane is out of truth it is not capable of doing good work and must be "jointed," i.e., planed true.

In selecting a wooden plane care should be taken that the annual rings are parallel with the sole, and the medullary rays or "silver grain" vertically to it (Fig. 11), as in shrinkage contraction takes place at right angles to the rays (Fig. 12); the less, therefore, they are inclined to the face the less will be the warpage or twist.

The blade of the wooden plane is of iron overlaid in part with steel, the under side having a bevel and a small facet, forming the ground and cutting angle respectively (Fig. 13). The bevel is ground at an angle of from 20° to 25° to the upper face. The facet varies according to whether the tool is intended for use in soft or hard wood from 10° to 15° greater than the bevel, so that the upper face of the iron lies at from 45° to 60° from the surface of the work. The angle at which the irons are placed in the various planes varies as their function. The most service-

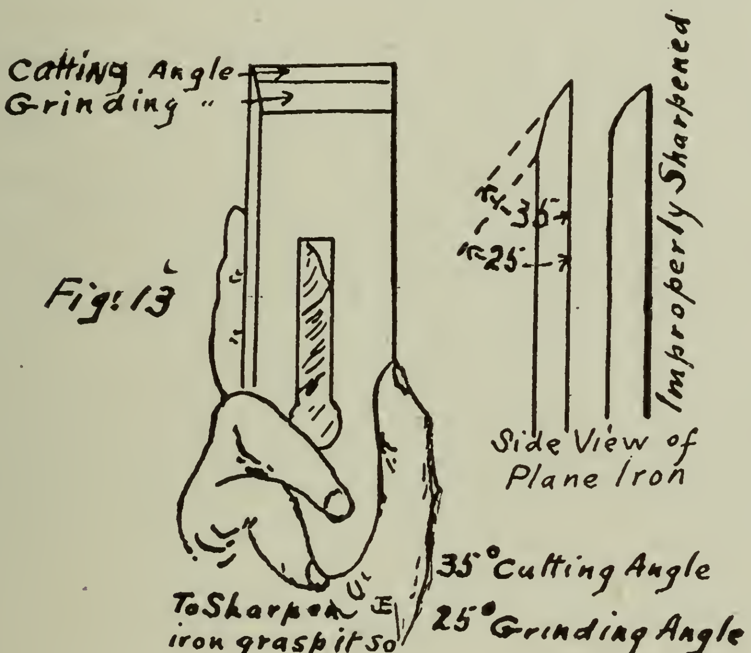


Fig: 13

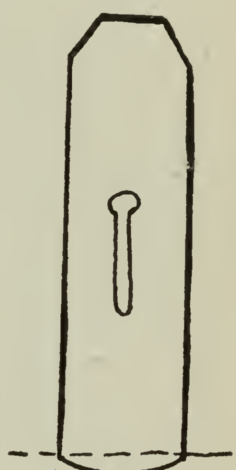


Fig: 16.

Fig: 14

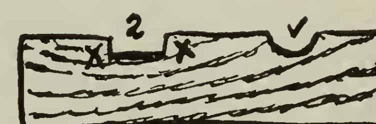


Fig: 15.

able angle is 45°, and is known as the common pitch, for when it is greater, especially in planing against the grain (Fig. 10-2), its action becomes more scraping than cutting.

Nearly all planes are distinguished by names having reference to the particular kind of work for which they are designed. The stock of the smoothing or hand plane is made short, so that by its use a surface may be smoothed without incurring the necessity of straightening it (Fig. 14). Thus if used on an uneven surface it will rise over elevated portions and settle in hollows, taking its shaving without interruption, producing no material change in the outline of the surface. But the jointer, fore or trying plane, similarly applied, will cut only on the higher parts and by so doing produce an even surface (Fig. 9). The jointer will smooth as well as the smoothing plane, but not until it has straightened the surface. This plane is longer and broader, for its immediate purpose is to remove the ridges caused by the "jack" (Fig. 15-1), and not to interfere with the surface at the bottom of the hollows, for directly its action penetrates below that level then occasion arises for cutting the side connection of the fibres (Fig. 15-2xx), entailing greater strength to push the plane along, and the effect of the "jack" begins to reassert itself in a worse form.

Although the length of the plane-stock determines in a measure the straightness of the work, the length of the jack plane bears no relation to the character of the work expected of it, but it is such as can be easily and firmly grasped by the worker. It is used for coarse work, mainly for taking off the rough and ragged surface of sawn lumber and leaving it in a better condition for the action of the smoothing or trying plane, by which the inequalities left by the jack plane are removed, and the whole surface rendered smooth, level, and perfectly even. What is the cutting edge of this blade made round for? To facilitate cutting heavy shavings the iron is ground and sharpened with slightly rounded edge (Fig. 16), so that the plane really cuts out a shaving thick in the centre and gradually tapering to nothing at the edges, leaving a broad and rounded furrow (Fig. 15-1) on the surface of the wood. Upon the curvature of the cutting edge depends the efficient action of the jack. If the cutting edge were straight, as shown by dotted line (Fig. 16), it would produce a shaving rectangular in section (Fig. 15-2), requiring greater amount of force to remove it, because of having to tear off the sides of the shaving (Fig. 15-2xx). The term "jack" as applied to various contrivances is a corruption of the Jewish "Jacobus" through Jacquemes to Jacques in France and James in England, and Jacques being the commonest Christian name in the former country was used as a contemptuous expression for a common man. The introduction of the word in the same sense into England seems to have led to the use of Jack as the familiar synonym of John, which happened to be there the commonest name, as Jacques in France.

> "Since every Jack became a gentleman,
> There's many a gentle person made a Jack."

The term then is applied to any mechanical contrivance replacing the personal service of an attendant, or to an implement subjected to rough and familiar usage. A jack, a screw for raising heavy weights; a boot-jack, a device for taking off boots; a jack-towel, a coarse towel hanging on a roller for the common use of the household; jack-boots, heavy boots for rough service; jack-plane, a jack-knife, etc.

Now, Tom, whatever you have to do, try and do it as well as it can be done, even if it were only a grit-box. Work hard, but do not hurry; do not fuss, and do not be anxious. The happiness of life consists in having something to do, something to love, and something to hope for.

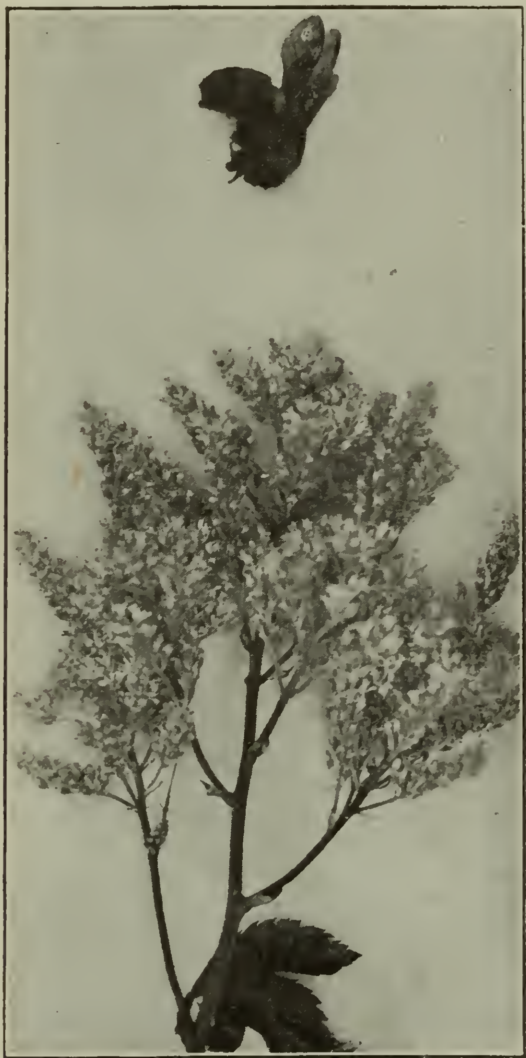
THE STORY OF A BUMBLE-BEE

Professor C. J. S. Bethune.

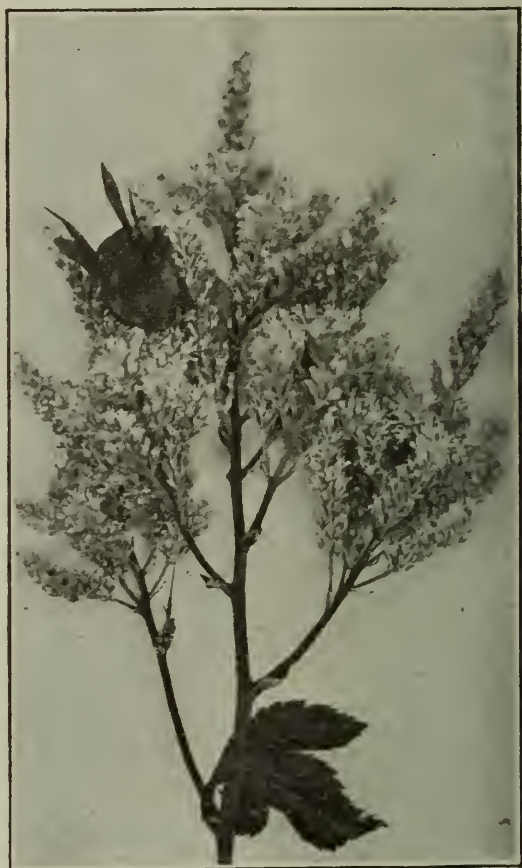
On a bright day in spring, when the willows are in bloom and when we feel that the long, cold winter is indeed over, we may often notice a great big yellow-haired bumble-bee flying about close to the ground and not joining with the myriad of other insects that are buzzing about the willow catkins. What is this great bee doing. Let us watch it for a little while. See, it has alighted on the ground and is creeping through the grass; now it comes out again and flies off a little farther; again it stops and creeps into a heap of brushwood or under an old stump—and there it stays for some time. It has probably found what it was searching for—you will hardly guess what!—an old deserted mouse's nest!

The great bee is a queen, and it has been searching for a suitable place in which to begin a new season's housekeeping. Many things will answer the purpose so long as the materials are soft and afford sufficient shelter for the future colony. Our field mice prepare for winter by gathering together a quantity of soft, dry grass, which they make up into a ball in some convenient place protected from the weather. This provides them with warm and snug quarters for sleeping and hiding, and from it they make their runways under the snow to any food such as roots of plants, tender bark of young trees, etc., as may be within reach. When winter is over they no longer need the nest, and so the bumble-bee can appropriate the deserted abode of the mice without any hindrance. When these nests cannot be found, the bee will choose something else. I have known a colony to be formed in a fur sleigh-robe which was carelessly left hanging in a barn, and within whose folds the queen found a nice soft place; at another time a nest was made under some clippings of grass left in a garden corner. What is needed is a mass of soft material for shelter and protection.

Having found what she was looking for—it may be after many a long hour's search, in doors and out of doors, in meadow and garden and field, around the barn, amongst the remains of the old straw stack, in a heap of stones or pile of rubbish—somewhere the diligent seeker has been rewarded for her toil and has found the mouse's nest or the next best thing to it. Now she feels free to join the honey-seekers about the tree-blossoms and to partake of a well-earned meal. But soon she begins to work again. She is all alone and has to prepare her nest, lay her eggs, gather honey and pollen, mix them into a mass and start a colony. What an amount and variety of work for one lone bee to do. But she sets to work with a will and soon gathers material from flowers and blossoms for a rough lump of mingled pollen and honey, which she puts together in the middle of her abode. In this she lays some eggs, and while waiting for them to hatch provides more material and lays some more eggs. From those first laid the young soon come out in the form of little grubs and begin to feed upon the pollen mass with which they are surrounded; they grow rapidly and eat voraciously, forming large cavities in the food material that surrounds them. When fully grown they spin a silken wall about them and change within it to the chrysalis state; soon a further change takes place and there comes forth a winged and fully-formed bee. These new bees are like the parent queen in color and markings, but are much smaller and are neuters or sexless creatures. It is not theirs to found new colonies and be the parents of new generations; their duties are to toil and work for their own home, and to relieve their mother of some of the many labors she has had to perform alone. They are lively, busy creatures, with their yellow, furry coats and black shiny faces; they buzz about the flowers and fill the air with their cheerful hum. Sipping the nectar of flowers for food, they gather pollen with their bristly feet and fill to the brim with the yellow cargo the baskets on their hind pair of legs. This is brought home to the nest and added to the mass already there. Meanwhile more eggs hatch out; more holes are made by the devouring grubs and lined with silk, which the queen mother covers with a thin layer of wax, thus making impervious pots for the storage of honey. The laying of eggs and the hatching of grubs goes on; more workers are added to the winged community, and gradually a busy, populous colony is



A Bumble-Bee about to alight on a flower.



A Bumble-Bee feeding.

formed. In it, when summer is drawing to a close, may be found some large and handsome new queens, a number of smaller females which provide only male eggs and do not survive the winter, a swarm of workers and some males or drones, lazy creatures who do no work and soon die after mating with the queens.

When September has drawn to a close and October has come with its chilly and frosty nights and cold rainy days, a sad change takes place in our bumble-bee's nest. All the busy workers who have enlivened the sunshine of the summer days die, all the lazy drones also die, and the poor old queen mother dies—some in the nest and some elsewhere—none survive but the big new queens, who hide themselves away and sleep through the long cold months of winter in some safe resting-place. In the spring each one that survives establishes a new colony, as already described.

"What is the good of the bumble-bee?" some one may ask. They don't produce much honey, and what they do is poor stuff. Certainly they are of no value to us as honey-producers; that work is left to their cousins the hive bees. But they are most useful and important creatures in another way. You will be surprised to hear that without their aid we can get no red clover seed. In the early days of settlement in New Zealand the farmers procured their seeds of various kinds from Great Britain until they were able to raise them for themselves. Amongst other things, red clover was sown and grew and blossomed splendidly, but it produced no seed. A fresh supply was obtained, but the result was the same—no seed at all was developed. Why was this? After a time those farmers found out—there were no bumble-bees in New Zealand. When this discovery was made they sent to England again, but this time they wanted bumble-bees as well as more clover seed. With much difficulty and after many disappointments, a supply of the insects was procured and they soon multiplied and spread over the country. Since then the New Zealanders are able to grow their own red clover seed.

This may seem a strange connection, but perhaps if you examine a head of clover you will understand the matter. The head is composed of a number of long narrow flowers crowded together and having stamens which bear pollen before the pistils in their own floret are ready to receive it; it is, therefore, necessary that the pollen should be carried to other florets where the pistils are in a more advanced condition, for if the pollen does not reach the pistil, no seeds are developed. The flowers are so narrow and deep the wind cannot blow the pollen about, as it does from some flowers, and few insects have tongues long enough to reach the bottom. The honey-bee in search of nectar can sip it from the shorter white clover bloom, but it cannot do so from the red. A large number of other insects that feed upon sweets find the same difficulty—their tongues are too short. But our friends, the bumble-bees, have longer tongues that reach to the bottom of these flowers and enable them to lap up the sweet nectar they contain. While doing this some of the pollen dust in one flower sticks to the tongue and head of the bee and is carried to another, where it gets rubbed off on the pistil. Thus fertilization is accomplished and clover seed is produced—thanks to the bumble-bee.

Many other flowers are aided by the bumble-bees in a similar manner. Melons and cucumbers, pumpkins and squash all require the aid of these or other insects to carry pollen from one flower to another. Our apple and pear, plum and cherry and peach trees would bear no fruit at all if it were not for the insects of various kinds, especially honey-bees, which hum and buzz about them. And so it comes to pass that if the weather is wet and stormy during blossoming time there will be a poor yield of fruit, because the bees are unable to do their work. Boys and girls should know how much we depend upon many kinds of despised insects for various articles of food that we value very much, and should learn not to kill or molest these useful creatures.

Many a country boy thinks it splendid fun to rob a bumble-bee's nest—I know I did in days gone by. There was the cautious approach to the nest as near as one dared go—a poke with a long stick—a wild chase with the bee after the boy—perchance a sting on the back of the neck. Then, armed with bats of shingle or branches of cedar twigs, the assault would be made again, and each poor bee as it came out to defend its home would be smitten and killed. When all were slain the nest would be rifled and we would suck the scanty store of honey from the dirty-looking cells. It was certainly a cruel proceeding, but boys hardly think of that. We were, moreover, killing our useful friends to whom we owe so much, and who would never sting or injure us if only left to live in peace. This we did not know—there was no "Nature Study" in schools in those days. Boys now are better taught and know much more respecting the common things about us—birds and insects, snakes and toads and other useful creatures, as well as flowers and plants. They should understand that every living thing has its place in this world and its duties to perform, and that nothing should be destroyed unless there is a proper reason for doing so. Some insects, such as potato beetles and mosquitoes, are certainly injurious, and we have no hesitation in destroying them, but do not let us interfere with our good-natured, useful, busy, friendly bumble-bees.

THE STORY OF WOOL

Professor G. E. Day.

The next time you visit a fall fair, be sure you do not come away without going to see the sheep. If you are fortunate enough to visit one of our large fairs, such as Toronto, London, or Ottawa, you will find the sheep pens a very interesting place. Here you will see many different kinds of sheep; some large, some medium size, and some small; some with white faces, some with brown or grey faces, and some with black faces; some with their faces so covered with wool that they can scarcely see out through it, and some with no wool at all on their faces; some with horns, and many with no horns—in fact, the longer you look at these beautiful creatures the more you will find to interest you. There is one thing about sheep that makes them look very different from all other farm animals, and that is the warm coat which they wear. This coat is so thick and so warm that the sheep can stay outside in the coldest weather without minding the cold in the least, while a horse, or a cow, or a pig, will shiver and look very uncomfortable indeed. Now, the horse, cow and pig have coats, too; but their coats are made of hair, while the sheep's coat is made of wool, and wool makes a much warmer coat than hair.

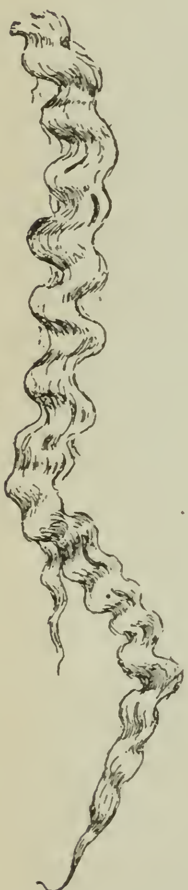


Fig. 1. Lock of wool showing coarse crimp.

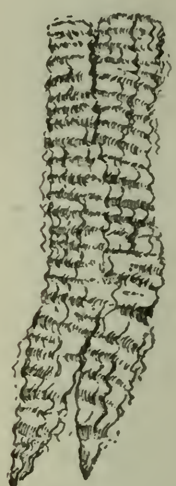


Fig. 2. Lock of wool showing medium crimp.

Did you ever think of what is the difference between wool and hair? If you part a sheep's wool with your hands you will find that it is made up of a great number of very fine wool hairs, or fibres, which grow out from the skin of the sheep so close together, and so long, that they form a coat which the wind cannot blow through. After handling the wool you will find that your hands are quite greasy. This grease, or oil, comes from the skin of the sheep, and is called "yolk." It keeps the wool fibres soft and smooth, and keeps them from tangling or matting together. It also helps to keep out water, so that a sheep can stay out in quite a heavy shower of rain without getting its coat wet through. Then, again, if you look at these wool fibres closely, you will see that they are not perfectly straight, but that they have a wavy appearance. In some kinds of wool these waves, or bends, in the fibre are much closer together than in other kinds. Look at the two locks of wool shown in Figs. 1 and 2. In the first there are very few waves in the fibre, while in the second the waves are close together. The finer the fibre is the more waves it has, while wool with coarse fibre has very few waves. These waves, or bends, are called the "crimp" of the wool. When the waves are very close together, the crimp is said to be fine, so that fine wool has fine crimp and coarse wool has coarse crimp.

But there is another difference between wool and hair. If you take a single fibre of wool, and take hold of the end that grew next to the body of the sheep, and then draw the fibre between the finger and thumb of the other hand, you will find that it slips through very smoothly. But if you take hold of the other end of the fibre, and then draw it between the finger and thumb as before, you will find that it seems to catch, and does not slip between the fingers nearly so easily. Why is this? It is because every wool fibre has hundreds of very, very small scales on it, something like the scales on a fish, only so small that they cannot be seen without looking at the wool with a microscope, which makes the wool fibre appear many times larger than it really is. These tiny scales all point towards the outer end of the wool fibre, so that when you took hold of the outer end of the fibre and tried to draw it between the fingers of the other hand, the points of these little scales caught on your fingers and made it hard to pull. The picture (Fig. 3) shows how these scales grow on the wool fibre, but the fibre and scales are made to appear very much larger than their natural size. Hair also has scales upon it, but the points of the scales on the hair are rounded and they lie so close to the hair that they do not catch hold of anything they rub against; while the scales on the wool fibre have sharp points and rough edges, so that they catch and cling to everything they touch. This difference in the kind of scales is the most important difference between wool and hair.

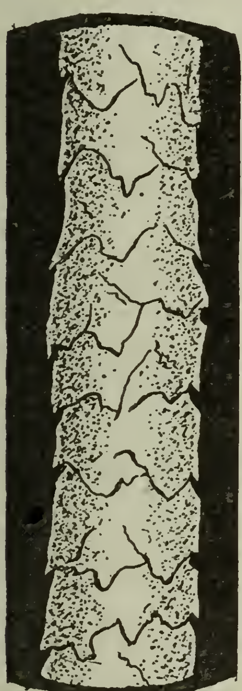


Fig. 3. Wool Fibre, showing scales.

Now, when the weather grows warm in the spring, the sheep does not need its warm winter coat, and so the farmer clips it all off, or shears the sheep, as we say. The wool is then sold, and is sent to the large factories, where it is made into all sorts of clothing, blankets, yarn and other goods.

Before it is made into cloth the wool is twisted, or spun into yarn. If the wool fibres had no crimp, they would not stay tightly twisted together, and the yarn would be of very poor quality. Then the yarn is woven into cloth by machines, and the way the wool is handled in spinning and weaving causes the little scales, which we have described, to catch into one another and the wool fibres become all tightly matted, or felted together, making a firm, strong piece of cloth. From what has been said you will see the use of the crimp and the scales of the wool. The crimp makes it possible to twist the wool into yarn which will not easily untwist again, and the scales cause the wool fibres to stick together, or felt.

It would take too long to describe all the different things that can be made out of wool; so we shall mention only a few of the principal classes of goods. Wool that is very long, strong and coarse in fibre is often called "braid" wool, because it is from such wool as this that braid is made. Then there is other wool, not quite so coarse as the braid wool, but still quite long and very strong in fibre; this is made into what are called "worsted" goods. Worsteds are used very commonly in making men's clothing. Some sheep produce wool that is quite long and yet very fine in fibre. Wool that is between two and three inches long and very fine in fibre usually sells for a higher price per pound than other kinds. It is used very largely for making ladies' dress goods, such as delaines, and is often called "delaine" wool. Wool that is short and fine in fibre is used for making such goods as broadcloth, fine underclothing, tweeds and other goods of that kind. Some wool that is long and coarse has weak spots in its fibres; and any wool that has weak fibres cannot be used for delaines, worsteds, or braid, but is made into cheap tweeds, blankets, coarse underclothing, carpets, coarse stocking yarn, and such like. Thus, you see, there are many kinds of tweed, underclothing, blankets and such goods depending upon the quality of the wool that is used in making them.

Such goods as delaines and worsteds have a smooth surface. This is because the wool is put through machinery which stretches the wool fibres out straight, and they are then twisted together in such a way that all their ends are tucked in out of sight. This stretching is called "combing," and the wool fibres must be sound and strong in order that they may not break during the operation. But if you examine a piece of tweed or blanket, you will see the ends of the wool fibres standing out from the surface, making the material look rough. This is because the wool has not been combed, but has been put through a process called "carding," in which the wool is rolled up in such a way that when it is spun the ends of the wool fibres stand out from the yarn and give a rough appearance to the cloth after it is woven. As a rule, wool that is less than two inches long is not combed, but is used for carding; and wool that is weak in fibre will not stand combing, and therefore must also be carded. There are many other interesting things which might be said about wool, but I simply ask that whenever you see a sheep, you will think of what you have learned about the wonderful coat it wears, and remember that we should always be kind to these gentle and timid animals, because we owe them much of the most beautiful and most comfortable clothing which we wear.

THE AUTOBIOGRAPHY OF TOMBOY

J. Hugo Reed, V.S.

I am a four-year-old filly. My name is Tomboy. My mother is a half-breed, and her name is Duster. My sire's name is Jim Wassen; he is a thoroughbred. Therefore I am three-quarters bred. My mother is a large white mare, a great favorite of my master, who both rides and drives her. She is a grand saddle mare and hunter. She likes to gallop across country after the hounds with my master in the saddle. She jumps over fences, ditches, stone walls, and anything that is not too high; she can run fast and jump better than the other horses in the hunt. She is large and strong, and although my master weighs two hundred pounds, she likes to carry him, as he is kind to her, rides her well, never pricks her sides with the spurs, nor hits her with the whip, nor hurts her mouth by bearing too heavily on the reins. He has always been kind to her and fed her well, and that is why she is strong and sound and as lively as when she was young, although she has done a great deal of hard work in both harness and saddle.

The first thing I remember was one Sunday morning in May, 1898, when my master and Ernest, his stable man, came to the stall where my mother and I were. I was only about one hour old, but I was walking around the stall. They looked at me for a while, and then my master came into the stall and put his hand on me and spoke kindly. I was afraid at first and ran behind my mother, but he followed me, saying, "Poor little thing, do not be afraid, I will not hurt you"; so after a little time my fear left me, and I have never been afraid of him since, and he has always been kind to me, and provided me with a nice clean box stall with plenty of straw to lie on and good food to eat, and he never works me too hard. That morning, after looking me carefully over, he said, "Well, my little beauty, I am glad that you are a filly; you are tall enough but rather too slim, but time and good care will cause you to grow stouter; your knees are rather weak, but they will grow strong after a while; I will call you Tomboy; and if you make as good a mare as your old mother you will do well." He then gave my mother a nice feed of warm bran and crushed oats and a drink of water. He told Ernest to clean the stall out and put in a liberal supply of clean straw. I liked to lie on the straw, and did so most of the time for a few days. Whenever I got hungry I got up and took some milk and walked around a little. My mother did not lie down for three days after I was born; she appeared to be afraid to do so for fear of hurting me. My master and

Fig. 1. Tomboy's Mother, "Duster," 26 years old.

mistress came to see me often, and would always pet and handle me. I liked to see either of them come, and would always walk up to them to be petted. Ernest gave my mother her food and water, and kept the stall clean, and well supplied with straw. He liked horses and was very kind to us, and we both liked him, and would do what he told us. When I was three days old, my master put a little halter on me, and Ernest put one on my mother, and led her out of the stall. I was not afraid, but did not know what to do. My master, however, was kind and did not get angry and jerk or hit me but petted and coaxed me; he did not expect me to lead the same as a horse that had been trained to it; so I soon learned what he wanted me to do and went along with him. They took us to the yard between the stable and the house. I forgot to tell you that we live in town. There was some nice grass in the yard, and as soon as our halters were taken off and we were given our liberty, my mother commenced to eat it. The day was fine and warm, and it was nice to be out in the open air. I began to run around my mother and kick up my heels.

My master and Ernest stood and watched us and laughed at the fun I was having. Master said, "That is right, Tomboy, have a good time, but do not hurt yourself; you are not very strong yet and a little sun will do you good." When I became tired I lay down and stretched myself out in the sun. All this time my mother continued to eat grass, but would often look to see that I was all right; she was very proud of me. After a little while some bad boys came along and threw stones at me; one of them hit me on the head and hurt me. I jumped up and ran to my mother; the boys continued to throw stones, and mother became greatly excited; she galloped around and whinnied, and my master heard the noise and ran out. He was very angry at the boys, and told them that if they ever threw stones at me again he would horsewhip them. We were then taken back to the stable. We were taken out to the yard every fine day after that, and left there for a few hours, and I soon became stronger. When I was two weeks old I had my photograph taken. You can see by it that I was tall and slight, and that my knees had not yet become quite straight. When I was about three weeks old we were taken out as usual. A third man was leading my brother, who was a year old. His name is Banbury. Instead of leading us to the yard as usual they took us in the opposite direction, down a long street, until we came to a gate. They led us through this gate into a field, took off our halters, and set us at liberty. There was plenty of good grass in the field, and a stream of nice, cool, clear water running through it. Banbury and I had any amount of fun running and kicking up our heels; our mother would occasionally join us in our frolic, but usually she would just look on. I soon discovered that grass tasted nice, and I used to eat all I could. The weather was warm, and we stayed in the field day and night. There was plenty of grass and good water, and we had a good time, with nothing to do but eat, drink, play, and sleep. After a while, the grass became rather dry and less plentiful, and the flies began to torment us during the day time. Our master soon noticed this, and every morning, about the time that the flies were beginning to trouble us, he would mount his wheel and ride down to the gate, which he would open. Then he would whistle; and as soon as we would hear him we would all gallop up to him, when he would put a halter on my mother and lead her out of the gate. We would follow, and he would then shut the gate, mount his wheel, and start towards home. Banbury and I would sometimes run ahead and sometimes lag behind; but we never got far away. We all were taken to the stable and put into our stalls, the windows of which were darkened to keep the flies out. Ernest then gave us some nice new hay and crushed oats, having nailed a little box up in one corner of the stall, just the proper height for me to eat out of. I was too small to reach my mother's feed box. When evening arrived, we were taken back to the field, as the flies did not bother us now, and it was better for

Fig. 2. Tomboy when two weeks old.

us to be out than in the stable, and we liked it better. This was done every day until the weather became colder in the fall, and the nights were so cold that we would be uncomfortable in the field. The flies had mostly all disappeared by this time, so we were kept in the stable at night and turned out in the day time. After a time the weather became so cold that we were not taken to the field at all, but were allowed to run out in the yard for a few hours every fine day. The time soon arrived when I had to be weaned. I was taken to a nice stall in a part of the stable distant from my mother. I did not like to be taken away from her. Neither did she like to be left alone. I was taken to her stall and left with her for a few minutes three times a day for three days; then twice daily for three days; then once daily for a few days; after which I was not allowed with her at all for a long time. By this time I had grown quite stout and strong, and my knees had become straight, as my master said they would the first time he saw me. I was fed all that I could eat the first winter. Ernest gave me good hay and scalded chopped oats, with a carrot or two every day, and twice weekly he gave me a feed of bran. My stall was kept clean and well supplied with straw, and I was allowed to run out in the snow with Banbury every day that was not too cold or stormy. My master used to trim my feet every month. He said that the wear was not equal to the growth, and that if he did not keep them trimmed to the natural shape there was danger of them becoming ill-formed and injuring me for life. He used to put a little bridle on me and leave it on for an hour or two every day. He said this was to give me a mouth. By that he meant to accustom me to the bit. I did not like it at first, but after a few days I did not mind it in the least. Then he put a set of little harness on me and left it on for a few hours daily. He soon put a check rein on the bridle. A portion of this rein was elastic. He fastened the rein to the check hook, but did not check me up tightly.

When I poked my nose out the elastic would stretch; but when I relieved tension it drew my nose back to the proper position. He said that this would gradually teach me to yield to the restraint of the bit, give me a good mouth, and thereby make me a more valuable horse, and more pleasant to ride or drive. I did well the first winter, and I learned a great many things that came very useful afterwards. When the grass became plentiful and the weather fine in the spring, Banbury and I were taken out into the country and turned into a field on the farm of Mr. B. This was about the end of May. Our master told Mr. B. to watch us closely, and if we should not do well to be sure to let him know. The grass was very nice, and there was a stream of clear, cold water running through the field. We enjoyed ourselves very much, and resumed the sports of the previous summer, as we were always great chums and never quarrelled. In two or three days I began to feel unwell, my throat became sore, and I could not swallow easily. I felt cold all the time, although the weather was warm. I did not feel well enough to play with Banbury. I grew worse day by day. The soreness of my throat increased until I could not swallow anything without feeling great pain; my eyes became sore, tears ran down my cheeks, and I could not bear to look at the sun. My joints became sore. I had a painful cough and a discharge of mucus from the nostrils. Mr. B. saw us every day. One day he said to his son, "The filly has a cold, but I guess she will soon get over it." The son said, "But, father, you promised to let Mr. R. know if anything went wrong with the colts. You know he is very fond of them, and you should send him word about it." Mr. B. said, "I'll think of it some day when I am in town." I gradually became weaker, as I could neither eat nor drink. One day we saw our master coming down the lane, and we were both very glad. (Banbury was quite well, but was very anxious about my condition.) We knew that he would do something to help me. As soon as he saw me he said, "Poor Tomboy, how you have failed. What is the matter?" Mr. B. was there, and after our master had examined me, he said to Mr. B., "Why did you not let me know that the filly was ill? You are in town mostly every day." He said that I had influenza, and that it would require very careful nursing to pull me through. He was very angry with Mr. B. for not telling him. He took both Banbury and me home. I was very weak, and we had to go slowly. When we reached home he rubbed something on my throat and gave me some medicine, which did not taste nice, but did me good. He and Ernest gave me a great deal of attention, and my throat soon got better, and I was able to eat. When I got strong enough he turned me out to pasture on Mr. W.'s farm, where we remained until the weather became cold, when we were taken back to town. The following winter we both did well. One day my master put a set of harness on me and drove me out on the street. I was so accustomed to harness and to do as I was told that he had very little trouble with me. He did this a few times, and then he hitched me to a light cutter. It was something new for me to have to draw a load, but I knew that it was all right, else my master would not ask me to do it. He walked behind at first, but I went all right, so he got into the cutter and I drew him too. He drove me a little every day for a couple of weeks, and I heard him tell Ernest one day that I was pretty handy now and would never give any trouble in harness. The next spring we were again turned out on good pasture and again taken to the stable in the fall. We were well cared for during the following winter. Banbury did some regular driving, and I was driven some to continue my education. The next spring Banbury was four years old and I was three. One day a man came to the stable and looked at all the horses. He asked if Banbury was for sale, and my master said, "Yes, I will sell him; he will make an excellent lady's saddle horse." The man said that he wanted him to send to South Africa with the mounted infantry. My master then said, "Well, you cannot have him, as I will not sell him for that purpose"; so the man went away, and I was glad that he could not get Banbury to send to the wars. After a little while a lady came to the office one day and asked my master if he had a good saddle horse to sell. Banbury was taken out for her inspection. She liked his looks, and asked if she might ride him. My mistress's saddle and bridle were put on him, and the lady mounted and rode away. When she came back she said she liked him, that his paces were good, and he had an excellent mouth and good manners. She bought him. I was sorry to see him leave the stable, but glad that he had been bought by a kind lady who wanted him for herself. My master saw him a few months later, and I heard him tell Ernest that he looked well, that he was homesick for a few weeks, but was now quite contented and happy in his new home, that his mistress was kind to him, and very fond and proud of him. One day Mr. T., a friend of my master's, asked permission to ride me. He was told that I never had been ridden, that I was of a nervous, sensitive disposition and required very gentle, kind treatment, and that he would like to ride me first himself, but was too heavy for me. Mr. T. said that he would like to try me, so a saddle and bridle were put on me, and I was taken out to a vacant lot. My master held me while Mr. T. mounted, and then led me for a while. I was afraid, as I never had weight on my back before, but while my master went with me I knew that it was all right, and I went nicely. He said to Mr. T., "Now, I will let her go; be gentle with her and do not worry her mouth"; so he let go. I became nervous then and made two or three plunges. Mr. T. sat me well, was easy with my mouth, and spoke kindly to me, so I settled down and walked along quietly.

Mr. T. then said, "So, my lady, you thought you could unseat me, but I will teach you that I am master here." He then drew heavily on the reins and hurt my mouth, and he hit me a smart cut with his whip, which caused me pain. This made me angry, as he had no right to punish me when I was acting nicely; so I bucked and threw him off. He alighted heavily on the hard ground; and I stood still until he got on his feet. My master came to me and caught the bridle; he asked Mr. T. if he was badly hurt, and told him that he should not have punished me. Mr. T. said that he was not badly hurt and that he would mount again, which he did; and as he used me kindly I did not throw him again. The next day I heard my master tell Ernest that two of Mr. T.'s ribs had been broken by the fall. I felt sorry, but really it was his own fault. After this I was ridden daily by Ernest. He was kind to me, and I acted well. I soon became handy, and Ernest said that I was very easy to ride. One day my mistress asked if she might ride me; and my master said yes, that I was perfectly safe. So they put saddles and bridles on me and my mother, and my mistress and master rode us. After that she rode me often, and said that she liked me better than her own saddle horse. She sits me well and has very light hands. I like to have her ride me. She says that I walk, trot and canter well, and that my mouth is perfection. One day she asked me to jump a ditch, and I did it so well that she tried me over fences. I like jumping; I think I inherit the liking and ability to jump from both my parents. When the hunting season commenced, my master rode a big bay half-bred that he calls Pharoah, and my mistress rode her big bay half-bred mare, Dorothy. There are so many barbed wire fences and so many swamps around here that they cannot hunt foxes as they do in some countries; so the huntsman rides across the country with a ball soaked in oil of anise trailing after him. He avoids swamps and barbed-wire fences. Then the club comes on horseback, and the huntsman brings the hounds out. The hounds scent the anise, and follow the course that the huntsman had gone. This is called "hunting a drag." The hounds make a lot of noise which is called giving tongue. I heard my master tell the huntsman one day to make a short run, as he wanted to try Tomboy across country, and that he would ride Duster; that the one was too young and the other too old for a long run, and to make it about four miles. So we were taken out one afternoon. My master rode my mother, and my mistress was up on me. As soon as the hounds came in sight I noticed that my mother became excited. She pawed the ground and champed the bit and wanted to be off. I did not understand it, as I saw nothing to be excited about. There were about twenty ladies and gentlemen in the saddle. After a while the hounds scented the drag, and one of them gave tongue. My master said, "Old Cecil has found; steady, Duster, steady."

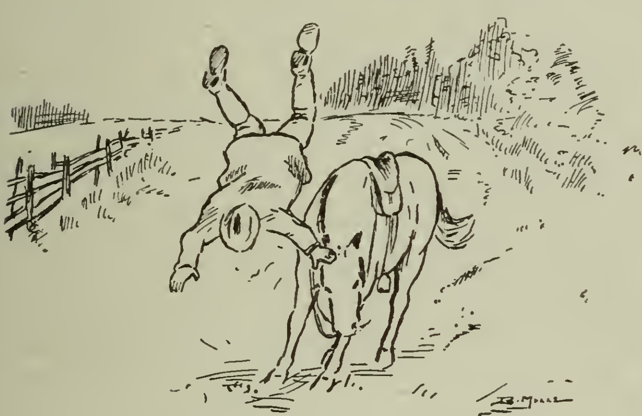


Fig. 3. The colt gives a lesson.

Away the hounds went over the fence. My master had his hands full controlling his mount, but he managed to steady her and said to my mistress, "Now, I will give you a lead; steady her well at the jumps." He gave my mother her head and took the fence. I followed and off we went after the hounds. The other riders followed. My mother was very anxious to go fast, but her rider held in, and said to my mistress, "Keep Tomboy back for a while; we will save our mounts at first, and see if the old mare and her daughter cannot beat them all out at the finish." I soon understood my mother's excitement, as I was becoming excited, too, and anxious to run to the front. Our riders held us back without being severe or cross with us, and we jumped everything that came in the way. We enjoyed the sport as much as our riders. My mistress talked to me and praised the way I was carrying her, and said she would let me have a brush with my mother at the finish. By this she meant that she would let me try to outrun her. I would rather have gone faster, but wanted to please my mistress, and I knew that she was the better judge. Some of the riders were ahead of us and some were behind, as their horses refused to jump. We went along steadily and did not make any mistakes, but took our jumps well. After we had gone about three miles we noticed those

Fig. 4. Tomboy and Duster lead the way.

in front of us stop short. The riders took their mounts back and then turned and whipped them; after which they ran to a certain place and balked. Two of the riders went forward over their horses' heads and were lost to view, while the horses galloped over the field with empty saddles. My master said to my mistress, "They have come to a stream and the horses refuse to take water." He meant that they would not jump over the water. "It is a broad jump, and our mounts will require speed to take it; steady Tomboy and follow me, but do not whip her." He gave my mother her head, and she went fast, with me close up. We passed through the other horses and both jumped the stream with ease. The hounds had lost the scent and were running around the field without making any noise. We came to a standstill and got a rest. Our master blew his horn, when every hound raised his head and looked toward us. He blew again, and they all came to us. In the meantime some of the horses got across the stream, but some would not take it. Master told the hounds to hunt, and Cecil again found and gave tongue. The others soon joined her, and away they went, making a great noise. Both my mother and I were excited now and anxious to be off, but our riders controlled us until the hounds got well away, when our master said, "We are near the finish now, so let us have a brush and try Tomboy's mettle." They gave us our heads and off we went side by side. I was anxious for my mistress to win; but my mother can run fast even though she is old. We left the other horses behind. There was an open gate leading into the road, and about a quarter of a mile off we saw the hounds had lost again, and we knew that this was the finish. We ran down the road very fast; and just at the last I got about half my length ahead of my mother and won. I think she allowed me to do so, but she will not admit it. This was near home, so we were ridden home, and my mistress gave me great praise and said she would never allow me to be sold, but would keep me for her own saddle horse. I was glad that I had done so well, as I liked my mistress and had a good home, and a horse never knows what kind of master he will get when he is sold. We were taken home and given a few mouthfuls of water, put into our stalls, and given a nice warm mash each, rubbed until we were dry, and bandages put on our legs, and left on for about three hours. The next day we were given some walking exercise, and we both felt quite fresh. My mistress intends to ride and hunt me regularly, but my master says my mother is too old for such violent exercise and he does not think he will hunt her again. He says he will keep her as long as she lives; that it would be mean to sell so good a servant in her old age; and that he could not bear to see her owned by any person who might not be kind to her.

THE STORY OF APPLE SCAB

Prof. J. E. Howitt.

Nearly every year black spots are seen on apples, especially on such varieties as Snows and Greenings. When we enquire what causes them we are told that they are due to a fungus disease known as Apple Scab. Naturally the next question that comes to our mind is "What is a fungus disease?" Most of us are inclined to think that a fungus disease is something mysterious, something which cannot be explained. However, a high power microscope shows us that there is nothing more strange about a fungus disease than there is about a dog having fleas. A flea is a small and low form of animal life which lives upon and obtains its nourishment from the dog, which is a larger and more highly developed form of animal life, while a fungus disease is caused by a fungus which is an exceedingly small and low form of plant life, which lives upon and obtains its nourishment from a larger and more highly developed form of plant life such as an apple tree or a potato plant.

These little plants, which are called fungi, are just as much plants as are sunflowers, turnips and maple trees. They differ from such well known plants as these chiefly in their very small size, in the fact that they have no roots, stems, leaves, flowers or green color, and also in the way they get their food.

Most fungi are very, very small, though there are some quite large ones. Some idea of how small many of them are can be had when we are told that we can only see them when there are several hundreds of them growing close together, and then usually only as mere specks.

Instead of being composed of roots, stems and leaves, fungi are made up of very fine and delicate threads, some of which bear little bodies called spores, which take the place of the seeds of our familiar plants. These seed bodies or spores are generally very numerous and always very small, so small indeed that they can only be seen without a magnifying glass when there are several hundreds of them massed together. Being so small they are very light, and, therefore, very easily blown about by the wind, washed around by rain, or carried on implements and clothing from place to place.

The familiar plants, such as trees, flowers, grains and vegetables, take certain substances from the soil and air, and out of these they manufacture their food. Fungi have not the power to manufacture their own food, so they steal it from other plants or get it from the bodies of dead and decaying plants or animals. Those fungi which steal their food from other plants injure them in various ways, and thus cause what are known as fungus diseases. So we see that after all there is nothing very wonderful about fungus diseases, except the small size of the little plants called fungi which cause them.

Now that we know something about the nature of fungus diseases we are better able to understand "The Story of Apple Scab." If we go into an orchard and look over an apple tree we shall see that there are black and brown spots on the leaves as well as on the fruits. If the spring and early summer have been very wet and the trees have not been sprayed, in all probability nearly all the fruits will be disfigured and many of the leaves destroyed by the apple scab. If we could examine under the microscope the black or brownish spots on the fruits and leaves we should find that they were made up chiefly of fungus threads and very small somewhat oval spores. These spores are produced just under the outer layer of the apple skin which is soon pushed off so that they are right on the surface of the spot, from which they are easily washed away by rain, blown about by the wind or carried off on the bodies of insects. By such means the spores produced on a scab spot are spread all through the orchard. Those that reach an apple or an apple leaf, if there is plenty of moisture, begin to grow. They send out very small threads called germ tubes which bore under the skin and grow into numerous fungus threads and spores which soon show on the surface of the leaf or fruit as spots. Plenty of moisture is necessary to cause the spores of the scab fungus to grow and produce new spots. This explains why apple scab is always worse in a wet season than it is in a dry one.

The spores found on the surface of the spots are often called summer spores because they spread the scab during the summer months. They are not, however, the only spores produced by the scab fungus. If in the early spring we examine the fallen leaves under an apple tree on which the scab has been bad the previous year, we shall notice on both surfaces of the leaves little black, pimple-like bodies, some mere specks, some as large as a pin's head. If we could examine these under a microscope we should find that they were round black cases, each with a very small hole or mouth. In each case we should find a large number of little sacks, and in each sack eight little spores. In the spring, when the weather begins to get warmer, if there is plenty of rain these spores are set free into the air, and some of them are blown on to the lower leaves of the apple tree, where, if there is plenty of moisture, they grow and produce scab spots with numerous summer spores, which, if the weather is wet, soon spread the scab through the orchard.

As these spores which are found on the fallen leaves in the spring of the year serve to carry the fungus over the winter, they are often called winter spores. Just when they are liberated in the spring of the year depends upon the time we get our rains. Moisture is required to set free these winter spores as well as to cause them to grow. In most seasons we get enough rain to set free the spores and cause them to grow just about the time the leaves of the apple trees are unfolding. The scab fungus only grows and spreads rapidly when there is plenty of moisture, so that the times of the year that the scab usually does the most damage are during the spring and early summer months, which are very likely to be wet, and during the early fall rains which we often have about the middle of August or first of September.

If we enquire how to prevent apple scab we are told to spray with lime-sulphur or Bordeaux mixture. These substances are what are called fungicides, that is, they kill fungi; and the object of spraying is to cover the surfaces of the leaves and fruits with them so that when a spore reaches a leaf or fruit it is poisoned and cannot grow and cause scab. We see, therefore, that if spraying is to accomplish its object it must be very thoroughly done; every fruit and leaf must be all covered with the poison so there is not the least space on which a spore can grow.

Spraying must also be done at the proper time. The poison should be on the leaves and fruit before the spores reach them. We have already learned that the spores only spread and grow during wet weather. The times of the year, therefore, that we get our wet weather are the times when we have to spray if we are going to prevent scab. One spraying with either lime-sulphur or Bordeaux mixture is not sufficient as the rain in time washes the spray off and, as the leaves and fruit grow larger, there is more surface to cover. In order to be sure of preventing apple scab we must spray with lime-sulphur or Bordeaux mixture from three to five times during the summer, the number of sprayings depending upon whether the season is wet or dry. The first spraying should be done early in the spring just as the leaf buds burst, the second just when the blossom buds are showing pink, the third immediately after the blossoms have fallen. If the weather is wet after this time another spraying should be given in about two weeks. After this last spraying we seldom get very much rain until late summer when the weather very often becomes cold and wet and favorable for the spread of scab. In such seasons it is necessary to spray again in August.

THE STORY OF THE SMALLEST LIVING THINGS

Prof. Dan H. Jones.

The smallest of all living things are known as bacteria. These are very tiny little plants that cannot be seen unless we use a very powerful microscope to look at them with. They are so very small that a million of them could be placed on the head of a small pin and not be crowded.

There are many kinds of bacteria. Some of them are round like a ball; some of them are straight like a pencil; some of them are twisted like a cork-screw; and some of them are long and thin like a thread. Some kinds when placed in a drop of water under a powerful microscope can be seen to swim about quickly like little fish; other kinds move about slowly like worms, while other kinds cannot move about at all. Those that move about have little whips called flagella sticking out from their bodies. Some kinds have these whips at the end of the body, while other kinds have many of them scattered all over the body. When they lash these whips about in the water it causes them to move like fish move when they wiggle their tails.

Bacteria are found everywhere that other living things are found. They are present on the ground, in the air, in water and on our hands and clothes. Many kinds are very useful to us and are used for many purposes. Others are very injurious as they cause disease and death. One kind causes typhoid fever and another kind causes diphtheria, while another kind causes tuberculosis or consumption, and still other diseases are caused by other kinds. One kind causes vegetables to rot in the ground or in the cellar, another kind causes a blight on apple trees and

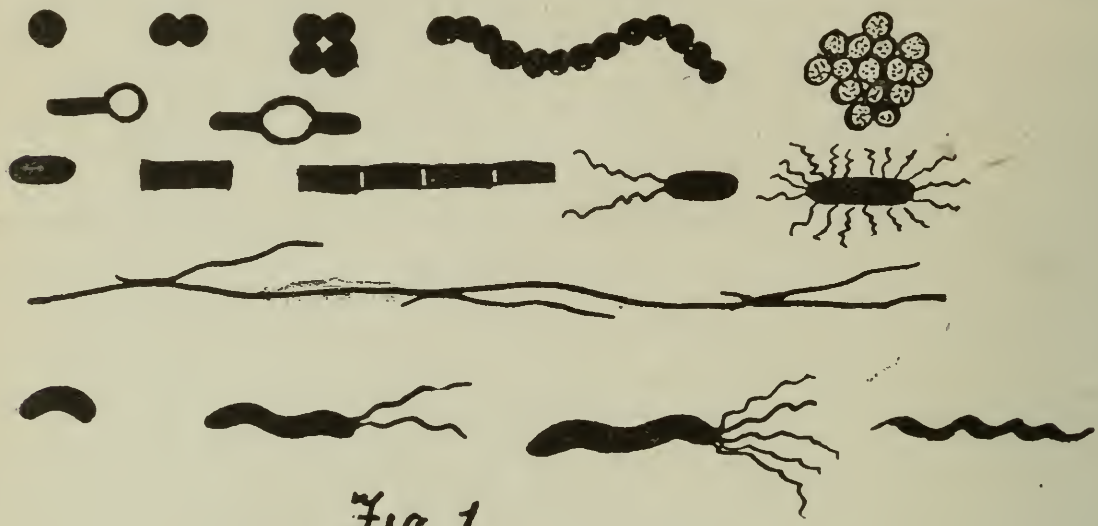


Fig. 1.

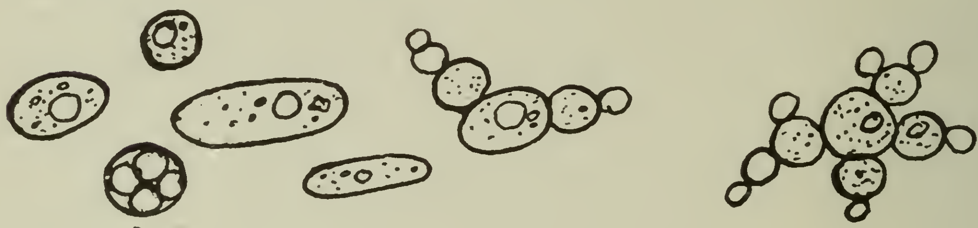


Fig. 2.

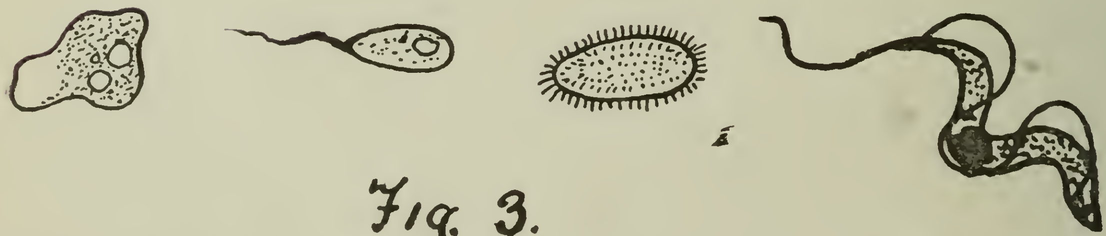


Fig. 3.

Fig. 1.—Different types of bacteria. Fig. 2.—Yeast plants, some of them budding. Fig. 3.—Different types of microscopic animals.

pear trees, and still another kind causes cucumber plants to wilt and die. So you see that though bacteria are very small, so small that we cannot see them without a highly magnifying microscope, they are very important and we should learn all we can about them so that we may know how to help the good and useful kinds and how to destroy the bad and dangerous kinds.

In the soil of the garden, the field and the woods, bacteria are very useful. They are not only useful here but necessary, as the plants and trees could not grow without them. They are known as the soil bacteria. Their work in the soil is to prepare the food for the plants. When we eat a piece of bread and butter or anything else we have to chew it in our mouth and then digest it in our stomach before our body can use it to make blood and bone and muscle. The bacteria in the soil digest the plant food that is there, and make it so that the plant can take it in through the root hairs to make leaves and branches and flowers and fruits. So you see that if the plants in the garden are to grow their best we must encourage the bacteria in the soil to digest or prepare plenty of food for the plants to take in. If they are to prepare plenty of food for the plants we must put plenty of food into the soil, as manures and fertilizers, for them to work on. Then, as the soil bacteria like plenty of air, we must keep the soil well worked up with the hoe and cultivator, as this enables air to get into the soil. They also require moisture, so we must not let the garden get too much dried out. In a teaspoonful of good garden soil there are several millions of soil bacteria. The richer the soil is the more bacteria there are, and so the more plant food is prepared for the plants that are growing in it, causing them to grow larger and better than plants growing in a poorer soil. Some kinds of soil bacteria, instead of digesting the plant food that is added to the soil, as manure, are able to obtain from the air itself much valuable food in the shape of nitrogen which they add to the soil and make it so that plants can use it. The plants themselves cannot do this.

If we keep fresh milk or cream in a warm place it soon turns sour or changes some other way. If we keep it in a cool place it will also turn, but it takes a longer time. These changes are caused by bacteria of various kinds. These bacteria get into the milk in many ways. If the milk pails, cans and bottles are not well scalded, there will be bacteria in them, and so when milk is put into these vessels the bacteria in them will begin to act on the milk right away. If bits of hay and straw and particles of dust and cow hairs and flies are allowed to drop into the milk they will bring many bacteria with them, and these on getting into the milk will at once begin their work of spoiling it. So you see how necessary it is if we are to have good milk, we must not only get it from good healthy cows, but we must be very careful to have all cans well scalded and to take all care to keep flies and bits of dirt and other things from getting into the milk. We must also keep the milk in a cold place, as the bacteria will not be able to change it so rapidly when it is cold as when it is warm, for, however careful we are, we cannot, in the ordinary way of caring for milk, keep all bacteria from getting into it, but the more careful we are the fewer will get in, and the better the milk will be.

In the dairy, when butter is to be made from cream, a "lactic starter" is first added to the cream and allowed to work over night. This is a culture of one kind of bacteria, the lactic acid bacteria, which has the power to give a good flavor to the butter. When butter is bad flavored it is generally due to other kinds of bacteria being present in the cream from which the butter is made.

In the summer time it is very difficult to keep raw meat in a fresh condition unless it is kept in a refrigerator. This is due to various kinds of bacteria getting on to the surface of the meat during the handling of it from the air and from flies. Flies have millions of bacteria on their legs and so when they get on to meat they plant bacteria on it wherever they walk over it. These bacteria on the flies' legs come from the filth and manure in which flies breed.

Another tiny microscopic plant which is different from bacteria is the yeast plant. If we take a very small bit of Fleischman's yeast on the point of a needle, mix it in a small drop of water on a microscope slide and look at it through a highly magnifying microscope, we shall see that it is made up of a very large number of oval or egg-shaped bodies. Each one of these oval or egg-shaped bodies is a yeast plant. In a cake of Fleischman's yeast there are many millions of them.

There are many varieties of yeast plants, though they look very much alike. Some of them, like Fleischman's yeast, are very useful and others are not useful, and some of them are even injurious. Yeast plants are used in the manufacture of bread, beer, wine, whiskey, root beer, cider, etc. When yeast plants get into anything containing sugar and water, or fruit juices, they begin to grow and multiply. They feed on the sugar water by absorbing it and almost immediately begin to bud. At first very small buds will begin to show on the surface of the yeast plant. These buds will quickly grow until they are as large as the plant that has produced them and then they will begin to bud, and so they continue growing and budding, or multiplying, as long as the material they are growing in is suitable for them. During this process they act on the sugar and change it into alcohol and carbon dioxide gas. It is this carbon dioxide gas that causes the dough to rise when bread is being made. It helps to make the bread light, spongy and digestible.

Yeast plants are very common on the surface of fresh fruits, though, as they are so small, we cannot see them. If, however, we put some fruit into a jar or bottle and crush it, then allow it to stand for a few days, a fermentation will take place in the fruit juice. This fermentation is the result of the growth and multiplication of the yeast cells that were on the fruit at the time it was put into the bottle. If when canning fruit for preserves we are not careful to kill, by boiling or steaming, all the yeast and mold plants that are on the fruit then the jars of fruit will ferment and spoil. Many jars of fruit are spoiled in this way every year.

In the manufacture of wine the grapes are crushed and the juice extracted is allowed to ferment. This fermentation is caused by the growth and multiplication of the tiny yeast plants which were invisible on the surface of the grapes. Sometimes the wine is good and sometimes it is bad. Whether it is good or bad depends as much on the varieties of yeast plants that are on the grapes as on the quality of the grapes themselves.

In the manufacture of cider the apples are crushed and the juice strained off into barrels. It is then sweet cider. If the cider is to be used as sweet cider it has to be pasteurized. That is, it has to be heated to 70-75 degrees centigrade for twenty minutes to kill all the yeast plants that are in it that have come from the surface of the apples. Care must also be taken to keep yeast plants from getting into it after it has been pasteurized or else it will ferment.

If it is intended for hard cider then it is not pasteurized but filled into barrels and allowed to ferment. This fermentation is brought about, as in the case of wine, by the growth and multiplication of the yeast plants that were on the surface of the fruit that was crushed. Sometimes a little Fleischman's yeast is added to the juice when it is put into the barrels. This hastens the fermentation. The fermentation results in changing the fruit sugar that was in the apple juice into alcohol and carbon dioxide gas, and the fermented juice is then known as hard cider.

There are many tiny microscopic animals as well as microscopic plants. These, however, are usually a little larger than bacteria or yeasts. They are very common in swamp water and roadside puddles. Like bacteria and yeasts they are too small to be seen without a highly magnifying microscope.

THE STORY OF THE PLOW

J. R. Spry, B.S.A.

You have seen your fathers or brothers plowing in the fields and are doubtless so accustomed to this commonplace farm operation that you may think that farmers always had horses, harness and plows like we have to-day. But plowing the fields was not always the simple and easy thing it is now, A long time ago the farmers had no horses, but had to use slow, clumsy oxen instead. They had no leather harness, but used willow branches twisted into thongs with which to hitch the oxen to the plow. They had no steel plow like your father's, but used a crooked stick as a substitute.

The first plow was a pig's nose. Not that the farmer plowed with a pig's nose, but the first plowing was done by pigs as they rooted over the soft earth in search of juicy plant roots or fat grubs. The farmer of long ago noticed the efficient manner in which the pigs turned over the soil and tried to imitate them. He cut down a small tree and trimmed off all but one branch, leaving this one about two feet long and sharpened on the end. A long stick was fastened to the trunk of the tree with which to steady it, and the plow was ready to use. This was dragged up and down over the area to be planted and the earth torn up until it was sufficiently loosened to give a covering of soil for the seed to be sown.

Primitive plowing. Merely scratching the surface of the ground.

The only reason given for plowing the soil in those days was to get a covering of earth for the seeds. It was soon found, however, that the weeds got thicker and thicker after each crop, and as years went by and the field was plowed again and again the soil became harder to work. It would be very sticky when wet and bake into a hard mass when dry, and the plants were greatly injured by the dry weather.

The first type of plow with moldboard.

Now the reason of this was that the stick-plow did not turn the weeds and weed seeds under the soil to smother and die, neither did it turn up their roots to be killed by the frost. Neither did the plow crumble the soil as do the plows we now use; nor did this stick-plow loosen the soil to any great depth, for had the soil been worked deeper it would have held more of the rains and the plants would not have died of thirst in the hot season.

And so we see with such a poor plow only poor crops could be produced, and farmers were not very prosperous at this time. Some men who have studied the history of farming tell us that the story of the plow is the story of farming; that if the plow used by the farmers of a nation is poorly constructed and gives but indifferent results, we are sure to find that nation lacking in agricultural know-

The one-furrow plow; in common use in Ontario.

Plowing two furrows at one time.

ledge and the homes of the farmers not very comfortable. I suppose this shows that the man who is a good farmer is a careful plowman, and the boy or girl who would have a good garden must spade and hoe the ground carefully and often.

But even if these farmers of long ago had a poor plow they at least had grasped the idea suggested by the pig's nose, and many improvements were soon made in the shape of the plow which increased its usefulness. But for many years the plow remained at best a clumsy implement which served to stir the soil to only a very slight depth, and did not cover the weeds and grass as a good plow should do.

A peculiar custom in some countries was to draw plows by tying them to the tails of the horses or oxen. They had no harness-makers such as we have, and leather harness was unknown. So tying the plow to the horse's tail was about as handy and cheap a way of "hitching up" the horse or ox as could be thought of. After a while people began to see that this was a cruel practice, and laws were passed making it a crime to plow in this manner. About the time the first houses were

A large gasoline tractor plow which turns six furrows.

built where we now have the City of Montreal, an Irish Parliament passed a law entitled "An Act Against Plowing by the Tayle," which declared that any person plowing by hitching the plow to the tail of any animal should be fined and imprisoned.

The plow of those days left the soil lumpy, and the farmer or his sons broke up the clods with a club. One of the reasons for plowing is to make the soil fine and granular. It would never do to leave the ground all lumps.

A lumpy soil will not germinate seeds well, for to make seeds come up quickly the soil should be fine enough to touch the seed on all sides. A lumpy soil will not grow large and healthy plants, for the roots find it difficult to obtain food and water. In Ontario if our plow should leave the soil lumpy when plowed in the fall, the frosts of winter push the little soil grains apart, the lumps fall to pieces, and the following spring where we had lumpy soil we have a loose, easily worked soil layer. So in this country the frost does the work of breaking up the clods which the farmers' sons had to do in the olden times. For this reason when the field or garden becomes baked hard during the summer it is best to plow the field and dig the garden in the fall so that the frosts will loosen up the soil for the following spring when the seeds of grain or flowers are to be sown.

All the plows we have been telling you about were made of wood, but they used to break easily and would wear out quickly, so some one made one partly of iron, placing the iron on the parts of the plow that used to wear out first; the other parts were still made of wood. Later the plows were made of iron except the handles. But a peculiar thing happened. You may remember hearing your grandfather tell how that when stoves first came into use that they were looked upon as something which would poison the air in a house, using up the good air and giving off air not fit to breathe. He might also tell you how that oil lamps were expected to explode and burn down houses, and how that people would sit away back from the table awaiting the calamity. These may seem queer ideas to you, but a new and useful idea is oftentimes ridiculed, and so it was with the iron plow. Some farmers said it made the weeds grow, others that it poisoned the soil, and many refused to use it. However, this strange opinion soon died out, and the wooden plows can now be found only in our museums.

And so to-day the plow your father uses is the result of 4,000 years of slow improvement from the crooked sticks that only scratched the ground to an implement that pulverizes the soil and exerts a more important influence on the productiveness of a soil than any other single tillage operation. As a result of all this your father works more land and grows better crops, and you live in more comfortable homes than did the farmer and his boys and girls who had only a crooked stick to plow with.

A STORY ABOUT HONEY

Morley Pettit, Provincial Apiarist.

This is a story of flowers, sunshine and bees, rain and good rich earth, and of the sweetest thing that children ever eat.

When warm and moist, rich earth grows healthy flowers, which produce sweet nectar. Bees fly in the sunshine, gather nectar from the flowers and carry it home to make honey. So that is what flowers, sunshine and bees, rain and rich earth have to do with the honey boys and girls like so much.

Some flowers do not secrete nectar, and many that do are so rare as to be of little value to bees. There are a few, however, of which the bees are very fond, and I am going to tell you about some of these and how they are affected by sunshine, rain and soil.

In the early spring, as soon as bees can fly, they begin to hunt for nectar. About the first they find is in the "pussies" of the willows down by the creek or in the swamp. There are so many kinds of willows that no one has been able to name them all. They keep on blooming all through the spring, and bees get a great deal of nectar from them.

Soon after the earliest willows, and before they have any leaves at all, the maples show their red-brown glow of blossoms, and if it is warm enough, the bees are as busy as can be carrying home their nectar. Next come the fruit blossoms—cherries, peaches, pears, plums, and all the rest, till last of all the apple orchards turn one glorious mass of pink and white. Now it all depends on the sunshine whether the bees get nectar, and whether the trees set fruit. For if it is cool and cloudy bees cannot fly, and if they do not visit the flowers to scatter the life-bearing pollen, there is no fruit. So you see the bees are not the only ones who need the sun.

After the fruit blossoms come the beautiful dandelions, which spread a mat of gold over lawns and meadows, making one think King Midas must have touched everything with his "golden touch." These also need the sun for they go to sleep at night and only open their bright eyes when the sun appears.

Honey bees on apple blossoms.

Now if there is warm sunshine and frequent showers bees gather nectar from all of these, but the boys and girls do not get the honey. Let me tell you a secret. In each hive the mother queen is daily laying hundreds of eggs. The nurse bees keep them warm, and from each egg after the third day a baby bee appears. It doesn't look much like a bee though. It is just a tiny white grub called a larva. These baby bees are great eaters, and the nurses are kept as busy as can be feeding them. All the nectar brought in during the spring is used in preparing this food, which is something like milk and something like jelly. Each larva lives in its own little cell in the comb feeding and growing faster than any boy you ever saw. When it is six days old the nurses help it cover itself up, and for twelve days while it is hidden from sight wonderful changes take place until it becomes no longer a helpless worm, but a busy bee with bright eyes and gauzy wings and active legs and a sting, and energy enough to chase you off the place if you don't watch out. These workers which are hatching by hundreds—yes, thousands—daily in every hive usually eat all the nectar brought in during spring; but when the main harvest of summer comes they make up for it by storing the kind of honey we want most.

By the first of June the beekeeper is watching out for the first white clover blossom. When he sees one he knows that in about ten days the main "honey flow," as he calls it, will begin. There are three common kinds of clover, the big red heads, the little white Dutch and the pink alsike. Red clover keeps most of its nectar for the bumble bees, because its flower tubes are so deep that the honey bee cannot reach the bottom with its tongue.

The White Dutch and alsike clovers are by far the best honey plants in most parts of Ontario, and the nectar they produce will depend on the kind of soil in which they grow. They do best in heavy clay with lots of lime and good drainage. They also like lots of rain while they are growing and as much heat as possible while they are producing nectar. They are called two-year plants, because they grow and get strong the first year, then blossom and give nectar the second. If they have plenty of rain the first year while they are growing, they seem to store up a great deal of the material from which honey is made. Then bright sunshine and hot days and nights at the right time help the blossoms to give large quantities of the sweet liquid which bees gather and make into honey.

Perhaps it will help you to understand this if you remember the kind of summers we had in 1915 and 1916. The former year it rained and rained, so that the farmers had the hardest time to save their crops. But while it was raining so hard and people were afraid the whole country would be ruined, the new clover was growing big and strong all over the fields and down the lane and along the roadsides. Then the next spring it started and rained again, and it rained and rained until lots of spring seeding was not done at all; but all the time those same clover plants were growing bigger and stronger and storing up material for making nectar, and in June great big blossoms came out all over them everywhere.

Then what did it do but turn dry and so hot that you could hardly do anything but look for a shady place, and then you could not possibly keep cool. But how those bees did work! They were out in the morning as soon as they could see, and at it until dark at night. They even worked nearly all night evaporating the nectar and making it into honey, and the roar in the hives of many thousands of wings fanning to ripen the honey was like distant thunder.

In some hives they would gather as much as eight or ten pounds of nectar in a single day and keep it up for several days together. When you think that a bee can only carry one drop at a time, can you imagine how many bees and how many trips and how many clover blossoms it would take for ten pounds of nectar to be carried into a hive in a single day. But what else could they do? There were so many clover blossoms everywhere and they were so full of nectar that they could not possibly gather it all, and yet they could not bear to see it waste. It was well they did work hard, too, because it was all over in a few weeks, and very little more did they get that summer.

Some years the basswood trees with their creamy white blossoms give nectar after the middle of July; but if it is hot and dry then they are spoiled. The same may be said of buckwheat and other fall flowers. You will see then that sunshine, rain and good rich earth have much to do with flowers, bees and honey.

Now, we shall see how the honey really is made. You have heard that bees make it of nectar, which they gather from flowers. Let us watch a bee at work on a clover blossom. It dips its long slender tongue down into one tube after another, then flits away to the next flower and does the same. What is it doing? It is drinking up the tiny sweet drops—and swallowing them. It must surely be eating it all and not saving any to take home. But no, I will tell you. The nectar it swallows does not go to its stomach, but to its honey-sac. When this is full the bee flies away home to its hive.

If you can get a beekeeper to show you the inside of a hive you will see many wonderful things. At first the hive seems to be filled with combs built in frames, but on looking closely you will see that there are narrow spaces between the combs, and it is here that the bees live. There are many thousand other bees which look so much like the one we have been watching that you could hardly tell them apart.

If you look closely, however, you will see that some are grey and fuzzy and others are brown or yellow, or golden. Others again are big, blunt, burly fellows. The grey ones are the youngest, the brown or yellow ones are older, and the big burly fellows are the drones.

The combs with which the hive is furnished consist of a great many little cups called cells. They are built by the workers of wax which they make themselves. They use the combs as cradles for the young and for storing honey and pollen.

All the thousands of bees in the hive have one mother. She is called the queen, and, of course, they are very fond of her. She does not do anything but lay

Opening a hive, showing comb of capped brood.

the eggs from which the young bees are reared. She places them in the cells of the comb, one in each. You have already heard how the young bees develop.

When a new bee comes out of its cell it finds itself in a crowd of busy jostling workers, who pay no more attention to it than though it were not there. It is rather weak at first, but soon gets food and before long is helping the other young bees with the housework. Like the hundreds of others coming out at the same time it finds its place and work in the community. It first does hive work, which consists in feeding the larvæ, secreting wax, building comb, ripening honey, "cleaning house," and the many other duties about the hive.

When two or three weeks old the young bees learn to fly and begin gathering nectar and pollen. They are then no longer "hive bees" but "field bees," and if there is all the work they can do, they work so hard that they only live three or four weeks after that. They have a happy life while they live, for a bee seems to like nothing better than flitting from flower to flower gathering nectar in the sunshine. Bees that come later in the season do not have so much work and live all winter.

But we must not forget our bee with its load of nectar. Like thousands of others coming in at the same time it deposits its load in a cell or gives it to a hive bee—bringing it up through its mouth and long tube-like tongue—then crawls into an empty cell and takes a good long rest before starting out on another trip.

When it is taken from the flowers nectar is sweet but very thin and has to be evaporated much as maple sap is boiled down to make syrup; only the bees do not boil the nectar. They dry and thicken it by fanning with their wings to cause a current of air through the hive. When so much nectar is coming in everyone in the hive is well fed, and white flakes of wax grow on the sides of the younger bees. That is the way beeswax is produced. They use these dainty white flakes for building comb, and as fast as cells are filled with ripened honey they are capped with wax.

Of course, the capped combs of honey are meant for winter stores, but there are generally some to spare for the beekeeper. He takes them from the hive, and with a sharp knife removes the capping before extracting them. The extractor is a machine which whirls the combs so rapidly that all the honey flies out. The combs are not broken or damaged in any way and may be returned to the hive to be again filled with honey.

The extracted honey is strained through cloth to remove all pieces of wax and then is ready for use. Clover or basswood honey is a clear or light amber color, but that from buckwheat and other fall flowers is quite dark.

Extracted honey soon granulates and turns hard and solid when the cool weather of autumn comes on. It is just right then to spread on your bread. I see some children smacking their lips at the very thought of it. Extracted honey is sometimes sold in small glass jars or bottles, but the best way to buy it is in tin cans or pails, because tin costs less than glass and you get more honey for your money.

Honey should not be kept in the cellar or refrigerator or any place where it might draw dampness. A warm, dry place, such as the kitchen cupboard is best.

When liquefying granulated honey one must take great care not to get it too hot or it will be spoiled. Place the can in a larger dish containing water on the back of the stove where it will keep warm but not boil. In fact, the water should not become too warm to bear the hand. When honey gets too warm it turns dark and the flavor is spoiled. After several hours of slow heating it will be as clear and taste quite as good as when the bees first stored it in the comb.

Now you have seen how flowers and bees need sunshine, rain and good rich earth. And when it rains and spoils your out-door fun you must remember that it helps the clover and will make lots of honey for the bees—and for you.

THE STORY OF A DOG

G. H. Unwin, B.S.A.

The dog I am going to tell you about lives on a farm. He is a big Scotch collie with a shiny coat, mostly black and white, and a long graceful tail, which waves in the air like a flag. As he has a kind master and is treated like a friend of the family this tail is generally waving about, sometimes fast, sometimes slow, as if he were trying to say: "I can't talk but this is my way of letting you know that all's well." By the way, I forgot to tell you the dog's name; it is Bill, son of Nellie.

When Bill first appeared on the scene he was a fat helpless little fellow without any clothes to speak of—I mean hair, of course—and he lay and squeaked and squirmed with his brothers and sisters and wondered when the next meal was coming. His eyes were tight shut and you would have had some trouble in picking him out that time, as all the pups looked exactly the same. They lay all higgledy-piggledy, and didn't seem to care whether they were on top of the pile or right underneath. Their mother was proud of them, and if you had told her they were not pretty she would have been very much offended. But then all mothers think their babies pretty, which is perfectly right and natural.

Before very long Bill opened his eyes and began to take notice. First he crawled all over his brothers and sisters looking for his mother; but she had left her family for a short time and had gone out for an airing. While he was poking about he suddenly stubbed his nose against something hard, which made him stop and think a bit. This hard thing was only the side of the old soap-box in which the puppies lived, but to Bill it seemed as big as the wall of a great barn, and though he stretched his little fat neck he couldn't see over the top.

Bill, age two months.

The puppies grew very quickly, however, and one day, by standing on the back of one of his brothers, who was asleep, Bill managed to get his forepaws over the edge of the box and took his first look at the outside world—which was really only the floor of the drive-shed. It looked very big and lonesome. Imagine a great flat field stretching away for miles with no grass or trees on it, but rising out of the centre a huge thing bigger than the largest house, supported on four great wheels. You will then have some idea what the drive-shed looked like to a tender puppy who had never seen anything but the inside of a soap-box. The large thing in the centre was the wagon. Bill looked and looked, and after a time he began to feel so curious that he forgot to be frightened and was soon trying hard to scramble over; and just then his brother, whose dreams were disturbed by Bill's hind feet prodding his fat ribs, woke up and gave a heave from below which sent Bill toppling over the edge. He lit on his nose, gave a little squeak, rolled over twice and then sat up and looked round him. Then he got up and wobbled off on a voyage of discovery.

What an exciting time he had! Everything he saw made him jump and thrill all over. I couldn't begin to tell you all the wonderful things that happened to him. He tripped up over everything that was small enough and ran into everything that was big enough. You see his eyes were not accustomed to things, and he couldn't tell how far away a thing was till he stubbed it with his nose. A large rat came out of a hole in the corner and ran along the wall to the harness room; and little Bill, who of course had never seen a rat before, and didn't know that all rats were the natural enemies of dogs, just sat down on his tail and stared after it with his head on one side and his forehead crinkled with amazement. He walked into a puddle of water and walked out again in a great hurry, leaving the track of his four little wet puds across the shed. Then he blundered into a pile of landplaster, and by the time he had got out of that his soft fur was streaked and powdered with white and he looked a queer object. After a bit he got very tired and was just thinking of crying for help when he saw a large grey animal, curled up in a patch of sunshine and looking very soft and comfortable. "This is worth looking into," thought he and so he waddled over to pay his respects. . . .

Poor Bill! it was a day of uncomfortable surprises.

The cat wasn't at all pleased to see him; she arched her back, spat twice, made some uncomplimentary remarks about dogs in general, and scratched him on the nose. What would have happened I don't know, but by good luck his mother came in just then, and puss didn't even stop to say "good morning," but was up on the wagon seat before you could turn round. Bill was picked up by the scruff of the neck and put back into the soap box; and very glad he was to find himself at home again. But he always remembered that cat, and when he got bigger used to chase her into a tree when nobody was looking.

When the puppies got old enough to run about by themselves they were jolly little fellows, round and soft and full of impertinence and mischief. They would play about for hours, knocking each other over and rolling in the dust. Then they would get angry and growl deep in the chest, and yap and fight till the wise old mother would put her nose under them and send them flying; after which they would forget all about it and go to sleep cuddled so close together that they looked just like one big lump of soft fur.

A pup has to be educated just like a child, and Bill was learning something all the time. He learned, among other things, to respect those who were older than himself and knew more. When he had grown into a long lanky creature, all legs and appetite, he found out that people didn't want him poking his nose into their concerns. His mother couldn't be bothered with him all the time; she had something else to do besides playing with lumbering pups, and several times she had to give him a nip to teach him to mind his own business. Then he learned that the man who gave him food and sometimes patted him and played with him was the Boss and had to be obeyed. When he was about half grown he had an idea that he was as good as anybody and that he could do just as he liked. But one day he got a surprise.

The Boss was taking the team out to plow the back field and Bill decided that he would go with him, but the Boss didn't want him and told him to go and lie down. Now Bill wasn't going to lie down for anybody; he gave a sharp bark to show his independence and trotted further into the road. Suddenly a large strong hand closed on the back of his neck: he was lifted from the ground and carried into the barn. Then whack! whack! went the whip and at each whack Bill sang a little solo of surprise and pain. The Boss didn't hit him really hard, but to the puppy it was the most terrible experience he had ever had. He crouched trembling in the straw of the end stall, not daring to move and wondering what was coming next. Nothing came except the cat on a mouse hunt, and you may be sure he didn't get any sympathy from her. So finally he did the most sensible thing; he made the best of it and went to sleep.

The next day the same thing happened. You see Bill, like many other people, had a short memory, especially when he didn't want to remember; so he got another beating and spent another afternoon in the end stall. But the third time, when the Boss said, "Go and lie down," he didn't wait for the beating, but went. As a reward the Boss let him come out to the back field, where he had a great time chasing the crows and never catching them.

In this way Bill learned the first great lesson which everybody must learn, men and women, boys and girls; the lesson the soldier learns first of all: "Obey Orders." After this there were very few beatings. For the Boss knew how to treat a dog properly, and never punished one without letting him know why he did it. He never lost his temper with Bill, nor frightened the sense out of him by shouting. And the puppy soon began to trust him completely, because he knew that what he said would be right.

Professor Graham, O.A.C., and "Colonel."

At the back of the farm was a big hilly pasture with a wooded ravine running through it and in the bottom of this ravine a stream which the boys called "the crick," and in which they sometimes caught little speckled trout; there was also a fine swimming hole near the lower end, where the stream got bigger, just before it emptied itself into the river. Well, one day the Boss called up the two dogs and started for the pasture. All the other puppies had been given away, so Bill and his mother were all that was left of the family. Bill always liked going for a walk, and now he showed his pleasure by rushing ahead and barking joyfully as much as to say, "What a fine fellow I am! Take a look at me." Nellie trotted soberly behind her master, looking up from time to time as though she knew what was going to happen. In this way they crossed the stream, climbed up through the woods on the other bank, and there in a broad stretch of green pasture land they came upon a flock of sheep. Most of them were close together, grazing quietly or lying down, but there were little groups of four or five spread about here and there as far as they could see.

The man and the old dog began driving those farthest away into the centre, moving quietly so as not to frighten the sheep. This was too slow for Bill and he decided to show them how it ought to be done. With a loud bark he made a rush for an old ewe, chasing her straight across the pasture. All the sheep they met turned and ran from them and in a few minutes the flock was scattered over the pasture and Bill was trotting up to his master wagging his tail and feeling proud of himself. There was only one thing to do and that was to show him that he was wrong, so the Boss gave him one or two taps with his stick which made him sit down and think things over.

Meanwhile the old dog was getting the sheep in line again. She ran out beyond the furthest sheep and started them gently back again, then she picked up another bunch away to the left and steered them in with the others. Now and then she would give a single bark to remind them that she was there and that they must go forward. When a startled, half-grown lamb tried to break back and get away she pounced after it like lightning, but after it had turned the right way she didn't chase it any more, as she knew it would go after the others. Here and there she moved, swiftly and quietly, gathering in stragglers, keeping the leaders from straying aside, always moving them on with gentle little barks. Soon the sheep were all together, a close mass of woolly backs and twinkling feet all moving towards the corral, which was near the pasture gate.

Now Bill was a true sheep dog. His mother and his grandmother and his great-grandmother and her mother had all been brought up with the sheep. So he did not take long to learn how it was done. It was just like a boy who is born and raised on a farm: when it comes to taking hold of the plow or using a hay fork, the farm boy soon feels at home, but the city boy goes at it left-handed and awkwardly, although he can learn it after a time. Bill watched his mother working and tried to do the same. There wasn't much to do after the sheep got going; but after they had crossed the stream at a point where the banks were low and the trees thin some of the ewes made a break to the right instead of going straight on. Away went Bill through the bush, and before the runaways could get far he was in front of them barking and showing his teeth. Back they went helter-skelter, where they belonged. But Bill stood there like a policeman until he was sure they were all going right. Then he trotted along on the flank keeping his eye on the leaders and feeling as proud as Lucifer. When the sheep were all safely in the corral the Boss stroked him, pulled his ears and said: "You're all right, Bill." You may be sure he never forgot that day, and after that he knew the sheep were his special care.

He soon grew to be a splendid dog, bigger and stronger than his mother, but not wiser. She was the cleverest sheep dog for miles around, so you see Bill had everything in his favor. He certainly was a fine looking dog. His head was long and his nose sharp, but he had a good wide forehead which showed plenty of brain power. His eyes were almost almond-shaped, bright and intelligent, and his small ears were half pricked up and pointed forward, which gave him a very knowing expression. His coat was long and thick, especially round the neck and shoulders; rough on the outside, but if you took a big handful of it you could feel how soft and fine it was right near the skin. As I have said, his color was black and tan, but he had a white chest and front legs, also his hind feet were white. His back was strong and broad and over it curled a long feathery tail. His forelegs, or front legs, had soft feathery hair right down to the feet, but the hind legs were clean from the hocks down. His feet were small but thickly cushioned or padded, so that he could lope along for miles over the roughest ground without ever a sign of lameness.

The Boss was very careful about the dogs; he always said that if a man or a horse or a dog got sore feet he wasn't much use. So every night he would examine their feet for thorns or soreness, wash them carefully and sometimes put a little grease or ointment on them, especially in hot dry weather or after a hard day's work. He used to feed the dogs twice a day, once in the early morning, a light meal, and again in the evening, when he would let them have a little more. He was careful to comb out their coats from time to time and to take away all burrs, etc., and now and then he would wash their skin with lukewarm water with just a little carbolic acid in it.

Some of his neighbors laughed at him for taking so much trouble over a dog, but he just kept on and paid no attention to them; and his trouble was repaid, as his dogs never got sick or mangy and never wanted to leave the farm and roam over the country. They were there ready for work night and day, ready to watch and protect the sheep with their lives; and one night they had a good chance to show their courage and faithfulness.

The home pasture.

On a farm about two miles down the road lived Old Man Smith, and he was about as disreputable a farmer as you could find anywhere. His place grew nothing but thistles and pig weed, his horses were thin and covered with sores, and his yard was a disgrace, with rusty machinery, old boards and nail kegs, dirty sacks and rubbish of all kinds. He had two big, raw-boned hounds, one black and the other yellow. These he never fed or looked after, but they stayed with the old man because he was their master. They never got anything from old Smith but kicks or bad words; and yet if a stranger had tried to hurt him they would have torn him to pieces. Even the worst dog is faithful; and, as a matter of fact, all dogs are just what their master makes them.

Well, since these two were never fed they had to go round the country picking up what they could; and after a time they found that sheep were the easiest things to kill. One hot night, when the sheep were left out in pasture, these dogs got in and killed three of them; and when the Boss found them the next day he knew very well how it had happened, but he couldn't prove it. Besides, what was the good of going to Old Man Smith, who couldn't even buy food for his horses?

That night the sheep were put in the corral and every evening afterwards Bill and Nellie would go out together to the pasture, gather up every single sheep, and drive them into the corral, where the Boss would be waiting for them. This plan worked well for some time and the sheep-killers kept away. But after a time they got so hungry and desperate that they paid a night visit to the corral. Bill and his mother were sleeping in the corner of the yard near the barn, but they heard the racket in a minute. Bill jumped up with a growl and started for the corral, his teeth shining in the moonlight and all his hackles standing stiff. But wise old Nellie made straight for the house, barking to warn her master. As soon as she heard him jump out of bed she turned and ran down the lane to the corral.

When the Boss arrived with his shot-gun this is what he saw in the moonlight. The sheep were all jammed into one corner so tight against the fence that the hurdles were cracking and threatened to break any minute. In the open space beyond he could just make out the dim shapes of two dogs, rising and falling while they worried and fought; he could hear their breath coming with quick panting sounds or rumbling in their throats. Right against the fence lay Nellie, fighting to the last, but too small and too old to do much against the big yellow mongrel who was worrying her.

The Boss didn't waste any time. Bang! went the gun, and there was one yellow robber less in the world. Bill, after a fierce fight, had mastered the black hound and was shaking the breath out of him. He wasn't feeling very well when Bill got through with him, so the Boss let him crawl away home, as he knew that he wouldn't give any more trouble.

Next day the two dogs were a sight. Bill's ear was torn and he had to go on three legs, and poor Nellie could hardly move. The Boss doctored their wounds and the children made a great fuss over them. Bill didn't know what all the petting was about, but he wagged his tail as much as to say, "Don't worry, I'm here." That evening he went out to the pasture on three legs, rounded up the sheep and brought them into the corral.

So these two dogs worked beside their master year after year, and no man ever had two truer friends. Nellie died comfortably at a ripe old age, and for some years Bill kept the flock alone. At the present time he is quite old and stiff, and walks with short steps like a dignified old gentleman. There are two young dogs on the farm, and Bill keeps them in order and teaches them how to drive sheep. He is a great favorite with everybody, and when he goes his master will be able to say: "Well done, good and faithful servant."

THE STORY OF A WORMY APPLE

H. S. Fry, B.S.A.

"Oh, George," said Mary, "look at all those beautiful apples. Aren't you glad mother let us come to the fair instead of going to school to-day?"

"They are nice, but I would rather eat some of them than look at them and not be able to eat any," replied George.

"My, I wish, too, we could have one, but I suppose if we ate them, other people couldn't look at them any longer."

"Say, Mary, isn't that a daisy one over there at the back? And look! It hasn't any prize ticket on it at all. I wonder why."

"Oh!" said Mary, when she caught sight of it, "isn't it a beauty. I think it is ever so much nicer than the others. Let's go and ask the judge why he didn't give it a prize. Maybe he meant to give it a prize and forgot about it, or perhaps he didn't see it. It's back so far and the others around it aren't a bit nice."

"All right," her brother said, "you go and ask." So Mary skipped away to where the judge was awarding prizes to some other kinds of fruit.

Now, the judge was very busy and didn't want to be interrupted, especially by an inquisitive little girl; but when he saw how eagerly Mary awaited his answer, he told her very kindly that the big red apple had a worm hole in it, and couldn't be given a prize on that account. He said it was being shown as a single specimen Northern Spy, and but for the worm injury would have won the first prize of five dollars.

"Oh! I didn't see it," said Mary, and after thanking the judge, she went back very slowly to where her brother was waiting for her.

"Isn't that a shame," George said, when Mary had explained what the judge had told her. "Just the same, I'll bet it would taste pretty good if we could get it and cut out the worm hole. Why couldn't some of those other apples have the worm and let this one get first prize? It's certainly a beauty," he ended up wistfully.

"Ah, children," said a small voice from some place quite close to them, "one never knows in this world whether things are really as they appear to be or not, until one can examine them very closely."

"Why, what was that?" said Mary. "I didn't see anybody close by. Who spoke to us?"

"Hush!" said George, looking very much surprised, "maybe he will speak again, whoever it was."

"You must not become alarmed," went on the voice, apparently coming from the big red apple they were looking at, "although I've no doubt you are very much surprised to hear an apple talk. Yes, it's I, the big apple without any prize. I get very lonely here with nobody except these scrubby little fellows here at the back to talk to. They have never had any amount of ambition in their lives, and since they are not worth very much to their masters, they are perfectly contented to sit here day after day and watch the people go by in their fine clothes. I feel quite differently about it, and sometimes when thoughtless people talk sneeringly about me I feel embarrassed and humiliated. I want to get out of sight as soon as possible. I know that cannot be, and so I must stay here until some naughty boy or girl steals me away, or my master takes me home."

"Oh!" said George and Mary together. "We didn't know apples could talk. We are very sorry you didn't take a prize, but the judge told us you were wormy. Won't you tell us about it?"

"I will, indeed, children, if you care to listen. It isn't everybody who can understand our language, but I knew you could, just as soon as you stopped to look at me and I saw how interested you were."

"Well, to begin with, my mother is a fine big Northern Spy tree in Farmer Jones' orchard, about three miles out of town. She is about thirty-five years old and just in the prime of life, because you know, trees of my mother's kind live to be very old. The orchard, of which my mother is a part, is planted in soil which is a little lighter than the ordinary apple soil, so that we ripen a little earlier than other orchards about us. Then, too, our orchard is on a gentle southern slope and so, you see, we can get plenty of sunlight. We are extremely fond of sunlight, because basking in the sun all day makes us beautiful, and of course apples like to be good looking, just as well as little boys and girls do.

"I was born in May. I think my mother has told me since that it was the 25th of May, although I would not be sure. All my brothers and sisters were born within a week of each other, and I am one of the eldest. My father is a Baldwin tree that stands just next to my mother in Farmer Jones' orchard. I was, of course, very young, even when all my brothers and sisters were born, but I remember quite distinctly most of the things which happened then. Very early in my life I know that three of my brothers and myself formed a cluster all by ourselves out on the end of a small branch facing the sun at noon. Being the centre apple in this cluster, I was a little older than my brothers and stronger than they were. Poor fellows! They all died before they got to be very old but as their story is bound up very closely with my own, I will tell you about them, too.

"Before an apple can grow the mother tree must put out blossoms, which are very beautiful indeed. The blossoms my mother produced were not quite as pretty as the blossoms that a Rhode Island Greening bore nearby, but of course it would be too bad if anyone had all the good things in the world, for then so many people would be unhappy. Our mother told us that we should be quite satisfied to be considered among the very finest dessert or eating apples, while the poor Rhode Island Greening is only a cooking apple, and not at all beautiful. Apple blossoms are very beautiful, so that the bees and other insects will visit them to bring nectar. Then, when the bees come for the nectar, they bring pollen from other apple blossoms, and this pollen grows down in the centre part of the flower or pistil and fertilizes the ovary, which is at the base of the flower. As soon as this is done an apple is born and begins to grow.

"As I started to tell you, I remember that when I was about a day old, four blossoms beside me opened up and pretty soon some bees came after their nectar, as it was a very bright, sunny day, and I could hear thousands of other bees working in the orchard. Before they went away from these blossoms which were beside me, some pollen was brushed off their legs on the pistil of the flowers, and a short time afterwards my three brothers were born. I might have had four brothers, but something happened and the fourth blossom didn't get fertilized. I asked my mother about it one day, and she said that if all the blossoms were fertilized, she couldn't take care of all her children, but she knew many of them would never get a chance to develop apples, so she always threw out plenty. As it was, you will see that many of my brothers and sisters died very early in life, because our mother didn't have sufficient food for them.

"You may think it very strange that my mother allowed my brothers to be born when she knew they couldn't all live, and if I hadn't heard my master's little girl and her teacher talking about it some time afterward, I don't think I could make you understand. It seems that there is what people call 'the survival of the fittest,' and that all my brothers and I were engaged in what is known as 'the struggle for existence.' Now this means that some of us were better fed and stronger than others, and the weaker ones had to die, leaving only those who were 'fittest' or strongest to grow and ripen. This struggle for existence was going on all over Farmer Jones' orchard, and I could hear some of my brothers dropping off every day for a long time, because they were too weak to keep up the struggle any longer.

"So you must not blame my mother or me because my three brothers died. I was the strongest because I was in the centre, and consequently my mother could feed me better than the other three. I felt sorry for them, but couldn't help them any, and of course I didn't want to die too.

"Well, although I was sorry for them, I was much better off after they dropped to the ground, because I was the only one left, and could grow as fast as I chose. Plenty of food came my way, because I was right on the end of the small branch which was holding me up.

"Now, I must go back a little to the time when I was about five days old, because all my sadness dates from that time really. One fine morning, Farmer Jones and Tom, his hired man, came out in the orchard with a team, a big tank full of some liquid and a gasoline engine. Mother whispered to us quickly that they were going to spray us with a liquid, which I heard them speak of as arsenate of lead and lime-sulphur. It was very nasty smelling stuff, I can tell you, but mother said it would keep the worms from eating us, and when Farmer Jones said, 'Now, Tom, get up as close as you can and hit the calyx of every one,' my mother told us to 'never mind,' as it would do us good. She told us afterward that she could remember when Farmer Jones never used to spray, and she couldn't keep the worms away at all. The worms liked Northern Spy apples, but they didn't seem to like Ben Davis, who was just a short distance away, and whose children didn't get nearly so wormy as we Spys.

"However, the spraying started, and Tom, who was a very careless fellow anyway, was in bad humor that morning, and missed a lot of us, so that we didn't get sprayed nearly as well as we ought to have been. The calyx, you know, is the end of an apple opposite the stem, and most of the worms which hatch out from eggs laid by the codling moth enter an apple through the calyx, especially when we are very small, so you see why Farmer Jones spoke to Tom the way he did.

"I didn't get any spray in my calyx, and my mother as very angry at Tom's carelessness, because I was so big that mother was very proud of me.

"I grew very rapidly after that for quite a while, and soon was quite a bit bigger than most of my brothers. At first I was quite long, but in a month or six weeks I began to get stouter and to eat a very great deal.

"Finally, one day I was to feel the result of Tom's carelessness, and my pride was lowered a great deal. A hungry worm came crawling over me, and instead of biting me in the side and getting inside that way, as he could very easily have done, he crawled down to my feet and went right in at the side of my calyx. Of course he couldn't eat his way in very fast, but he stuck to it, and I have had to suffer ever since on account of him. He only made a very small hole, and my mother often told me no one would ever notice it, but I am naturally proud, and I hated to deceive people into thinking that I was such a beauty, when I knew down in my heart that I was only a wormy apple.

"However, time gradually lessened a part of my humiliation, and I consoled myself by thinking how big and strong I was. Some of my brothers were deformed, and mother said that was because the insects had not brought enough pollen to their blossoms, and so they did not grow as perfectly as I did. My master's little girl was told by her teacher that fertilization had not been completed before my brothers were born, and he said that meant that enough pollen had not grown down to the bottom of the flower, where the tiny ovules were waiting to unite with them. He said that if any ovule didn't unite in that way, then the part of the apple that ovule represented couldn't grow, and so the apple would be deformed.

"When I was nearly two months old my other brothers and I got quite a scare. There was a Duchess tree some distance away, so far in fact that my brothers near the ground couldn't see, but as I was up near the top, I and those of my brothers who were near me, could see a long distance away. We noticed, about the time I have mentioned, that the Duchess apples were getting quite big, and what hurt us more was that they were becoming very handsome. They were far more beautiful than any of the rest of us at that time, and took on a great many airs on account of it, too. Their cheeks were striped with bright red, especially on the sunny side, and we were quite jealous of their good looks for a time.

"Mother soon found out that something was wrong and smiled quietly to herself when we told her about it. She told us that we need not worry about it at all, because we would be ever so much more beautiful after a while than the Duchess. Mother said that the Duchess would soon be ripe, and that was the reason they were getting red and good looking, while we were still quite green. I have found out since, from hearing Farmer Jones talking to Tom, that Duchess are summer apples and are only good for cooking. He also said they were poor keepers, like most other early apples, and couldn't be transported very great distances on that account. 'Now the Northern Spy over there,' said our master, 'is a late winter variety, and one of our longest keepers.' 'Why,' he said, 'I've kept Spies in our cellar until June, and they tasted as good as ever. They are fine for cooking, and you will go a long way before you find a better apple to eat out of hand.'

"This made us feel good again, and we eagerly looked forward to the time when we, too, would begin to redden up. Sure enough, it came before very long. Our master had helped us, because he had not cultivated the orchard after I got to be about a month old, as he said we wouldn't color up well if we grew too big, and it would take a long time to check the growth which the branches all around us were making. I was one of the very first to show any color, and one of my cheeks slowly began to get a dull red. It was a long time, however, before we could feel very proud of our beauty. Our faces, as you know, are covered with a very thin, dull-looking substance, which Farmer Jones calls 'bloom,' and this makes us look very sober. When this is rubbed off with a cloth, we are really very bright and cheerful looking, although I have heard that we do not live so long if we are polished. I like to think we can make ourselves look very beautiful if we want to. There are some very beautiful families in our orchard, the McIntoshes and Snows, who are related to each other. One can easily tell they are related, because they look so much alike. I wouldn't like to be plain looking and homely like the Golden Russet and Rhode Island Greening, although mother says they come of excellent families and are respected everywhere. Tom says that 'beauty is only skin deep,' but I'm sure he likes pretty apples better than plain ones.

"Now, children, I've kept you a long time, and my story is nearly finished. When I was between three and four months old, Farmer Jones and Tom came out to the orchard one day and picked all the Duchess and took them away. Then came the Alexanders, Gravensteins, Wealthy, Maiden Blush, Wolf River, Fameuse, McIntosh, Winter St. Lawrence, Rhode Island Greening, Wagener, Tolman Sweet and Baldwin in turn, until there was no one left in the orchard except the Ben Davis and my own brothers and I.

"At last our turn came, and although our master was in no hurry to take us to the cellar, I heard him tell Tom he was afraid of heavy frosts if he didn't pick us soon. I was picked separately and very carefully handled, because Farmer Jones wanted to take a prize with me at the fair, which was to be held in a very short time. So here I am at the fair, and didn't even get a third prize, because of a worm hole. Farmer Jones didn't know about my trouble until the judge passed me by this morning, and he feels as much disappointed as I do.

"I'm very glad you were kind enough to let me talk to you, because it has shortened the afternoon so much for me, and I hope I haven't kept you so long that your mother will scold you when you get home. Good-bye."

George and Mary had been so interested in the story the wormy apple was telling them that they hadn't realized how late it was, and had to hurry home as fast as they could to be in time for supper. They surprised their mother very much by telling her they had been talking with an apple, as she had never heard of apples talking; but she didn't contradict them, because, as George told Mary, *they knew what the apple had said,* and that was proof enough.

GAMES, PLAY AND RECREATION

A. Maclaren, B.S.A.

Have you ever tried the game of picking out the different kinds of men, women, boys and girls that you know and putting them in different groups according to their natures? If you have not, try it some time.

There's the man we call "Old Grouch." If your ball flies over into his garden he comes out growling and grumbling and captures your ball and keeps it. He never smiles to the boys as they pass by. "Boys and girls are only a nuisance," he says, "they spend too much time with fun and frolic and never attempt anything useful," and so he goes through this world with a frown on his face, envy in his heart and no joy in life.

Then there's the farmer who won't send his cream to the creamery because somebody may get ahead of him, or the maker is crooked and cheats him out of his dues, or he can't have his own way about some business matter at the annual meeting; in short, whenever he has to work with anybody else they are always wrong and he suffers for it.

Then there's the boy who loafs around the store at the village and does nothing. He is too lazy. He doesn't want to bother. Games, such as football or hockey, are too strenuous and tiring, and so he loafs, and later becomes a waster and maybe a criminal.

Then there is the timid little fellow who, when some game is on, sits or stands around watching it instead of getting into the game and developing courage and the ability to do things himself.

There's another kind of boy—the kind none of us like—the "quitter." He starts in with the rest, all enthusiasm and energy, and all goes well until the job gets a little bit hard or things in the game do not come his way, and then he says, "Aw! I've had enough—let's play something else."

Then there's the fellow we all love—big, strong, hearty, always a smile on his face, ready to lead in any kind of fun or games, great at swimming, skating, hockey, football, baseball, one who always leads in everything good or bad. He has his faults, but we like him all the same. Why? Because he does things. He's the kind of fellow who, when the umpire gives a "raw" decision and the team begins to howl, says, "Come on, fellows, let's play the game." You never hear him talk back, no matter what happens.

And so we can discover a great many kinds of people in this world. What kind do you belong to? Are you satisfied to stay in that class or do you want to get into another class? It depends on you.

I want to tell you, if I can, how these different kinds of people have come into being. They are what they are either because they have learned to play games honestly, fairly, squarely, or they have never played games at all.

The "old grouch" is an old grouch because he never developed his stock and surplus of energy and happiness in playing games, and so he lost God's greatest gift, the spirit of play, in which we should do all our work. The farmer who suspects everybody of cheating him has never learned to play his place in the ball team. He never learned what it is to make a sacrifice hit, to play so that the team would win whether he got any individual glory or not, so he can never be a co-operator.

Then the loafer never felt the joy of overflowing physical power as you run the bases or dribble the football up the field, dodging all comers, and so he has allowed his physical powers to go to sleep from which there is no awakening.

And that timid little fellow. Through no fault of his own he has not the courage to face the hard tasks of life. Do you want to help him have the courage for doing great things in life? Then encourage him to come into your games. Don't laugh at his awkwardness too much. Remember! He needs the games.

And the "quitter," what about him? Well, don't let him in on anything unless he promises to carry it through. If he fails, then shut him out the next time until he learns to persevere.

We all want to be like the big, hearty, strong leader. Perhaps we can't all be such men and women but we can all get a whole lot nearer to it than we are now. You want to know how, don't you? Well, it's quite simple. Get into games and play them with all your might, honestly, fairly, behind the umpire's back or before his face; stick to the game till the end, help the more timid ones and enjoy it to the full yourself.

Now I want to tell you about some simple games that you can carry on in your own school playground or at home.

Heads and Tails.

Divide into two teams and line up the teams facing each other in two lines with about three feet between the lines. The teams take up their positions in the middle of the playing space each with their backs turned to their own den and facing the opponents. One side is called the "heads" and the other "tails." A leader is chosen who tosses up a coin—when it falls "heads" he calls out "heads," if it falls "tails," he calls out "tails." The side whose name is called turns and runs for its den, which may be a wall, fence or a line drawn about thirty feet from the centre of the playing space. The other side meantime tries to tag as many of the team called as possible before they get to their den. Everyone so tagged has to pass over to the other team. The teams then line up as before and the coin is tossed again and again until only one player is left on one side or the other.

Animal Blind Man's Buff.

One player is blindfolded and stands in the centre of a circle with a wand, stick, or cane in his hand. The other players dance around him in circle until he taps three times on the floor with his cane, when they must stand still. The blind man thereupon points his cane at some player, who must take the opposite end of the cane in his hand. The blind man then commands him to make a noise like some animal, such as cat, dog, cow, sheep, lion, donkey, duck, parrot. From this noise the blind man tries to guess the name of the player. If the guess be correct they change places. If wrong, the game is repeated with the same blind man.

The players should try to disguise their natural tones as much as possible when imitating the animals, and much sport may be had through the imitation. Players may also disguise their height, to deceive the blind man, by bending their knees to seem shorter or rising on toes to seem taller.

Where there are thirty or more players, two blind men should be placed in the centre.

Over and Under Relay.

The players stand in two or more files, the files containing an equal number of players. The game is a passing relay, the files competing against each other. The leaders of each file have two balls, bean bags, or blackboard erasers. At a signal, a ball (or whatever is used) is passed back over the heads of the players until it reaches the last one in the line, who keeps it. The leader counts ten after the ball leaves his hands and at once passes back the second ball between his feet, the players bending over to pass it along. When this reaches the last player he runs forward with a ball in each hand and takes his place at the head of the line, which moves back one place to give him room. At once he passes one ball backward overhead, counts ten, and passes the other between his feet. This continues until the original leader, who has been gradually backing to the rear of the line, reaches the front again, carrying both balls. The line wins whose leader first accomplishes this.

This game has some admirable exercise in it, keeping the players bending and stretching alternately. Quick play should be encouraged. When played in a schoolroom alternate aisles should be kept clear that the runners may use them in running to the front of the room.

Dodgeball.

The players are divided into two even groups. One group forms a circle (this need not be marked on the ground). The larger the circle the more sport in the game. The other group stands within the circle, scattered promiscuously. The object of the game is for the circle men to hit the centre men with a basket ball, or football, the centre men dodging to evade this. They may jump, stoop, or resort to any means of dodging except leaving the ring. Any player hit on any part of his person at once joins the circle men. The last player to remain in the centre is considered the winner. The groups as originally constituted then change places for the next game, the centre men becoming circle players and the circle men going to the centre.

There is no retaliatory play of the ball by the centre players; they merely dodge it. The ball is returned to the circle either by a toss from a centre man or by a circle man stepping in for it if it should not roll or bound within reach. When two centre men are hit by one throw of the ball only the first one hit leaves the centre. The ball can be thrown only from your place in the circle.

Schoolroom Dodgeball.

The players are evenly divided into two teams. One team takes its place around the outer edge of the room; the players of the other team scatter through the aisles or seats, which latter should be turned up if possible. The outer team tries to hit the inner team with the ball, any player so hit taking his place in the outer team and joining in its play. The player who remains longest in the centre is considered to have won.

Only a hit from a ball on the fly counts. A hit from a bounce does not put a player out. If a ball touches any part of the clothing or person it is considered a hit. If two players are hit by the same throw, only the first one hit is considered out. Players may dodge the ball in any way. The ball is returned to the circle players by a toss from one of the inner team, should it be out of reach of any player of the circle team.

If desired, the hit players may leave the game instead of joining the outer circle. This leaves the teams intact, and each then keeps a separate score.

If successive games be played the teams change places, the inner players going to the circle, and *vice versa*. The game may then be played in innings if desired, each team to be given three minutes in the circle. One point is then scored against a team while in the centre for every player hit and the team wins which has the smallest score at the end.

Circle Seat Relay.

This game starts with the players all seated and with an even number in each row. At a signal the last player in each row runs forward on the right-hand side of his seat, runs around the front desk, and returns on the left-hand side of his own row. As soon as he is seated he touches the player next in front on the shoulder, which is a signal for this one to start. He runs in the same way. This is continued until the last player, which in this case is the one sitting in the front seat, has circled his desk and seated himself with hand upraised. The line wins whose front player first does this.

This is one of the best running games for the schoolroom. As in all such games, seated pupils should strictly observe the rule of keeping their feet out of the aisles and under the desks.

Players must observe strictly the rule of running forward on the right-hand side and backward in the next aisle, else there will be collisions.

Volley Ball.

This game consists in keeping a large ball in motion back and forth across a high net by striking it with the open palm. The ball must not be allowed to touch the floor.

Ground. For large teams this game should be played on a ground measuring fifty feet long and twenty-five feet wide. For smaller teams a smaller ground will answer.

A tennis net, or net two feet wide, preferably the latter, is stretched across the centre of the ground, from side to side, extending one or two feet beyond the boundaries on either side. The upper edge should be from six feet six inches to seven feet six inches above the ground.

Players. Any number of players up to thirty may play. The players are evenly divided into two parties, which scatter over their respective courts without special arrangement. There is a captain for each side. An umpire is desirable.

Object of the Game. The object of the game for each party is to keep the ball in lively play towards its opponents' court, as each party scores only on its opponents' failures to return the ball or keep it in the air.

The ball is put in play by being served by the party which is to score. The service of the ball, and with it the privilege of scoring, pass to the opponents according to the rules described hereinafter.

Start; Rules for Service. The ball is put in play by being served by a member of one side, who should stand at the rear of his court with one foot on the rear boundary line and the other behind the line. From this position the ball is tossed upward lightly from one hand and batted with the palm of the other hand toward or into the opponents' court.

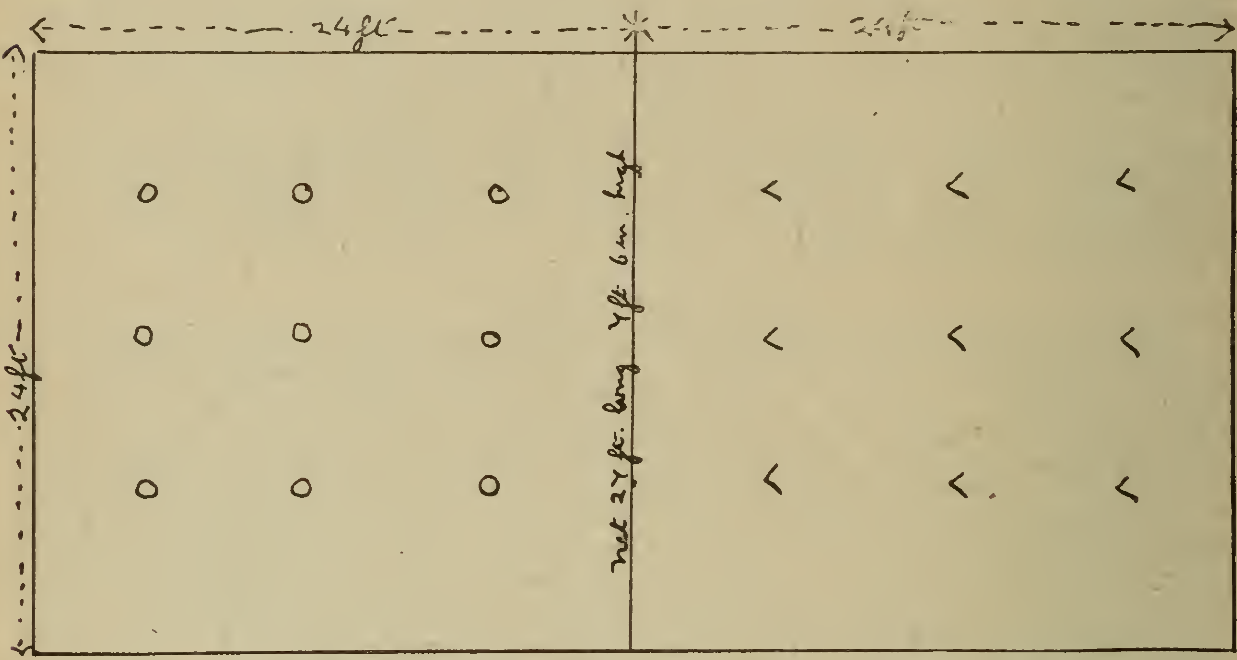


Diagram illustrating lay out of volley-ball court and position of players.

Each server has two trials in which to send the ball into the opponents' court. The service being over a long course with a comparatively heavy ball, the following privileges are allowed: a served ball may be assisted on its course by any two other players on the servers' side; no player so assisting the ball on the serve may strike it more than twice in succession, and the server under such circumstances may not strike it more than once; but should the ball then fail to land in the opponents' court the server loses his second serve.

In serving, the ball must be batted at least ten feet by the server before being touched by any other player on his side.

No "dribbling" is allowed in serving.

A successful server continues serving until his side allows the ball to touch the floor, knocks it out of bounds, or fails to return it to the opponents. A server may also lose as follows:

If a returned ball hits a player on the server's side and bounces into the opponents' court, it is considered in play. If it hits such a player and does not bounce into the opponents' court, the server is out, losing his second trial.

If the ball hits the net during service, it is counted a dead ball and loses the server one of his trials.

If a served ball falls outside the opponents' court the server loses his turn.

The players on a side take turns in serving.

Rules of Play.—The ball must always be batted with the open palm. The ball should be returned by the opponents before it can strike the ground. Any number of players may strike the ball to send it across the net, but no player may strike more than twice in succession. Having struck the ball twice a player may resume his play only after some other player has struck it. The ball is thus volleyed back and forth across the net until one side fails to return it or allows it to touch the floor, or until it goes out of bounds. A ball is put out of play by hitting the net in returning after a serve. A ball which bounds back into the court after striking any other object except the floor or ceiling is still in play. It is permissible to strike the ball with both hands at once (open palms).

If a player touches the net at any time the ball is thereby put out of play. Should this player be on the serving side his side loses the ball and it goes to the opponents. Should this player be on the receiving side the serving side scores one point. Should the net be touched simultaneously by opponents the ball is thereby put out of play and the serving side serves again.

No dribbling is allowed at any time through the game; i.e., no keeping the ball in the air by one player hitting it quickly and repeatedly.

In sending the ball across the net players should aim for an unprotected part of the opponents' court, or try in other ways to place them at a disadvantage.

Score. This is entirely a defensive game, the score being made on opponents' fouls and failures. Aside from fouls, only the serving side scores. A good serve unreturned scores one point for the serving side. A point is similarly scored by the serving side at any time when the opponents fail to return a ball which is in play. Failure of the serving side to return a ball to the opponents' court merely puts them out; that is, the serve passes to the opponents, but no score is made on the failure. Should a player touching the net be on the receiving side, the serving side scores one point. A ball sent under the net is out of play and counts against the side which last struck it, their opponents scoring one point. If the ball strikes any object outside the court and bounds back, although it is still in play, it counts against the side which struck it out, their opponents scoring one point. A ball sent out of bounds by the receiving side in returning a service scores one point for the serving side. One point is scored for the opponents whenever a player catches the ball, or holds it for even an instant. The game consists of twenty-one points.

Captain Ball.

Ground. On each side of the ground at corresponding distances from the centre three small circles are drawn for bases at the points of a triangle. The circles should be from two to five feet each in diameter, the more skilful the players the smaller the

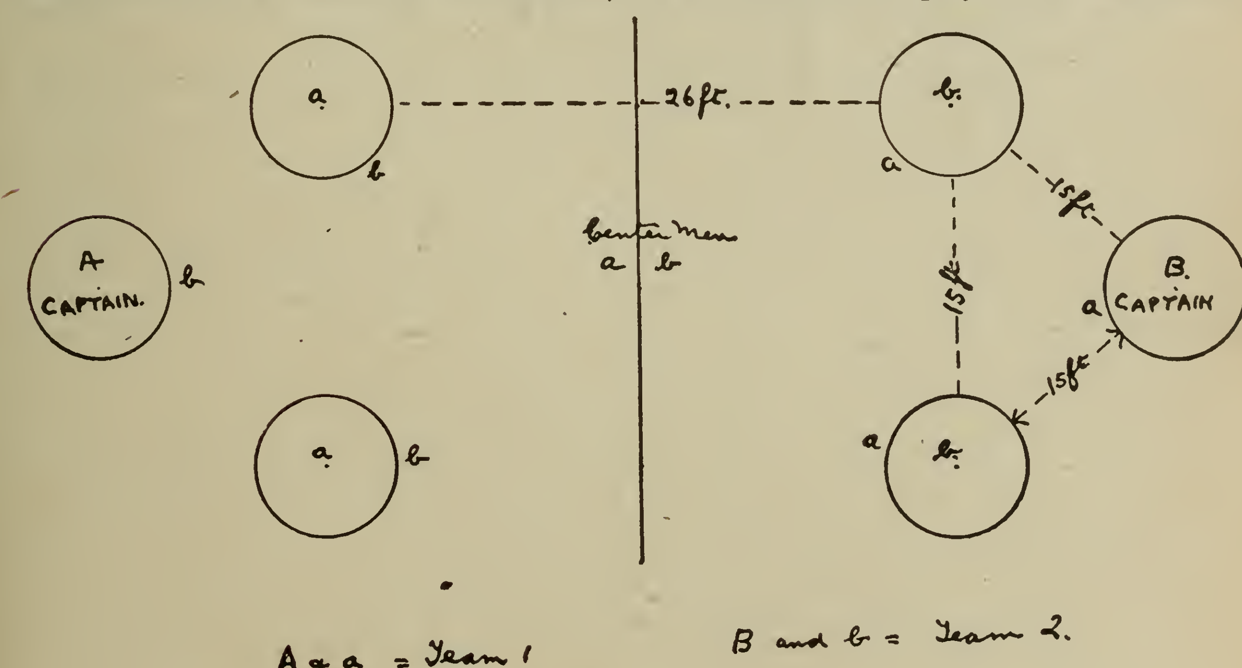


Diagram illustrating positions of players in Captain Ball.

circle. The distance between each two circles forming a triangle should be at least fifteen feet, and the distance across the centre of the field between the two inner circles from fifteen to twenty-five feet.

Teams. The players are divided into two teams, each consisting of three basemen, three base guards, and one fielder. One of the basemen is captain and stands in the base at the end of the ground farthest from the centre. Each team has a guard stationed near each of its opponents' bases, and a fielder whose general place should be near the centre of the ground, but who is free to run to any part of the ground, and who should pick up the ball whenever it goes afield. The ball should then be put in play again from the centre as at the start.

Object of the Game. The object of the game is to have a captain catch a ball from one of his basemen. A ball caught by the captain from the guards or fielder of his team does not count. Of course the guards will try to prevent the ball being caught by a captain from one of his basemen, or by one of the basemen from his fielder, and on the other hand will try to secure the ball and send it back to their own baseman or fielder.

Start. The ball is put in play by being tossed up in the centre of the ground by a third party between the two fielders, both of whom try to catch it. The one who succeeds has first throw. Touching the ball is not enough for the first catch: it must be caught in both hands. In case of dispute the ball should be tossed again. The ball is again put in play in this way after each point scored; also after going afield and being picked up by one of the fielders.

Rules. The basemen may put one foot outside of their bases or circles, but at no time both feet. Each guard must remain near the base he guards, but may not step within it even with one foot. Should either side transgress these rules or make any other foul the ball is thrown to one of the basemen of the opposite side, who is given free play to throw it to his captain without interference of his own guard, though the captain's guard may try to prevent its being caught. A ball that goes afield is put in play again at the centre as at the opening of the game.

Fouls. It is a foul: (1) to transgress any of the rules given above; (2) to snatch or bat the ball from an opponent's hands; (3) to bounce the ball more than three times in succession; (4) to run with the ball; (5) to kick it; (6) to hand instead of throwing it; or (7) to hold it longer than time enough to turn once around quickly, or three seconds. Penalty for fouls consists in allowing opponents a free throw from one of their basemen to their captain, as described under rules.

Score. The ball scores one point whenever a catch is made by a captain from one of his basemen. It does not score when the captain catches it from a guard or fielder.

The game is played by time limits ranging from ten to thirty minutes. The time is divided in halves, and at the end of the first half the teams have an interval of rest, and the basemen and guards change places. The team wins which has the highest score at the end of the second half. The ball is put newly in play after every point scored.

Here's hoping you will have a good time playing the games.

BULLETIN NO. 244] DECEMBER, 1916

Ontario Department of Agricult

Hints to Settlers in Northern Ontario

INTRODUCTION.

The object of the writers of the following pages is to furnish the settler of Northern Ontario with suggestions, facts and figures that will help him to better understand how to meet and overcome some of the problems peculiar to the country. Year by year the Great Clay Belt is opening its arms to receive men and women from other parts of the Province of Ontario as well as from many different parts of the world. People of other countries, who are unacquainted with pioneer life in a new land often become discouraged because they do not know how to adapt themselves and make the best of the means at hand. Pioneer life is still much the same as when the early settler began hewing down the forest of Old Ontario, in that it requires men and women of virility and determination, with a vision of better things to come. Success can only be achieved by earnest, faithful endeavor on the part of the beginner, and in agriculture as in every other profession, to know is to succeed.

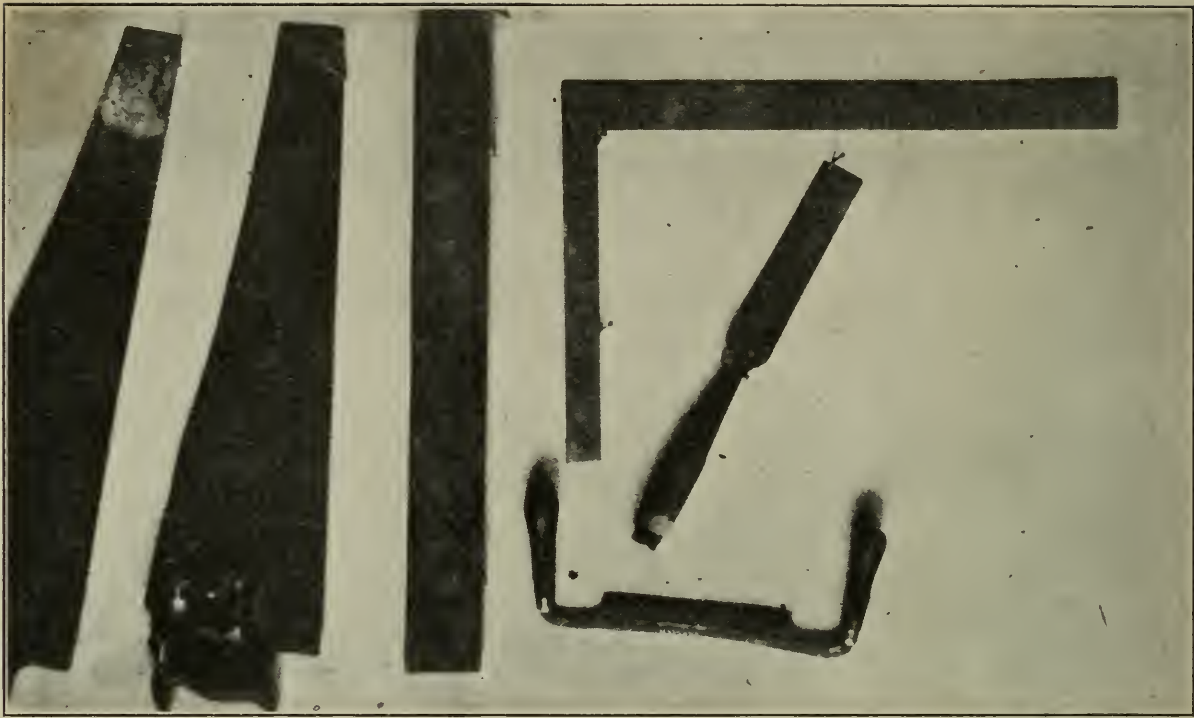
Northern Ontario still contains many millions of acres of fertile land awaiting development and which may be made to produce abundant crops. But before the land can be tilled it must be cleared of its timber and brush, and the writers trust that the following may enlighten and instruct the new beginner.

Locating a Lot.

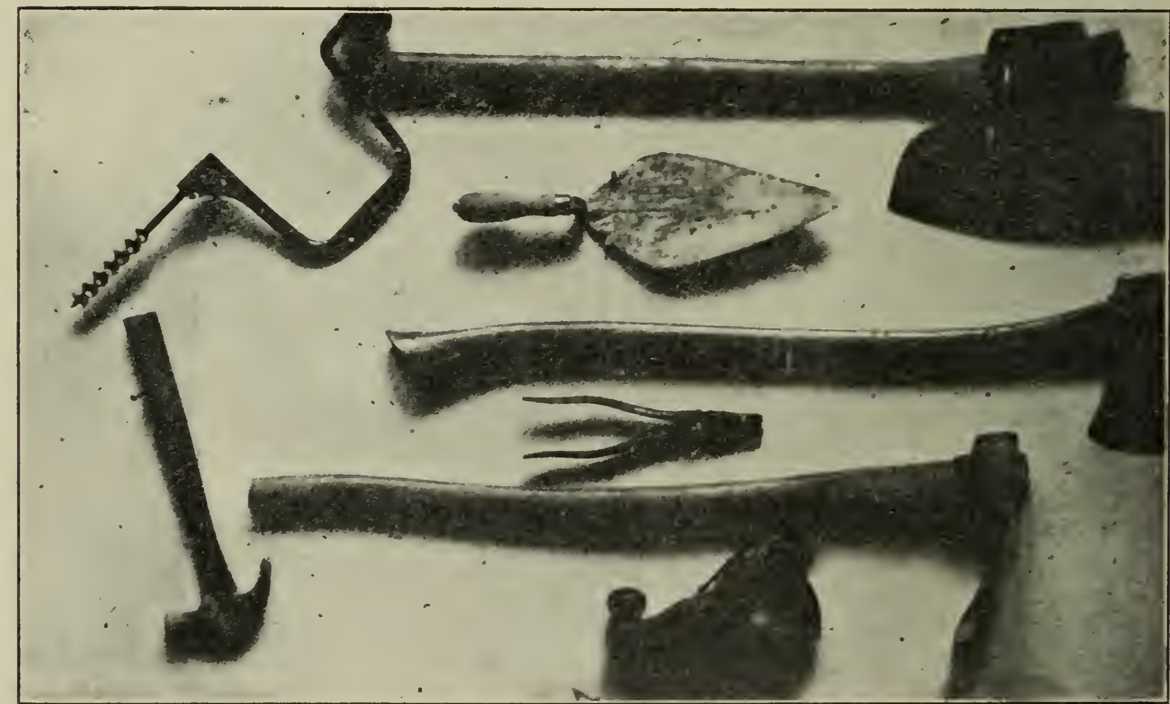
Each lot consists of a quarter section, or 160 acres. Particulars regarding location, and regulations governing the same, may be had by applying in person or by letter to H. A. Macdonell, Director of Colonization, Toronto, or to any local Crown Lands agent. After finding out as many particulars as possible about the lots available, the prospective settler should then thoroughly acquaint himself with the situation and general lay of the lot he intends to locate. He should familiarize himself with the relation of his lot to the main and cross roads. Having fully satisfied himself with the general lay of the land, he will next select a suitable place for erecting his house.

Building a House.

Considerable care should be exercised in choosing a site, it is advisable to build on a well elevated part of the farm to secure good drainage and more congenial surroundings. Buildings should be near a main or cross road and not too distant from a neighbor. Existing conditions of course must govern the selection of a site, but do not make the mistake of building in an out-of-the-way place or too close to an adjoining lot. As the first clearing should be done along the main road, therefore, the house and barn should not be too far distant from it.



Hand-saw, rip-saw, level, drawing-knife, chisel and square—necessary building tools.



Broad-axe, pole-axe, adze, trowel, pinchers, smoothing plane, brace and bit, and hammer—all useful tools in a new country.

The regulation size of a settler's house is sixteen by twenty feet. However, it is sometimes necessary to build a larger house, or it may be advisable to build a smaller one to do for the first few years. It is generally advisable to make things as comfortable as possible, although not advisable to expend a great deal of money on these buildings, as there is more or less danger from fire, until there is considerable clearing around them. For this reason the first clearing should be done immediately around the buildings.

A very comfortable and warm house may be constructed of round or hewed logs, but sometimes lumber can be purchased cheaply, and so one must be governed by the capital on hand and the risk to be taken. By having all the logs hewed (or round) cut the proper length and drawn to the spot selected as a site and then making a "bee"—that is getting the neighbors to co-operate—a suitable dwelling can be erected in a very short time. Make the house at least one and a half stories high, this will provide sleeping accommodation in the upper story.

Put in sufficient windows to thoroughly light the inside, as a well-lighted room is much more cheery and comfortable than a dark one. Moss and clay, or a mortar made from lime, water and sand can be used to chink or caulk the cracks between the logs, or between the logs and wooden chinking, where same is necessary. White building paper may be used to line the inside of the house, this will make it warmer and more home-like. In nearly every instance sufficient lumber can be purchased to put on the roof, make doors, erect partitions, etc. Two-ply of roofing paper properly tacked down, with the joints tarred, makes a very warm and water-proof covering for the roof. The gable ends may be boarded and finished the same as the roof. By utilizing the upper story for sleeping accommodation, two very comfortable rooms, a kitchen and a living-room, can be made down stairs.

Have the front of the house either to the south or east if convenient at all. Screen doors and windows made of wire gauze or two-ply mosquito netting are a great source of comfort during fly-season.

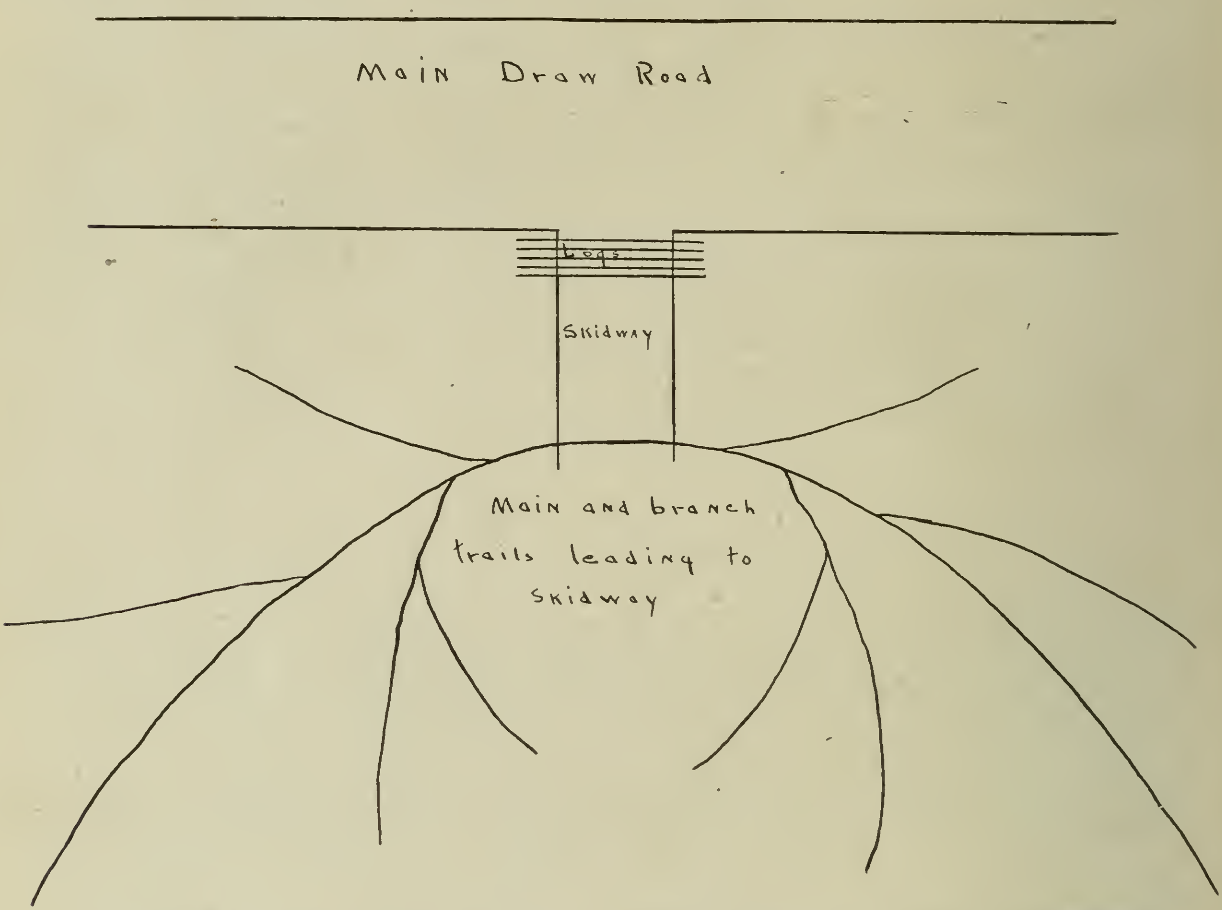
Locate stables and barns north-east, east, south, or south-west of house. This will prevent obnoxious odors blowing toward the house, as the prevailing winds are from the north-west. These buildings can be very economically constructed from logs, building and roofing paper.

Cutting Timber.

The kind of timber to be cut will govern largely the manner of cutting, that is, whether it be hardwood or softwood. Where the land is heavily timbered with large trees, it is usually profitable to underbrush all small trees and shrubbery and place in piles before beginning to cut the large timber. This will greatly facilitate getting around through the timber and in many cases eliminate the necessity of cutting trails. However, as a very large proportion of the timber consists of spruce, balsam, tamarack, etc., a different system is used.

After having decided on the extent of land to be cut over, the first thing to do, is, decide where the main road is to be and cut it out. It pays to make this road as straight as possible and to build it well, as bush roads go. A well constructed road will save a great deal of time and labor when hauling commences. Skidways are built at intervals along the main road on which to pile the timber after it is cut. In some cases it will be necessary to have branch roads away from the main road and to have skidways built on them. It saves time to have these skidways built where the timber is thickest, as it shortens the haul from stump to skidway.

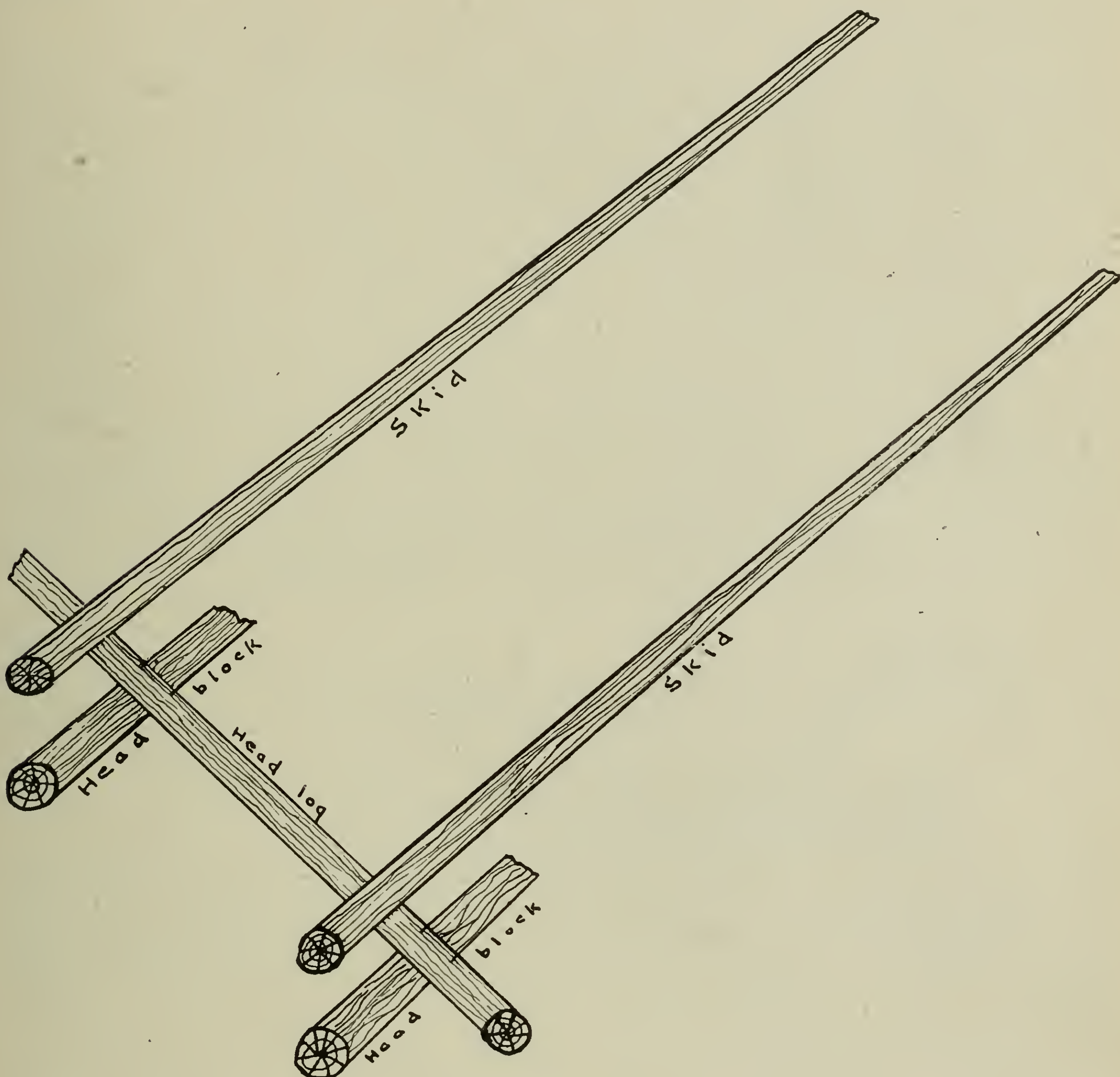
Begin cutting at the farthest point away from the skidway and gradually work towards it. Whenever possible fall trees so that the buts will point to trail leading to skidways and by bunching two, three or four pieces together time is saved in skidding. All trails should be wide enough to easily allow one horse to pass along without danger of hurting himself. They should lead on from either side of the skidway and not directly from the back of it. The density of timber growth will influence the manner of cutting and piling brush. In some cases it pays to fall trees in windrows, where the trees are sparse, in order to have sufficient brush in one place to insure a good burn. Then again where the timber is very thick by falling the trees promiscuously here and there time is saved and a good ground burn is insured. This latter plan applies more particularly to sections where timber is small and dense and of little commercial value.



Drawing showing relation of skidway to main road, and of trails to skidway.

Cutting timber and clearing land usually makes up the work of any settler for the first few years, and the proximity of the market, for timber, and the capital on hand, will be factors in deciding whether or not he can profitably market his pulp and logs. The wasting of good timber should not be practised, if it is possible to prevent it, even though a settler is not making more than expenses. In this way he will be conserving what capital he has on hand, and have it to fall back on in case of necessity.

The man who has had no experience in bush work will naturally be handicapped for a time until he becomes acquainted with handling an axe, saw and other tools necessary in work of this kind. He should, if possible, work with some settler who has had a thorough knowledge of bush work until he gains some experience in it. By co-operating with neighbors in cutting and hauling, time and expense is saved. Many new settlers hire help to cut timber, clear land, etc., and very soon find out that the hired man is making more money than they are themselves. Co-operate as much as possible even though a smaller amount of timber is marketed. By so doing, one is saving expense, and in the end is farther ahead than if hired help had been engaged and a big wage paid that soon eats up the profits.



Drawing of skidway. The front is elevated to make loading easy. The back end of skidway may be placed on a knoll to give a downward slope to the front; this makes rolling much easier.

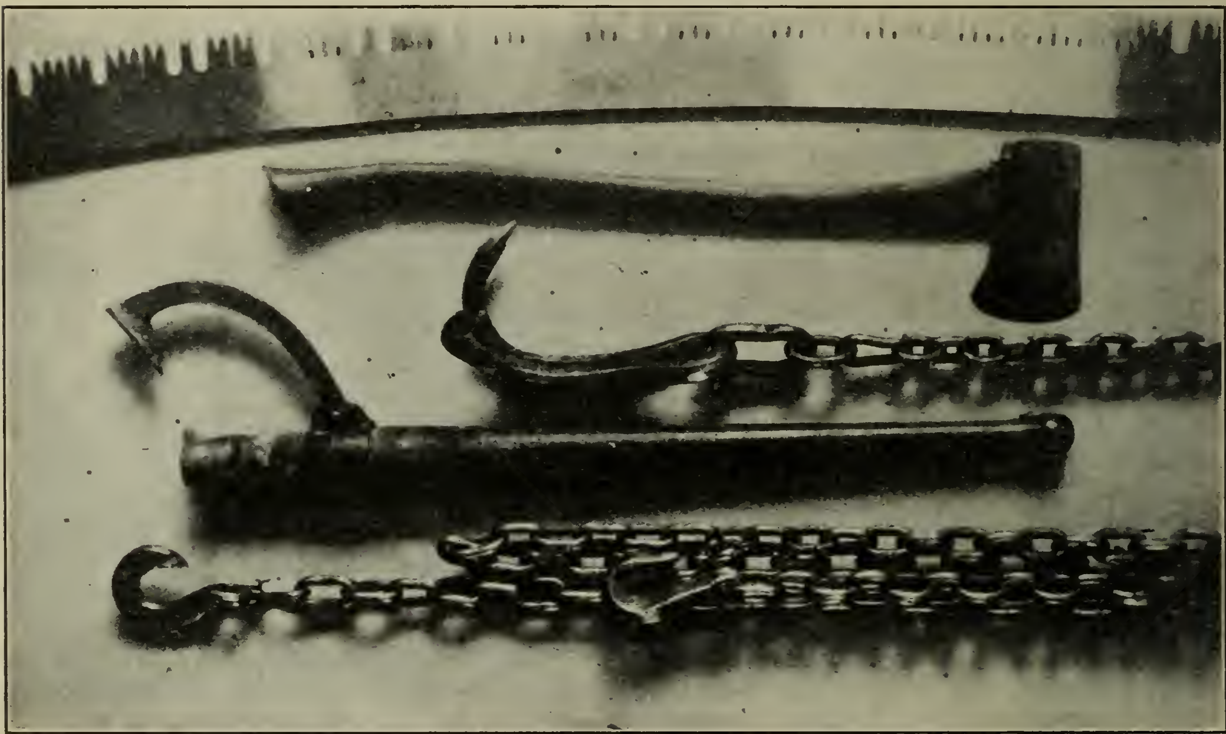
Table Showing Detailed Cost of Timbering and Slashing Nine Acres on the Monteith Demonstration Farm.

Material	Amounts	Cost of Cutting	Cost of Skidding	Cost of Hauling ½ Mile	Cost of Making Roads	Totals
Lumber	22,642 ft.	$36 88	$28 58	$17 28	$2 72	$85 46
Pulp..........	30 cords	37 33	31 24	20 59	2 72	91 88
Wood..........	50 cords	28 77	11 82	10 83	2 72	54 14
Slashing undergrowth						28 77
Sharpening axes, saws, harness repairs, etc.						5 35
Milling 22,642 feet of lumber, at $4.25 per M.						96 22
Total cost						$361 82
Average cost per acre						40 20

REVENUE.

22,642 feet of lumber, at $15.00 per M.	$339 63
30 cords of pulpwood, at $3.25 per cord	97 50
50 cords of firewood, valued at cost	54 14
Total	$491 27
Revenue per acre	54 58
Difference between revenue and cost per acre	14 38

The above table shows in detail the cost of timbering and slashing nine acres of virgin forest. The prices allowed for material are very conservative, especially for the firewood. It is valued at just what it cost to produce it, which is below the market price. All the work on this lot was done during mid-winter, beginning on January 23rd, and finishing in March, so that it really cost more than if the cutting and skidding had been done in the early fall. Still, a favorable balance of $14.38 per acre is shown, after having paid the highest wages to have the work done. The table therefore, shows that it is possible, even under adverse circum-



Cross-cut saw, axe, root-hook, cant-hook and logging chain—necessary land-clearing tools.

stances, to make $14.38 per acre over and above expenses. Moreover a great deal of the best of the timber on this lot had been taken out previously. This greatly decreased the amount of marketable timber, especially lumber which is the most valuable. It lessened the cost a little also, but reduced to a much greater extent the amount of revenue realized.

In order to get an accurate account of the actual cost of timbering the lot, it was necessary to handle all the different kinds of material separately. This added greatly to the cost of handling the timber on account of having to go over the ground more times than would have been necessary had the timber all been cut at the same time.

HAULING.

Hauling can be most profitably done before the snow becomes extremely deep. However, it may be carried on throughout the entire winter providing roads are properly constructed and kept in good repair. Of course all cutting and skidding

Virgin Forest.

Burned-over slashing.

All stumps removed and made ready for piling. Horsepower and powder were the means used to remove these stumps.

Stumps, logs, roots, etc., piled and ready to burn as soon as dry.

New land ready for the plow.

First plowing on new land. The roller is being used to smooth down the land, before using the harrow or cultivator.

A crop of oats.

A fifteen-acre field of red clover yielding three tons of hay per acre.

should be finished up before the snow gets deep. In some cases a person may find it necessary to do more or less cutting during mid-winter, but every effort should be made to have it all done before this time. Hauling is made easier by having the timber well decked up on the skidways. This lessens the surface exposed to snow fall, and also makes less work in digging snow from off and around the skidways. The same thing applies when the timber is cut into short lengths, four feet or less, and piled in rows.

Burning.

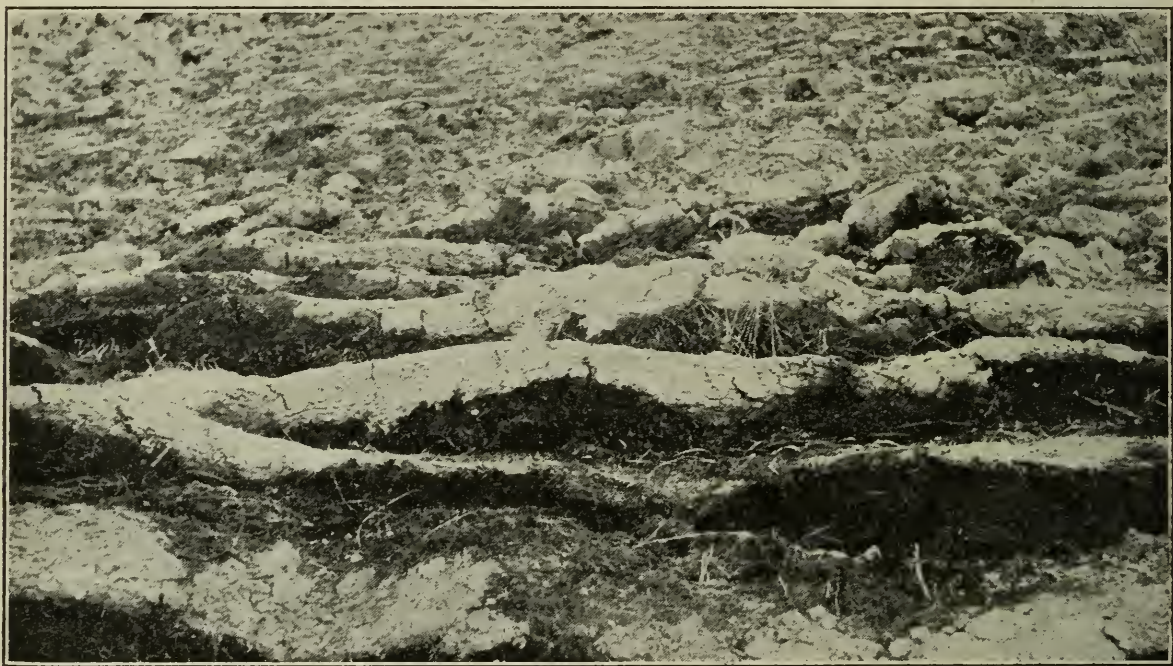
The proper time to burn a slashing depends on certain local conditions and also on the density of the material on the ground; that is, whether it be sparse or thick. It's an old saying that "fire makes a good servant but a poor master," and it is just as applicable to-day as it ever was. Hardwood can usually be burned without causing any serious outbreaks or large bush fires, but where there is a thick evergreen and resinous woods considerable care should be used in burning off an adjacent slashing. It is usually a good plan to back-fire around buildings and near woods one wishes to protect, however, this will not always insure protection, as high winds sometimes carry live cinders for long distances. After there is considerable new growth over the ground and on the trees, there does not seem to be so much danger of fire spreading. A few barrels of water placed near buildings may prove to be very useful in case of danger. Avoid burning when everything is extremely dry, as large and disastrous bush fires are often caused from a small fire started in a very dry time.

All timber that has been slashed so as to fall south-east by north-west usually dries and burns better. The reason is, that the prevailing winds are from the north-west, and consequently drives the fire directly through the log from end to end rather than up against the side of it, also the sun has an opportunity of shining on both sides of the log. The cells of the tree being lengthwise rather than crosswise accounts for this. This is a minor point, of course, but nevertheless is worthy of consideration.

Logging or Picking Up.

Probably the most profitable time to do this work is immediately after the big fire has somewhat subsided and before it dies completely out. However, the extent of the area to go over and the labor available are two important factors governing this part of the work. Then again, if the ground surface is very wet a second burn may be necessary before any picking up is done. But too many ground burns are injurious, as they burn off all the top soil or humus and leave only the clay or sub-soil. It is advisable to conserve at least six inches or more of the black muck or top-soil to mix with the clay. It requires the two combined together to make an ideal soil; one is incomplete without the other. The important point in logging off a burned-over slashing is, that there is a certain time immediately after the first or second burn when the roots, sticks, logs, etc., can be more easily picked up than after they become tramped into the ground and when "coppice" or second growth has started. All logged-over land and newly burned land whether logged over or not, should be seeded down with grass seed, preferably clover and timothy. A mixture of red clover, alsike and timothy in the proportion of four, two and one will give good results. If this seed is sown soon after the land is burned over, while it is in a loose mellow condition and before the surface becomes hard and compacted, it will require less seed and give better results. Four to six pounds per acre, if sown at the right time, will produce an abundance of pasture and prevent second growth starting. By sowing a few pounds more per acre a large quantity of hay may be cut the second year. Very good results are obtained by seeding on the snow in the spring just before the last of it disappears, when a couple of inches remains. The ground is in an open, porous state at this time of year, and the melting snow carries the small seeds sufficiently far into the ground to insure germination. Do not neglect to seed down rough or fallow land even though it is to be plowed up in a year or two, it will provide good pasture and improve the general condition of the soil. Be sure and buy perfectly clean seed, it does not pay to produce weeds.

In the spring of 1915, twenty acres of land on the Demonstration Farm, Monteith, that had been slashed in 1906 and 1907, was blasted free of stumps. Seven and one-half acres was divided into three sections of two and one-half acres each and an accurate account kept of the cost of labor and material.



This photo shows the black muck top-soil and clay sub-soil. Always try to conserve at least six inches of muck, and ten is better.

SECTION NO. 1.

Number of stumps	118	
Number of sticks of powder, at 8c. each	95	$7 60
Number of feet of fuse, at 70c. per 100 feet	120	84
Number of caps, at 1c. each	120	1 20
Number of hours labor, at 20c. per hour	15	3 00
Total cost		$12 64
Cost per acre		5 05
Average cost per stump		10

SECTION NO. 2.

Number of stumps	114	
Number of sticks of powder, at 8c. each	114	$9 12
Number of feet of fuse, at 70c. per 100 feet	145	1 01
Number of caps, at 1c. each	145	1 45
Number of hours labor, at 20c. per hour	15	3 00
Total cost		$14 58
Cost per acre		5 83
Average cost per stump		12

Section No. 3.

Number of stumps	136	
Number of sticks of powder, at 8c. per stick	117	$9 36
Number of feet of fuse, at 70c. per 100 feet	155	1 09
Number of caps, at 1c. each	155	1 55
Number of hours labor, at 20c. per hour	16	3 20
Total cost		$15 20
Cost per acre		6 08
Average cost per stump		11

The amount of work, and cost of same, to blow out a given number of stumps will depend on the efficiency of the operator. The work represented by the foregoing tables was accomplished by a man who had no previous experience in the use of dynamite, and therefore should be truly representative of what any new beginner might do.

To place a charge under a stump, first punch a hole under the centre of it with a crowbar, this hole should be under the firmest part of the stump and fairly well down. Next attach the cap to the fuse and attach fuse and cap to the dynamite, or place it directly on the dynamite after it has been shoved under the stump. A broom handle makes a good ramrod for shoving the charge into the hole and also for packing the dirt in as well. Do not jar the powder when placing it in the hole, nor yet when packing in the dirt. Measure the hole in order to estimate the length of the fuse.

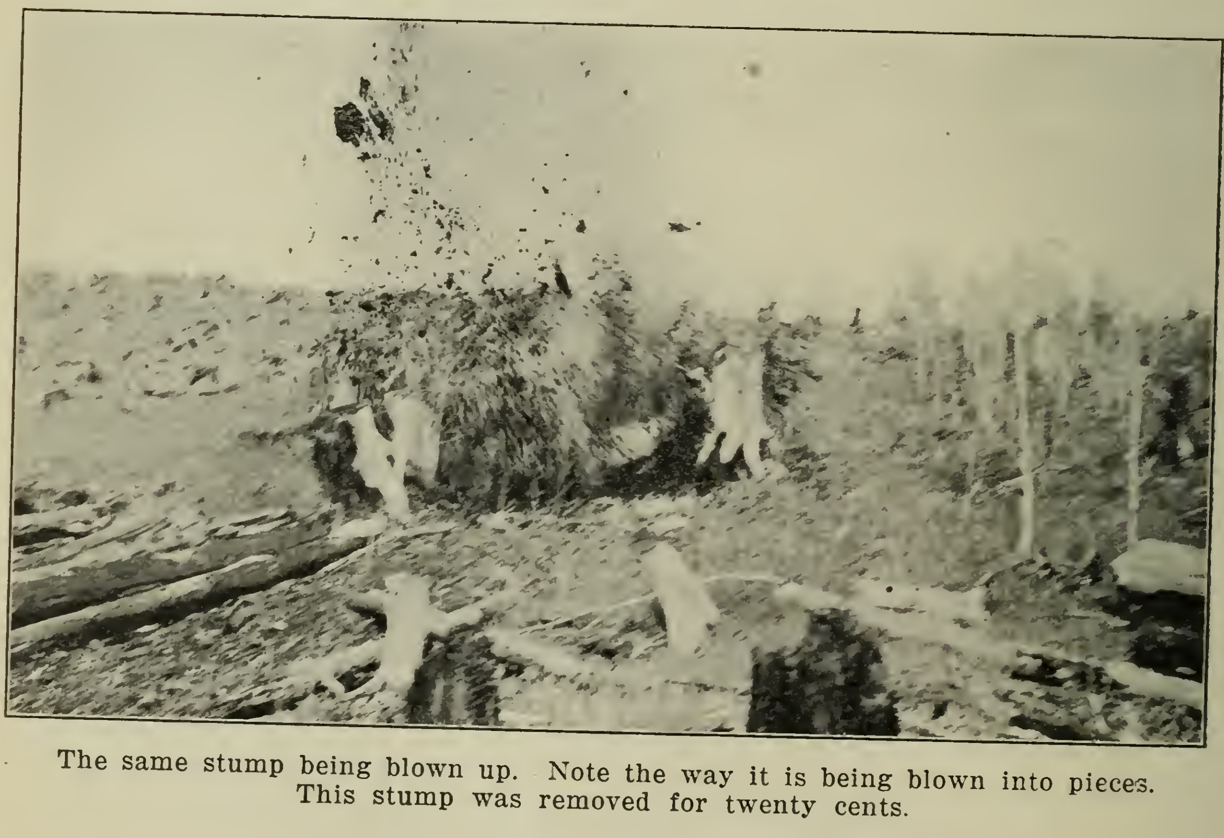
Table Showing Total Cost Per Acre of Clearing Sections One, Two, and Three, Including all Labor, Team Work. Powder, Etc.

Lot	Acres	Man Hrs, at 20c.	Team Hrs. at 20c.	Powder, Caps, Fuse	Total
1	2½	127—$25 40	20—$4 00	$9 64	$39 04
2	2½	138— 27 60	26— 5 20	11 58	44 38
3	2½	182— 36 40	40— 8 00	12 00	56 40
			Cost of Branding, 114 hrs. at 20c.		22 80
			Total		162 62
			Average per acre		21 68

The above table gives in detail the actual cost of clearing seven and one-half acres of land that had been timbered, slashed and burned some years previously. It shows an average cost of $21.68 per acre. It also shows a difference between sections one and three of $17.36. This is accounted for by the fact, that a great deal of second growth had grown up on section three while none had grown on section one. And $17.36 represents the cost of clearing two and a half acres of second growth as illustrated in the photo. This is conclusive evidence that it does not pay to allow second growth timber to grow up before the land is finally cleared of stumps.

From the table we learn that it cost $40.20 per acre to timber the land and $21.68 to do the final clearing, or a total of $61.88, also that a revenue of $54.58 per acre was realized. These figures show that the cost of clearing per acre, over and above the revenue shown, amounts to $7.30. However, had the final clearing been done before the second growth grew up, the difference would be only thirty-five cents (35c.) or in other words the settler can figure on realizing enough from the timber to clear the land and at the same time allow himself wages at the rate of two dollars per day. Moreover, he has cleared land (if homesteaded) for fifty cents per acre, that in a few years (eight or ten) should be worth at least twenty dollars per acre.

Placing a charge of dynamite under a large poplar stump.



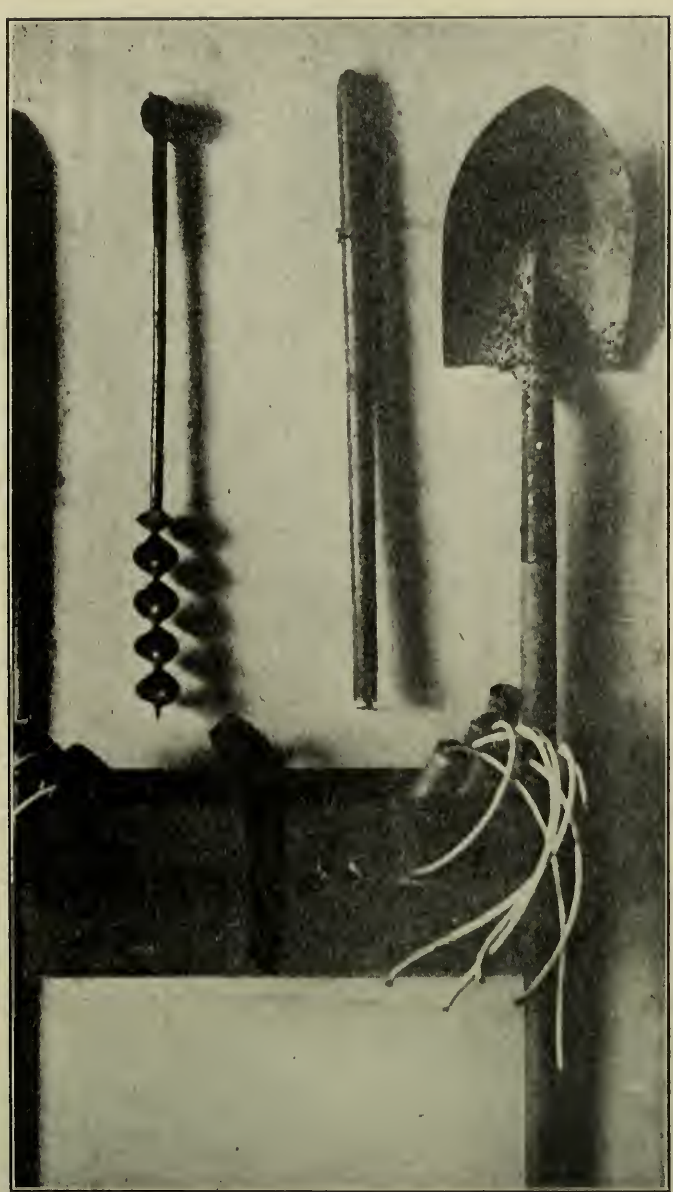
The same stump being blown up. Note the way it is being blown into pieces.
This stump was removed for twenty cents.

The figures given and conclusions drawn in the preceding paragraph are representative only of one instance, and to many who have had actual experience in such work, may at first sight seem to present an impossibility. Such, however, is not the case, as they are the result of correct calculation, etc., of all labor expended in clearing said land. Circumstances will of course influence ones chances of realizing similar results. They may be represented by quality of timber, distance from a market, knowledge of the work and individual effort. Unless one has the ability, knowledge and individual effort necessary to properly take advantage of the best means at hand, he cannot hope for best results. Why is it that one man succeeds where another fails? What the settler may or may not realize on capital, time and effort expended, depends largely on his ability to best fill the position he occupies. Of course circumstances, over which a person has little or no control, may arise to handicap one, but these are exceptional. In order to succeed one must know and in order to have knowledge one must learn. This sometimes requires years of costly experience that should, if possible, be prevented. The settler should first familiarize himself with the timber situation, keeping in mind future demand and prices, then figure on the prospects of conserving or marketing his timber or whether he would be further ahead in the end to clear the land as soon as possible and get it into crop. He will have to decide which scheme will be the most lucrative over a period of years.

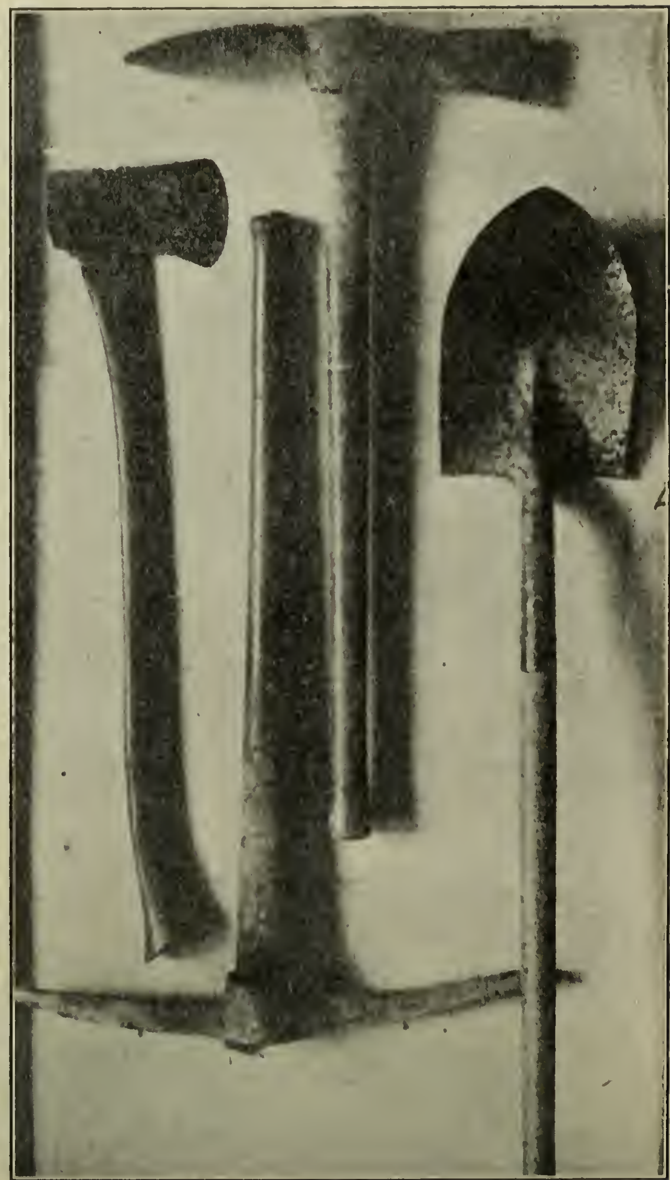
Stumping.

The great majority of virgin forest throughout Northern Ontario consists of trees averaging from six to twelve inches in diameter and the nature of the timber will influence the time and cost necessary to clear land of stumps. There are exceptions to this where heavy hardwood timber is found, and also where areas of white and jack pine are found, but generally speaking the timber is much smaller on an average than that of "Old Ontario." Then, the different root systems of different kinds of trees influence the cost of their removal. Practically all evergreen trees have a spreading root system that spreads out through the top-soil, while nearly all deciduous or broad-leaved trees have a tap-root system that penetrates quite deeply into the sub-soil. The latter are more difficult to remove than the former. The time allowed to lapse between the cutting of green timber and removal of stumps will have a decided influence on the cost of stumping. Usually a great many small stumps are partially burned out with the first big fire, and can be pulled with one horse or removed by hand at the time the land is logged-off. Stumping machines may also be used to advantage where the stumps are small and thick and also on sandy land. It is not advisable for a settler to purchase a stumping machine until he is sure he can use it profitably and to good advantage. Stumps are naturally more easily removed after two to four years have elapsed, as this allows the roots to rot and makes pulling a great deal easier. This is an important factor in land clearing and should have a tendency to make a settler do his best to systematically cut so many acres of green timber each year, seed down the slashing to pasture, or hay land and allow the stumps to decay. By so doing there will be a certain number of acres coming on every year to be freed of stumps and put into tillable condition. The acreage slashed and made ready from year to year will of course depend on the amount of capital and labor on hand.

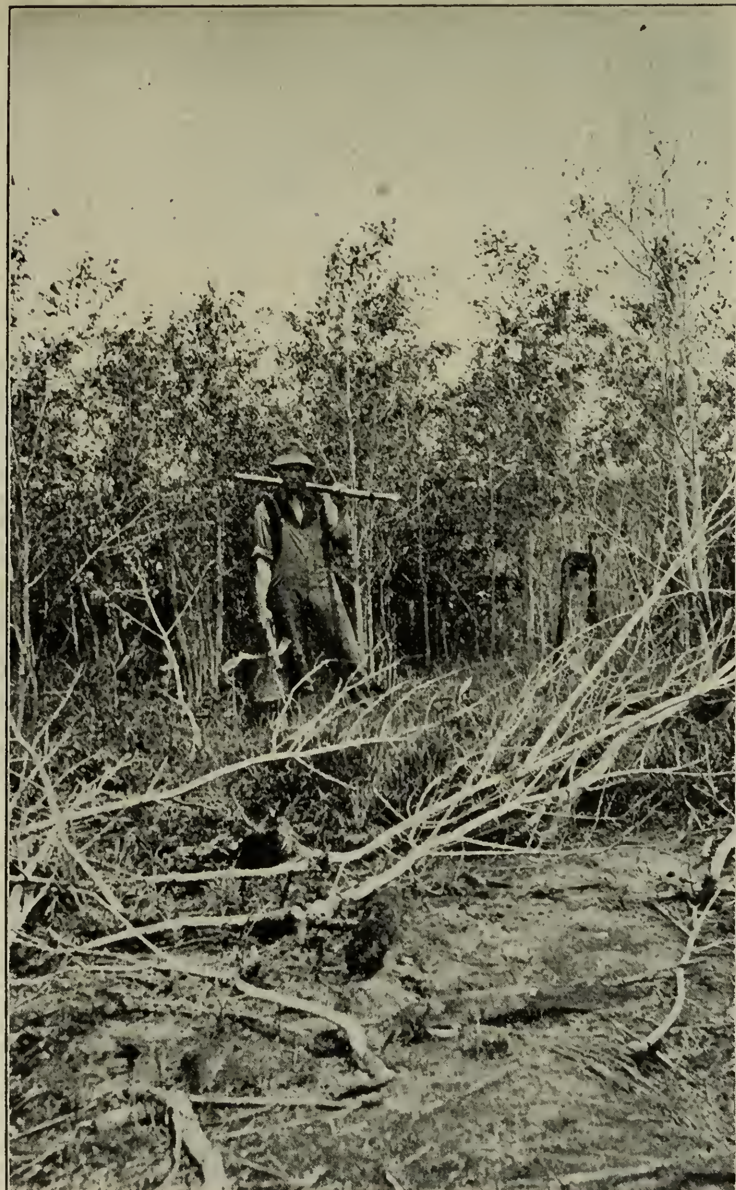
Stumping or blasting powder is being used to quite an extent to-day for removing stumps, and it is a very cheap and efficient means of getting rid of large stumps. Any person of average intelligence can handle this explosive without danger of serious results. Care and precaution in warming the powder, placing



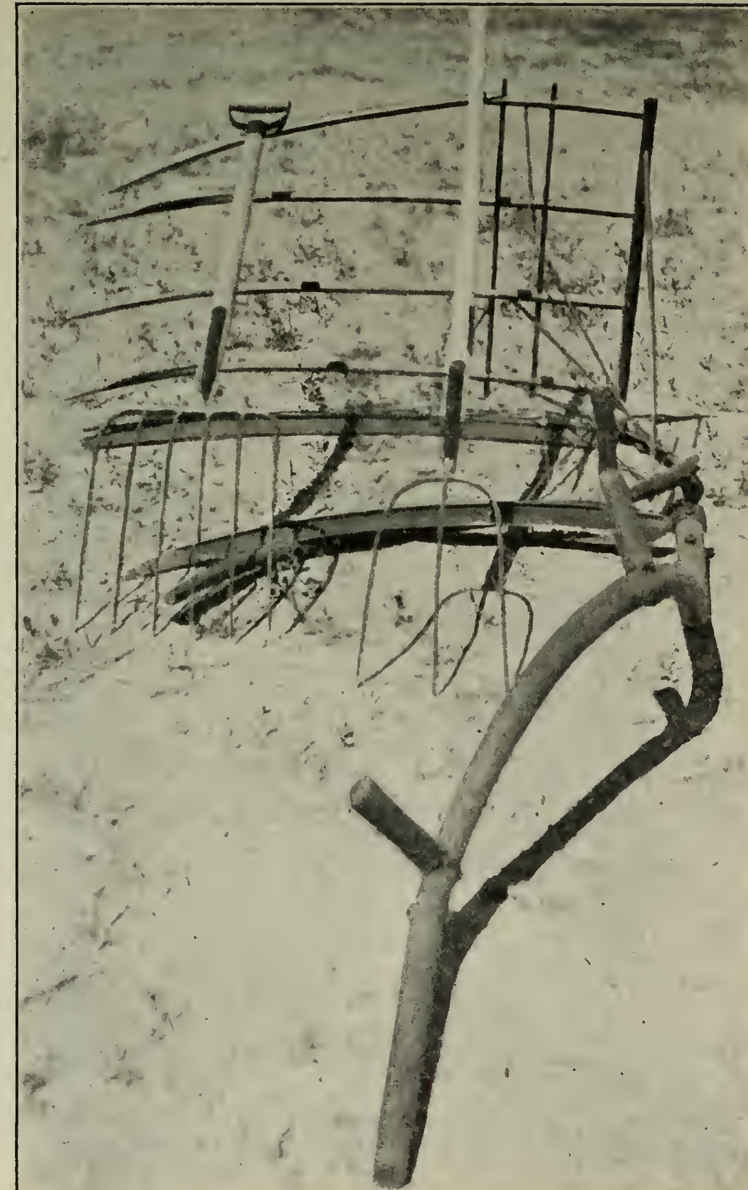
Crowbar, auger, tamping stick, shovel and powder box. Powder sticks have fuse attached.



Crowbar, axe, pick, grub-hoe and shovel—land-clearing tools.



This picture shows the second growth that grew up on section three. It cost $17.36 to remove this, in addition to what it cost to clear the land of stumps. Settlers should avoid this extra cost, if possible.



Grain cradle, mowing scythe, three and six-pronged forks—handy tools for haying and harvesting on stumpy land.

the cap on the fuse, attaching fuse to powder and placing the charge, are both essential and necessary. If the person handling the powder is careful to remember at all times that carelessness is dangerous, there is little chance of accident.

Stumping powder can be used much more effectively on certain kinds of soil than on others, and also to better advantage at certain times of the year. The best time to blast out stumps is in the spring, as soon as the frost is out enough to allow punching a hole beneath the stump. At this time of year the soil is wet and heavy and more resistent and consequently the powder does better work on the stump than when the soil is dry and loose. It also gives better satisfaction and does better work on clay soils than on sandy soils, although it is often used to advantage on sandy soil when it is wet and soggy. The size of the stump and the time of year the work is done will determine the amount of powder to be used. By experimenting with different amounts on different sized stumps, a fair idea can be formed as to the most economical and profitable amount of powder to use. One decided advantage in blasting out large stumps is that they are almost entirely free from dirt when out and are broken up in several pieces. They are, therefore, more easily handled and dry out and burn more readily than when drawn out, either by team or machine, covered with a great mass of dirt and often so heavy that they can only be handled with difficulty. A home-made jumper or stone-boat will be found very useful in gathering up stumps and roots. Any person handy with an axe can make either one with little trouble or expense. Stumping powder costs approximately ten dollars per box, but may at times be purchased for less money. As stumping powder is usually in a frozen condition when taken from the box, it is necessary to thaw it out before using it. This is very easily done by placing the sticks of powder on the sunny side of a knoll or stump a few hours previous to the time it is to be used. Never handle dynamite carelessly.

First Cultivation.

In very many cases the first two or three crops will be sown and harvested before the land is stumped. And the first seeding is often harrowed in among the ashes and loose top-soil and good results obtained. However, as soon as the stumps are taken out it is customary and advisable to plow the land. All plowing on heavy clay land should be done in the fall of the year if possible at all. Sandy or loamy soils may be plowed in the spring, but as early seeding is necessary in Northern Ontario, to obtain best results, it is advisable to have all land plowed in the fall. The action of weathering agents, alternate freezing and thawing, rain, wind and sun, all have a beneficial effect, especially on clay soils. These agents also destroy hordes of insect life that pupate in the ground in the fall of the year. When the soil is turned up they are so exposed that they die. Deep fall plowing is preferable at all times to shallow spring plowing and is essential to insure best results on clay soil. It also pays to do the first plowing well; it may take considerable time, but with a good plow and with share and coulter kept sharp, the arduousness of the work is lessened. A single walking plow is best for breaking up new land. It pays to thoroughly cultivate the land, working up a good seed bed to insure a quicker and more even germination. Anything worth doing at all is worth doing well.

Crops.

Cereals, legumes or hay crops, roots and fruits make up the different kinds of crops grown in Northern Ontario. Many kinds of grains do well if the proper varieties are sown and seeding is done at the right time. For the production of grain it is very necessary that early maturing varieties be used and that seeding be done early. The new beginner should be careful in this regard, and make inquiries from older settlers or get in touch with the local representative of the Department of Agriculture. Late maturing grains may be sown for hay, but not for grain. Corn can be profitably grown only in some parts. All kinds of clovers do exceedingly well and large yields of very nutritious hay are obtained. Profitable yields of clover and timothy seed are grown practically all over the agricultural part of Northern Ontario, the seed is of exceptional quality and vitality. Alfalfa is giving very good results in many parts of Northern Ontario, when the proper varieties are used. Southern grown United States seed should never be sown in Northern Ontario. Seed of Grimm, Ontario Variegated or of the Russian varieties only should be used. However, since alsike and red clover grow so luxuriantly the settler need not worry even though he cannot grow alfalfa successfully.

No part of the Province of Ontario can grow roots and vegetables more abundantly than Northern Ontario. Almost any kind of vegetable will give an excellent yield. Potatoes give large yields and turnips and mangels also do well. In

Pure-bred Shropshire sheep, well adapted to northern conditions. Sheep can be profitably kept even by the beginner.

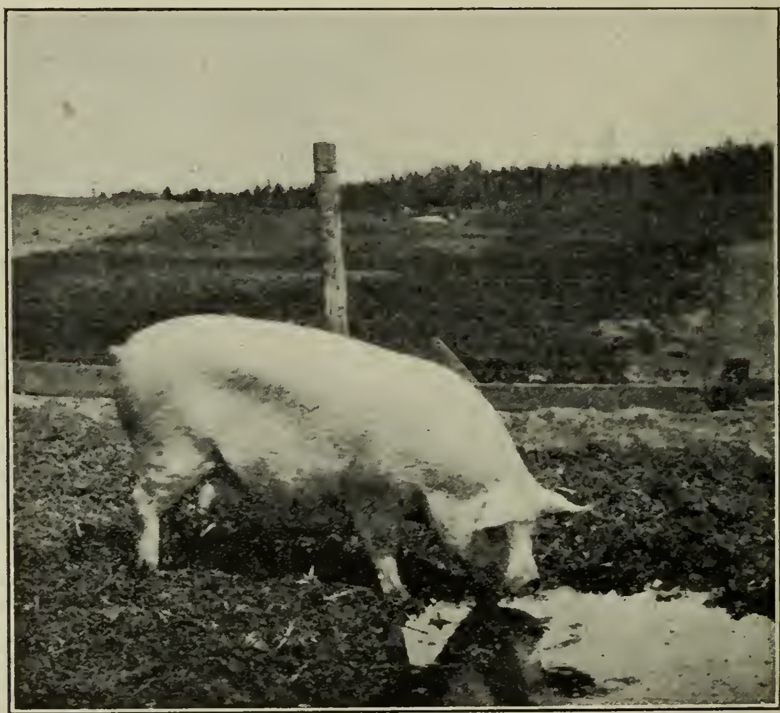
growing potatoes an early variety should be used, especially in the new parts. Late spring and early fall frosts are injurious to late maturing crops. In the older parts of the country where the land is becoming pretty well cleared of timber summer frosts are gradually disappearing. Practically all small bush fruits, such as strawberries, gooseberries, currants, etc., grow successfully. Crab apples also do well but large apples are recommended only for that part of the country along the north shore of the Great lakes and around any large inland lakes. The new beginner should not attempt to grow fruit without making inquiries about it. There are many kinds of small edible fruits growing wild that can be picked and preserved for household use; there are wild black currants, strawberries, blueberries, raspberries, etc.

Live Stock.

Conditions and situation will influence the kind of stock that a settler may keep, and one thing to be remembered by a person locating on a bush lot is, that it will be a few years before sufficient feed can be produced to properly feed a few head of stock throughout the winter. Some make the mistake of trying to keep

Cows in pasture.

too much stock for which they have to buy feed, at exorbitant prices. This very soon reduces the amount of cash capital on hand and does not bring sufficiently large returns to warrant such expenditure.



A pure-bred Yorkshire sow of the proper type, an economical producer of wealth.

Horse power being an important factor in clearing land, naturally means that a horse should probably be the first animal purchased. But as this involves the expenditure of considerable capital, one should be sure the investment is necessary. Co-operation among the settlers in the purchase of horses and the cutting of timber, clearing of land, etc., will mean more economical and rapid progress. For instance, two neighbors may have one horse each that can be made into a team for doing team work and a team and two men will accomplish more by co-operating in certain lines of work than can be accomplished individually. Individual effort is, of course, necessary, but co-operation is vastly superior in many cases.

Because a cow and a hog, of the right kind, contribute a good deal toward the necessary food supply of any household, it is usually advisable to keep such just as soon as circumstances will allow of doing so. The slashing that has been seeded with clover and timothy will in many cases provide ample summer feed. A hog will live on clover pasture alone during the summer and do well. Berkshires or Yorkshires are recommended, and a cow of the dual purpose type will provide both milk and meat of good quality. Dual purpose cattle are generally more hardy and as good, if not better foragers than the strictly dairy breeds. What ever kind is purchased, remember that it does not pay to keep a poor producer, or in fact an inferior animal of any kind. The dairy shorthorn is the leading dual purpose cow to-day, and is giving a very creditable account of herself. While it is

Forge, anvil and tools. These often prove to be a great help in time of trouble.

essential to have a good individual, it is just as essential that sufficient feed of the right kind be given to allow the animal to do its best.

On account of the fact that Northern Ontario is an A1 grass-growing country; it must eventually develop into a great stock producing country. Large prices are often a great temptation to settlers to sell a great deal, if not all, of their hay and grain. Force of circumstances sometimes induces them to do so, but the fact remains that no matter how productive any soil may be originally, it will succumb sooner or later unless it is getting something back in return. Producing hay and grain and selling it, depletes the soil of its fertility, keeping stock and returning barnyard manure to the soil insures a permanent production.

Machinery.

The settler should not purchase machinery that he does not actually need. He should not allow any implement agent to decide for him what machinery he ought or ought not to have. Co-operation in the buying and using of machinery might well be practised among neighbors for the first few years, until such times as it becomes necessary to have it individually. A great deal of valuable capital may be tied up in machinery that might have been used to much better advantage in clearing land or buying stock. In some instances settlers may have machinery that they have purchased, possibly when living on a rented farm in Old Ontario or elsewhere, and it will no doubt pay to bring this machinery along if the distance and cost of transportation is not too great. One very important thing is to protect all kinds of machinery from sun and rain, as exposure to the elements will do more damage to implements in a year's time than the work they have been subjected to. Remember that capital spent in purchasing unnecessary machinery, and then leaving it without protection, is like throwing money away.

Markets and Marketing.

These do not concern the settler much for the first few years, as he has more to do with buying than with selling. However, whether buying or selling, he should keep directly in touch with market prices, especially of those commodities that directly concern him. Usually there is a market for certain commodities as early vegetables, small fruits, etc., that a settler can sometimes take advantage of. This will depend on his situation and proximity to a market. In any event every settler should make an effort to grow enough carrots, cabbage, beets, onions, etc., to supply the household demand. In a really new section of country only the earliest maturing kind of vegetables and potatoes available should be planted.

As time goes by and clearing increases, make a point of producing as much of the produce that will bring best returns as is possible. The farmer's earning power depends largely on what he realizes on his marketable produce. If it pays to produce a finished product, do so by all means. Remember, the consumer can only utilize the finished article no matter what it is, therefore aim to produce what will bring the largest net profit.

District Representatives.

District Representatives of the Ontario Department of Agriculture are located at the following places in Northern Ontario:—

Muskoka District	Huntsville, Ont.
Timiskaming District	New Liskeard, Ont.
Sudbury District	Sudbury, Ont.
Algoma District	Sault Ste. Marie, Ont.
Manitoulin Island District	Gore Bay, Ont.
Rainy River District	Emo, Ont.
Thunder Bay District	Port Arthur, Ont. Fort William, Ont.
Kenora District	Kenora, Ont.

Monteith Demonstration Farm.

Timiskaming District, situated at Monteith, Ont.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 245

Food Values

By

R. HARCOURT

Professor of Chemistry

TORONTO, ONTARIO, DECEMBER, 1916

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

FOOD VALUES

R. Harcourt.

The cost of living has increased rapidly. The price of flour has advanced over 50 per cent. in the last year or two; potatoes are almost double what they were a short time ago, and breakfast foods, meats, eggs, etc., are all selling for much higher prices than formerly. It is not the increase in the cost of those foods which may be called luxuries that is bothering the consumer; but it is the fact that the cost of the plain necessaries of life have advanced so much that providing for the wants of the family has become a serious problem.

It is not necessary to discuss the causes for this; but, undoubtedly, the shortage in our own field and garden crops and the heavy demands for overseas consumption has resulted in a decreased supply for home use. These changed conditions render it necessary for us to study the foods available in order that we may determine which are our best and cheapest foods and how these may be combined to produce the best results. It is true that palatability and agreeableness enter largely into the problem, and that the cheapness of a nutritious food is not the only point to be considered; for few people, even to effect economy, will eat a food they do not like unless driven to it by necessity. However, people differ in their likes, and we shall discuss the foods on the basis of their nutritive value, pointing out those foods which furnish the most nourishment for a given sum of money, leaving the question of palatability to be decided by the consumer.

The constituents we value most in our foods are: protein, fat, carbohydrates and ash. *Protein* is the name commonly given to a class of substances which furnish the materials for the formation of bone, flesh, blood, etc. This constituent is absolutely essential in the food of animals; for, without it, no animal can grow or even subsist. Moreover, the animal is totally unable to create protein; that is a function of plant life. The animal can simply appropriate and transform the protein of plants into the particular protein of the body. Protein, when oxidized or burned in the body, will produce heat, and if eaten in excess of that required for other purposes, may form fat. Altogether protein is one of the most important constituents of a food, and the one which is the most expensive. Hence we naturally like to find a food rich in this substance.

Fat, or ether extract, is that part of the food which may be extracted from the water-free material by ether, benzine, gasoline, etc. It is of value for the formation of fat in the body and for the production of energy and heat. For this latter purpose it has more than twice the value of protein and carbohydrates. Fat may, therefore, be looked upon as a concentrated heat producer.

The Soluble Carbohydrates, or nitrogen-free extract, consist mainly of starches, sugars, and closely allied compounds. In the cereal breakfast foods these soluble carbohydrates form about two-thirds of the whole material. Their particular function in the body is to form fat, or, when oxidized, to produce heat and energy. They are frequently called the energy, or heat, producers.

Crude Fibre is the term applied to a group of carbohydrate substances which form the woody or straw-like framework of plants. It is so indigestible that it has almost no food value, and, further, it frequently renders the rest of the food less digestible by protecting it from the action of the digestive fluids. Therefore, a large amount of it in a food is not desired. Yet it is undoubtedly physiologically useful in giving the needed bulk to the food.

Ash is the inorganic or mineral part of foods. It is of great importance in the food of the young, as it furnishes the phosphates, chlorides, and other salts of calcium, magnesium, sodium, potassium, iron, etc., which are needed in building up bone and the tissues of the body.

Heat of Combustion.—The various nutrients above referred to when supplied in the food enable the body to grow and to repair its tissues as they are worn out in the necessary exercise of the body functions. They also supply the body with the energy needed for doing work, both internal and external, and furnish the heat to keep the body warm. All the nutrients, except the ash, may be oxidized or burned in the body, and are, therefore, sources of energy. Consequently, the total energy value of a food may be determined by measuring the amount of heat given off when a definite weight of the food is burned. This energy value is conveniently stated in terms of heat, the Calorie, or unit of heat, being used for this purpose. The number of Calories of heat a gram of each food is capable of producing, if fully burned, is given in the last column of the Table.

Comparatively recent investigations in the problem of nutrition indicate that there are probably very small quantities of certain unidentified compounds in our foods which have a very marked influence on their nutritive value. Very little is known about these accessory compounds, and we are not in a position to ascribe values to them. We can, therefore, assume that in foods of like nature, especially when used in a mixed diet, the digested protein, fat and carbohydrates from one source are as valuable as those from any other. To make the comparison closer, however, we must bring these various factors to some common basis. As one of the main objects of food is to produce heat and energy, it is generally considered that if there is sufficient protein in the diet to do the work which it alone is able to perform, the amount of heat a food is capable of producing is the best basis upon which to make a comparison. With this idea in view, we have figured the number of Calories of heat as well as the pounds of protein, fat, and carbohydrates that will be furnished in one dollar's worth of a number of our common foods. This data is given in the following table, with the foods arranged in the order of their heat-producing power.

A study of the accompanying table shows that the foods derived from the cereal grains stand at the top of the list. This is not surprising, as they contain a large amount of carbohydrates, which are the cheapest fuel material among our foods. But it is worthy of note that they also furnish comparatively large quantities of protein and fat, much more than can be purchased for the same money in the form of meat, fish or eggs. Thus one dollar's worth of oatmeal at prevailing prices will contain two and a half pounds of protein. The same amount of money expended on a good spring wheat flour will furnish three pounds of protein; bread, a little over one and a half pounds; milk, over one pound; while sirloin steak will only supply two-thirds of a pound and eggs about one-third of a pound. Consequently the cereal foods not only stand first on the list in fuel value, but they also are capable of furnishing more protein for a given amount of money expended than can be procured in meat, fish or eggs. It is true that the protein of these latter foods is more easily and completely digested, but the foods from the cereal grains contain so much more of it that this could not possibly make up the difference, and, furthermore, these cereal foods contain an abundance of the cheap heat-producing carbohydrates to do the work of digestion. Among the foods placed in the table buttermilk and skimmed milk are our cheapest source of protein, and they are probably as fully and as easily digested as the protein of meats.

PROTEIN, FAT, CARBOHYDRATES AND FUEL VALUE OF ONE DOLLAR'S WORTH OF EACH FOOD.

	Price.	Protein lbs.	Fat lbs.	Carbohydrates lbs.	Fuel Value Calories.	Comparative Values.
	$ c					
Rolled Oats	5 per lb.	2.5	1.36	14.3	36,950	100.
Fall Wheat Flour	4 75 " cwt.	2.0	.20	16.0	34,307	92.8
Spring Wheat Flour	5 00 " "	3.0	.20	14.3	33,780	91.4
Corn Meal	5 " lb.	1.31	.25	16.26	33,735	91.3
Farinas	5 " "	1.9	.20	15.6	33,394	90.4
Rolled Oats (package)	25 for 4 lb.	2.00	1.09	11.5	29,560	80.0
Sugar	8 00 per cwt.	....	....	12.5	23,250	62.9
Rice	7 " lb.	1.06	.05	11.3	23,210	62.8
Peas	7 " "	3.00	.19	9.0	23,121	62.6
Farinas (package)	15 for 2 lb.	1.26	.14	10.3	22,207	60.1
White Bread	16 " 3 "	1.58	.38	9.1	21,650	58.6
Buttermilk	10 per gallon	3.0	.50	4.8	17,362	47.0
Skim Milk	10 " "	3.4	.30	5.1	17,070	46.2
Barley, pearl	10 " lb.	.84	.10	7.8	16,492	44.6
Beans	10 " "	1.95	.27	6.0	15,500	42.0
Potatoes	2 25 " bag.	.87	.04	6.24	13,397	36.2
Malta Vita	10 " 12 oz.	.74	.10	5.87	12,716	34.4
Toasted Corn Flakes	10 " 12 "	.42	.11	6.06	12,517	34.0
Grape Nuts	15 " 17 "	.81	.07	5.56	12,143	33.0
Milk	8 " qt.	1.04	1.27	1.66	10,402	28.2
Shredded Wheat	13 " 12 oz.	.63	.05	4.42	9,659	26.1
Beef, flank	14 " lb.	1.21	1.36	....	7,970	21.6
Butter	45 " "	....	1.88	....	7,933	21.5
Cheese	30 " "	.93	1.22	1.4	7,138	19.3
Mutton Chops	24 " "	.56	1.20	....	6,106	16.5
Ham, smoked	28 " "	.51	1.19	....	5,963	16.1
Beef, sirloin	25 " "	.66	.65	....	4,000	10.8
" round steak	24 " "	.79	.53	....	3,718	10.6
Lamb, hind quarter	27 " "	.61	.60	....	3,672	10.0
Ham, smoked and cooked	45 " "	.44	.50	....	2,930	8.0
Salmon, canned	25 " "	.78	.30	....	2,716	7.3
Salmon Trout (fresh)	15 " "	.61	.34	....	2,569	7.0
Cod (salted)	18 " "	1.05	.02	....	2,307	6.2
Eggs	48 " doz.	.37	.29	....	1,912	5.2
Halibut (fresh)	25 " lb.	.61	.18	....	1,894	5.1

Among the vegetable foods, the legumes contain the largest percentage amount of protein; but, owing to the present high price of beans, a dollar's worth of this food does not furnish so much protein as wheat or oat products.

The cereal products have not the same decided advantage over the meats in the fat purchased for one dollar. Some of them do supply more fat than the meats;

but, owing to the separations made in the preparation, others are low in fat. Thus the higher grades of flour and some of the wheat farinas are low in fat.

Among foods of unlike nature, such as we have in the above table, it is admittedly hard to make an absolutely just comparison. Students of these problems are, however, pretty well agreed on the principle that when there is sufficient protein in the diet the number of calories of heat a given amount of food will furnish is the best method upon which to compare this nutritive value. It is true that some foods may be prized for their content of certain substances; thus meats contain a high proportion of protein, which is after all the expensive part of our foods and, furthermore, the meats have a condimental value when used with vegetables. These facts give meats a peculiar value for which they possibly do not receive full credit in this method of comparison. Reference to the column of the above table giving fuel values, shows that this method of comparing the foods places the meats so far below the cereals that it cannot be lightly explained away. To bring out this comparison more clearly, rolled oats, which stands first on the list, is given a mark of 100, and all the others figured in proportion. Thus, according to this basis of comparison, if rolled oats be given a value of 100, fall wheat flour, at the prices used in the figuring, should be assigned 92.8, bread 58.6, cheese 19.3, sirloin steak 13.5 and eggs 5.2. Or, in other words, assuming, because rolled oats stands highest in the list of foods given, that one dollar spent on this food will give us full value, or 100, an equal amount of money spent on flour will furnish only 92.8 per cent. as much, steak 13.5 per cent., and eggs 5.2 per cent. Or that one dollar spent on eggs procured only 5.2 cents' worth of food material when compared with what could be got if the money had been spent on rolled oats, which is only about one-twentieth the returns for the money.

Turning now more especially to the cereal foods, it will be noticed that oatmeal, cornmeal, wheat farinas, and flour are our cheapest foods. The cost of buying the breakfast foods in package is well illustrated. According to the above data, when rolled oats are bought in package we only get 80 cents' worth for the dollar, that is, one-fifth of the dollar was spent on the package. In the case of wheat farinas, which are prepared from approximately the same part of the wheat kernel as the high patent flour, and are sold under the name of cream of wheat, meat of wheat, wheat crystals, etc., the difference in price is even more marked. Thus, the data in the table shows that in purchasing these goods we obtain 90.4 cents' worth of food for the dollar, taking rolled oats in bulk as our standard, and that this shrunk to 60.1 cents' worth when the farinas were purchased in package. Or, in other words, we pay 30 cents for the package, and it is extremely doubtful if we get anything else for the money. The goods put into the package are usually no different to those that are put into the barrel, and if, as is frequently the case in the larger stores, the whole of the contents of the barrel is done up in parcels at one time ready to hand out when required, the goods will be as fresh and clean as the package goods.

The prepared breakfast foods stand much lower in the list than the oat, wheat and corn meals. It must be said these ready-to-serve foods are put up in neat packages and that the goods have a clean, appetizing appearance, and, furthermore, that there is no expense incurred in their preparation for the table; but they are expensive. Toasted Corn Flakes furnish only 34 cents' worth of food and Shredded Wheat only 26 cents' worth for the dollar, taking oatmeal as the standard. What it costs to cook oatmeal is hard to estimate; much will depend upon whether a special fire has to be kept going for the purpose.

The position of bread in the table is interesting. The bread, like the prepared breakfast foods, is ready to serve; and one dollar, even at 16 cents for the large loaf, will purchase approximately twice as much actual food as if spent on these prepared cereals. It stands first in our list of cooked foods. It is worthy of note, however, that while a dollar expended on spring wheat flour furnishes 91.4 cents' worth of food material, bread only supplies 58.6. The difference presumably is what it costs to make and deliver the bread.

Skim milk and buttermilk at 10 cents a gallon hold a good position in the list of common foods, and too little of these cheap foods are used. At present prices they furnish the cheapest source of food protein. Milk and corn meal or milk and bread form an almost perfectly balanced diet. It may not be the most appetizing diet, and it may be too bulky for the adult, but it is one that will be sustaining.

Potatoes have been figured at two dollars and twenty-five cents a bag, an unusually high price, yet they hold a fairly good position in the table. At present prices, however, the American practice of substituting rice for potatoes with meats is an economy.

Beans and peas are the only legumes included in the table. They do not hold the high place that might be expected of them. This is owing to the fact that they are in great demand for export and are consequently very high in price. The legumes are frequently referred to as the poor man's beef, but at present prices they do not furnish this constituent any more cheaply than the cereal grains.

The meats, fish and eggs are evidently our most expensive foods. Beef flank at 14 cents per pound stands highest in the list; but it lacks the cheap heat-producing carbohydrates, and, consequently, does not furnish as much heat as can be purchased in many forms of cereal foods for the same money. Neither does it supply an equal amount of protein. In fact, using its heat-producing power as the basis for comparison, beef flank is five times more expensive than oatmeal. On the same basis smoked and cooked ham costs twelve times as much as oatmeal, sirloin steak about nine times, round steak ten times, eggs twenty times as much as the oatmeal product. As previously stated, meats have a condimental value, the gravy often adds a decided relish to the vegetable used with it, and, possibly, the animal foods, including milk, add a something to the diet that cannot be secured from any other source. Yet it is evident that if economy is any object the amount of meat used should be reduced to the minimum. Meat once a day is ample, especially when milk and milk dishes form an important part of the diet. In fact, under these conditions, no ill results will follow doing away with meat altogether.

There appears to be quite an erroneous idea abroad regarding milk. In many families it is purchased so sparingly that it is more a luxury than a staple food. It furnishes animal protein more cheaply, even at 8 cents a quart, than most cuts of the meats. Cheese has gone up so much in price recently that it has not the same advantage over meats it had a few years ago, but it is still a cheaper source of animal protein and fat than meats.

At the prices prevailing so far inland as Guelph it is evident that fish are even more of a luxury than meat. All these foods lend variety to the diet and are valuable, but if economy is an object it is evident they must be used sparingly.

Many people will possibly be surprised at the position of eggs in the table, as we have often been told of the wonderful nutritive value of an egg. It is safe to say, however, that when eggs cost more per dozen than an equal weight (one and one-half pounds) of steak they are more expensive. On the other hand, a pound of eggs (usually eight) will go further in serving a number of people than a pound of meat. In this sense they may be more economical than meat.

A great deal has been said about the advance in the price of food materials. To show more clearly how much they have advanced, we have calculated the amount of each constituent supplied by some of our most common foods at the old prices. These figures are given in the following table.

PROTEIN, FAT, CARBOHYDRATES AND THE FUEL VALUE OF ONE DOLLAR'S WORTH OF EACH FOOD AT THE OLD PRICES

Name of Food	Price	Protein lbs.	Fat lbs.	Carbohydrates lbs.	Fuel Value Calories	Present Purchasing Price of $1.00
						$
Spring Wheat Flour......	$3.00 per cwt.	3.90	.03	25.1	55,000	61.3
Rolled Oats..............	7 lbs. for 25c.	3.5	1.9	20.0	51,730	71.4
Farinas..................	6 " " 25c.	2.3	.24	18.7	40,070	83.3
White Bread	3 " " 10c.	2.52	.6	14.6	34,375	62.9
Potatoes	90c. per bag	2.18	.10	15.6	33,492	40.0
Beef, flank	8c. " lb.	2.12	2.37	....	13,944	57.1
Cheese...................	17c. " lb.	1.63	2.16	.24	12,593	56.6
Beef, sirloin	18c. " lb.	.92	.90	....	5,509	72.0
Eggs	25c. " doz.	.79	.56	....	3,853	50.0

The above data shows that at the old prices spring wheat flour was cheaper than rolled oats, and that we got 55,000 calories of heat for the dollar instead of 33,780, showing that the purchasing power of the dollar, so far as flour is concerned, has shrunken to 61.3 cents, and that when the three-pound loaf of bread sold for 10 cents a greater return for the money was secured than is got from the raw flour at present prices. In the last column of this table we have shown the calculated reduction in the purchasing power of one dollar for the various foods. Thus at present prices one dollar spent on rolled oats only goes as far as 71.4 cents would have some time ago, while the purchasing power of one dollar has fallen to 62.9 cents in the case of bread and to 40 cents with potatoes.

No attempt has been made to show the decrease in the value of the dollar when spent on what might be termed luxuries. It is worthy of note, however, that it is very easy to have the condiments and relishes cost as much as the real substantial part of a meal, and that to-day, even with the high price of living, it is possible to supply the real necessities of life for very little money. Thus Hutchison, in his book on Dietetics, says that the average man doing light work can get along very well on 120 grams of protein, 50 grams of fat and 500 grams of carbohydrates per day. This may be supplied by using 1¼ pounds of rolled oats, 1 pint of whole milk, 2 pints of skim milk and 2 ounces of sugar per day, at a cost of 12½ cents for the materials. All whole milk would raise the quantity of fat above that required. Corn meal or wheat farinas and whole milk may also be arranged so as to form a balanced diet. These are extreme diets, and probably we would soon tire of such daily food, but they are no more extreme than what many good people have been brought up on in the past, and they serve to illustrate the fact that the cost of living can be very much reduced if necessary.

Furthermore, the methods used to prepare many of our foods to meet present-day demands has added much to the cost of living. Thus, in the case of corn meal, in order that it may keep longer the germ is removed in grinding and with it the fat. Consequently, most of the corn meal we have on the market contains less than half a per cent. of fat, while the grain contains 5 per cent. If all this fat was retained in the meal, the food would be much more nourishing, but it would have to be used when it is fresh. Somewhat the same thing takes place in making flour from wheat. The demand has been for a white flour and naturally the millers have produced the article, with the result that much of the valuable part of the grain has gone for cattle food. Good, wholesome, nutritious bread can be made from the ground, unbolted wheat flour, or what is true Graham flour, and the cost of preparation be much reduced. A case is reported, where a farmer had some flour made in this way at a cost of seven cents per bushel and the family were delighted with the bread made from the flour. Allowing $1.80 for the bushel of wheat and 7 cents for grinding, this flour cost $3.10 per hundred pounds. Another case is reported of where a small coffee mill is used in the home to break down wheat for use as a breakfast food. The actual cost of this food was what was paid for the wheat, which at $1.80 per bushel is 3.0 cents per pound. The wheat farinas cost 5 cents per pound.

The step taken by the British Government in demanding that all flour sold for home consumption shall represent a certain percentage of the grain, appears to be in the right direction. The object is to force the production of a straight grade flour and retain more of the grain for human consumption. The demand has been for highly refined products. This has not only increased the cost of the food, but it has also, in some cases, reduced the nutritive value of the food. A swing back to the simply prepared foods would do much to reduce the cost of living.

The following notes on food economy were prepared by Miss M. U. Watson, Director of Home Economics, for another purpose, but they are so suitable to the present conditions that it has been thought well to include them in this publication.

1. Intelligent Buying of Foods.

Learn the real cost—not how little did it cost, but how much real nourishment was secured with the money spent.

Plan the meals ahead so that one may dovetail with another, and the leftovers be satisfactorily used in succeeding meals, and so that you may avoid constant small orders to the tradesmen. Remember that the customer pays for paper bags, string and delivery.

Avoid the expensive meats and other foods, the price of which is high in the early season and lowers later, e.g., spring lamb, broiling chickens, early strawberries, early vegetables, etc.

Buy sparingly the foods which are procured more for their taste than their nourishment, e.g., bouillon, many relishes and condiments, many imported or hot-house fruits and vegetables.

Buy Canadian grown and Canadian manufactured foods. There are too many imported jams and canned foods on our grocers' shelves. Leave them there and they will disappear.

People with a garden and the necessary time can greatly lessen the food cost by canning their own fruits and vegetables. Meats also may be canned to advantage when prices are low.

2. Fruit Economy.

Home-grown fruit is cheaper than any other. A small garden may be made to yield a great variety.

Fruit from the grocer or fruit-dealer always costs more because, in addition to the dealer's profits, the consumer must pay enough to cover the cost of the package, the cost of transportation, and the cost of what spoils on the dealer's hands.

It is always poor policy to buy poor fruit; not only is the flavor usually poorer, but usually the same money spent on good fruit will go farther.

As a rule it is well to see fruit before purchasing. Telephoned orders frequently result in mushy berries, bruised fruit, or green fruit.

As much as possible use fruit when fresh, and at its best and cheapest season, when it is most wholesome; the family enjoys it better, and it takes the place of cooked dishes, which take more time and labor to prepare.

Store fruit supplies with care. Turn berries and small fruits out on platters or trays in a shallow layer to prevent their further crushing and to prevent moulding, and keep in a cold place. Pick over the basket of apples, plums, peaches, etc.; remove any showing the least decay, spread the rest on trays and keep in a cold place. Oranges, grape-fruit and cranberries will keep in ordinary rooms, but are better spread out on shelves.

Watch fresh fruit stores closely, and if it cannot be used while fresh, stew or preserve it before it spoils.

At the beginning of the preserving season, it is a good plan to get out the jars, match up jars and tops, and make sure they are thoroughly clean and ready for sterilizing, and do them all in one big job instead of waiting until fruit is on one's hands.

If the garden yields little fruit at a time, the preserving is lightened if sugar syrup is made by the crockful and stored away. It is then an easy matter to fill a jar or two with the fresh fruit, fill up with the syrup, and place it in the oven on a block of wood, to cook while other work is going on.

Fruit supplies valuable mineral matter, which helps to keep the blood in good condition, therefore it is unwise to do without it. A fruit bill yields more satisfaction than a doctor's.

3. Vegetable Economy.

Home-grown vegetables are the cheapest, and a very small garden yields great variety.

All fresh vegetables are valuable for their mineral matter, and some yield a good deal of carbohydrates, while the legumes yield cheap protein. Reference to the Food Value tables will show that there is great opportunity to lessen the vegetable bill by using more of the root vegetables, especially in winter, and less canned stuff or expensive green stuff.

Canadians need to pay more attention to the cooking of vegetables. Too frequently they are spoiled by under-cooking or over-cooking, or careless seasoning. Their value as meat substitutes or meat seasonings is not half appreciated.. Too frequently their valuable mineral matter, our chief excuse for buying them, is poured down the drain with the cooking water.

Canadians need to study the possibilities of the legume vegetables. Even at present prices they furnish cheap protein. Split pea soup and baked beans are not the only dishes to be made from them. With potatoes at the present price, legume dishes are cheap substitutes for both meat and potatoes.

4. Milk Economy.

Secure the best milk at any price for the babies. Their lives depend upon it.

Whole milk, skimmed milk, buttermilk for the children, instead of so much meat, is both more wholesome and cheaper. Give them all they will take.

Buy skimmed milk for milk soups and desserts, because it is a substitute for meat protein and costs about a quarter the money.

5. Meat Economy.

Use less; once a day is ample if supplemented with legume dishes, milk soups, cheese dishes, attractive bread and cereal dishes, and eggs when they are cheap enough.

Serve carefully at the table; it is better to serve twice than to send remnants to the garbage pail.

Use cheaper cuts. We pay largely for flavor, tenderness and excessive fat in the expensive cuts.

We buy meats chiefly for their protein food value. The cheaper round, shank and neck cuts give more for the money.

The cheaper cuts chopped fine make a Hamburg steak as quickly broiled as a porterhouse.

Prolonged cooking at the lower temperatures will make the toughest cuts tender and improve their flavor. This can be accomplished economically in the double-boiler when the coal or wood fire is being used for other things; in the casserole or close-covered stone crock in the coal-stove oven when it is left for the night; or in the fireless cooker when gas or electric stoves are used.

Stews.—To many Canadians the word brings a memory of savorless chunks of meat swimming in a watery gravy. In intelligent hands it becomes a dish of infinite variety through the combination of different meats with different vegetables and seasonings, into juicy pieces of meat bedded in most savory sauce.

Make a little meat go a long way. Spread the flavor over other nutritious but more neutral-flavored food, e.g., meat pies, Irish stew, potpies with dumplings, stews with plenty of savory gravy, served in a border of rice, mashed potatoes, boiled beans, macaroni or vegetables.

Use every part of a meat purchase. Try out the fat not used for the table, and use for shortening and other purposes; trimmings and bones for soups, and left-overs for "made" dishes. Avoid using too strong heat for roasting and broiling, which ruins bones and trimmings for the soup pot, besides wasting heat.

Eliminate meat from the diet of the small children. The normal child will thrive better on milk, cereals and eggs in place of meat. A child's appetite is what the parents make it. Do not feel sorry for the child whose breakfast is oatmeal and milk, and supper is bread and milk with a bit of biscuit and jam; the child is well fed.

Eggs may replace meat in the adult diet whenever the price per dozen goes below the cost of 1½ pounds round steak.

6. Fat Economy.

The cost of meat fat is high. At the present time we pay 28 cents for bacon, 30 cents for ham, 26 cents for porterhouse steak, 24 cents for pork chops, and 35 cents for early lamb. It must always be remembered the fat is paid for at the same price as the lean.

Much of the fat paid for tries out of the meat in the cooking and is not sent with the meat to the table. Much of the fat of the meat sent to the table is not eaten. What becomes of it? Much of it never reaches the table again. Too frequently it is fed to a useless dog, dumped into the soapgrease, scraped into the garbage pail, or even thrown into the fire and burned.

The thrifty housewife saves every ounce of sweet fat for future cooking, and seldom has to buy special lard or oil for cooking. When any fat cannot be used for cooking it is converted into soap.

One housekeeper reports her experience of saving and keeping the different kinds separate for different purposes as follows:

Beef drippings for potatoes.

Pork drippings for sweet potatoes, gingerbread and ginger cookies; mixed with beef dripping for meat pastry.

Ham, bacon and sausage fats for soups, vegetables and things too numerous to mention.

Lamb fat for warming over beans.

Veal fat for omelets.

Chicken, duck and goose fat for cookies, gingerbread and spiced cakes.

Chicken fat with a little bacon proved especially delectable for cooking oysters in.

There is no doubt that a careful saving and use of meat fats lessens the butter bill to a considerable extent.

7. In General.

Excessive tea and coffee is costly in nerves as well as money.

Use all the cereal foods possible. Their protein is quite as valuable as animal food protein and much cheaper.

Cheese is especially valuable as a flavoring for combination with breads and more neutral flavored foods.

Use leftovers attractively.

Too often leftovers are served unattractively. There are many simple ways of converting them into dishes the family welcomes.

Use more time and lower heat in cookery to develop flavors and secure all the goodness in the foods. This means forethought in marketing and planning for the work.

METHODS OF MAKING BREAD IN THE HOME.

At the present time an unusual interest is being taken in making bread in the home. How much more economical this home made bread may be depends upon many conditions which we will not attempt to discuss here. But without allowing anything for labor and presuming that the fuel used in baking the bread would be burned anyway for cooking, heating, etc., there is sufficient margin to warrant the economical housekeeper to seriously consider the matter. For the convenience of those who wish to try making bread the following long and short methods are given:

Long Fermentation Method.

1 dry yeast cake	2 tablespoons sugar
2 quarts liquid	2 tablespoons lard
2 tablespoons salt	flour

Note.—All measurements are level.

Preparation of Ferment.—Put a pint of water at a temperature of about 90 degrees F. into a bowl, drop the dry yeast cake into it and soak for half an hour, then stir in enough flour to make a thin batter, add one tablespoon sugar, and beat with a dover beater until well mixed and full of bubbles. Stand in a warm place (about 70 to 80 degrees F.) until light, which will take from four to five hours.

Preparation of Sponge.—When the ferment is ready put the rest of the sugar, salt and lard into a bread-pan, bring the rest of the liquid to 90 degrees F. and add it to the ingredients in the pan. Add enough strong flour to make a batter that will beat without spattering; add the ferment and beat until it looks smooth and elastic. This will probably take 15 or 20 minutes. Cover closely and keep at a temperature of 70 degrees F. until light and spongy. This will take from 9 to 10 hours.

Preparation of Dough.—When the sponge is ready stir in strong flour until too stiff to use the spoon, then mix in more with a stiff-bladed knife or the hand until the dough no longer sticks to the fingers. Turn the dough out on the moulding-board to knead, leaving the pan quite clean. The dough should knead without flour being put on the board or hands; if it proves sticky return it to the pan and mix in more flour. Remember that while too slack a dough makes coarse textured bread, too stiff a dough makes slow-rising bread which will dry out quickly. Knead lightly until the mass is elastic and velvety, the surface covered with a film of tiny bubbles, and a cut with a sharp knife shows the inside full of fine even bubbles and free from lumps or unmixed portions. Grease the bread-pan lightly with sweet dripping, warm both pan and cover if they are cold, put in the dough, cover closely, and keep in a warm place (about 80 degrees F.) until rather more than doubled in volume, or until a gentle slap with the tips of the fingers causes it to fall in. This will take from two to three hours.

Knead lightly in the pan for a minute to get rid of the larger bubbles and return to rise a second time until double in volume. This will take from one to two hours.

Divide into loaves that will half fill the bread tins. Knead each piece only enough to get rid of large bubbles and smooth the surface and put it into a greased tin. Keep in a warm place (about 70 or 80 degrees F.) until doubled in volume, when they should have a bold, nicely-rounded appearance.

Bake an hour in a moderate oven. When done, the loaves should give a hollow sound when tapped on the bottom.

When baked remove at once from the pan and stand on edge or across the top of the pans that the air may get to all parts and cool it quickly.

Short Fermentation Method.

2 cups scalded milk	2 cups water
2 tablespoons sugar	2 tablespoons shortening (butter or lard)
4 teaspoons salt	1 compressed yeast cake

Dissolve yeast and sugar in half a cup of luke warm water. To the rest of the luke warm liquid (90 degrees F.) add sufficient warm flour to make a batter that can be beaten without spattering, add yeast mixture and beat until smooth and silky. Cover and put in a warm place free from drafts for from one and one-half to two hours. When light, add lard, salt and enough flour to make a dough that will not stick to the hands or board. Knead until smooth and elastic. Place in warmed and greased dish to rise again until double in bulk, about two hours, shape to half fill well greased bread pans. Cover, let rise till double in bulk and bake in moderate oven for about one hour.

The above calls for strong spring wheat flour. Soft fall wheat flour may be used for the dough stage, but must be kneaded down before it has quite doubled in volume each time. It is not advisable to use soft flour for the ferment and sponge stages as it does not stand the long fermentation.

Home-made yeast may be used instead of the dry yeast. Use one cup home-made yeast and only 3½ pints of liquid.

The liquid may be part milk (scalded) and part water. The latter may be potato water, i.e., water in which two or three potatoes have been boiled, removed and finely mashed and returned to the liquid.

The potato water may form the liquid for the ferment stage, and the mashed potatoes added when the sponge is made. Potatoes give that silkiness of texture so much desired by good breadmakers.

If the dough is kept covered while rising it will not form a crust. If it seems inclined to form a crust moisten with warm milk and water. A crust is to be avoided as it makes a streak through the loaf if kneaded in at the early stages and an unsightly crust on the baked loaf if allowed to form in the last stages.

The second rising of the dough may be omitted, although the extra rising makes the loaf a rather finer texture.

The bread-mixer may be used to knead the dough after it is known exactly how much flour the liquid will need to make dough of the right stiffness.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 246

Suggestions on Feeding Stock

BY

G. E. DAY, B.S.A.,

Professor of Animal Husbandry

Also "The Live Stock Situation from the Marketing Standpoint," by H. S. Arkell, Asst. Live Stock Commissioner for Canada

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Suggestions on Feeding Stock

G. E. DAY, B.S.A.

IMPORTANCE OF LIVE STOCK.

When we attempt to say anything upon the subject of stock feeding we are at once confronted by the fact that feed is scarce and very high in price at the present time. It is mainly on account of the scarcity of feed that this pamphlet has been prepared, but, before the subject of feeding is dealt with, let us consider briefly the importance of conserving the live stock upon Canadian farms, under prevailing conditions.

Owing to the scarcity of feed, no doubt there are many men in this Province who are compelled to sell at least part of their stock, and to these men we have nothing to say, but there are other men who are selling their stock merely because the price of feed is high and they wish to sell their crop. Let us consider what the effects of such a course are likely to be.

(1) Stock is being sold under conditions which do not favor securing full value for young or thin stock.

(2) Hay, which is the most abundant crop this year on Ontario farms, is being sold at prices which are low in comparison with the prices of concentrates, and which are lower than could have been obtained if the hay had been fed to good stock.

(3) Much material which can be given value only by feeding it to stock is being allowed to go to waste on those farms from which the live stock has been sold.

(4) The farms are being robbed of their fertility, and are having their productiveness injured for years to come.

(5) When an abundant crop is once more secured, the men who have sold their stock will be forced to re-stock their farms at higher prices than they received for the stock they sold, because the most reliable figures we can obtain go to show that the numbers of farm animals in Canada have been growing less from year to year for some time past. If this reduction goes much further it looks as though something approaching famine prices for live stock are almost sure to prevail in the near future.

The men who sell their stocks are facing all these disadvantages, and running the risk of serious losses, in order that they may sell a few bushels of grain at a high price, but they overlook the fact that with good stock and reasonable management they could have obtained, in most cases, more money from their season's crop if they had retained their stock.

Live stock will continue to be, as it has always been in the past, the most important factor in successful farming, and it looks as though its importance is likely to be greatly increased as a result of the war. He who can conserve his live stock will surely reap a reward and, in addition, will perform a patriotic service to his country and the Empire.

COMPOSITION OF FOODSTUFFS.

The subject of stock feeding is a very broad one, and in this brief treatment of the subject all that can be attempted is to offer a few suggestions, in the hope that they may prove helpful to the farmer when he has to make a selection from the foodstuffs offered on the market.

Very frequently requests are received at the College for tables showing the composition of foodstuffs, and hence there has been incorporated in this bulletin a table giving the composition of the principal foodstuffs, which are likely to be met with in the markets of this Province. The table, we hope, will meet the demand mentioned above, and will also prove useful for reference in the discussion of the relative merits of various fodders.

It will be noted that the constituents of the foodstuffs are given under six different headings, and for the benefit of those to whom the subject may not be familiar, a few explanations of the headings are offered.

Water.—This term requires no explanation. All foods, no matter how dry they may appear, contain a certain proportion of water. Some foods, like roots, for example, contain a very high percentage of water, and such foods are spoken of as "succulent" foods. Generally speaking, the exact proportion of water in a food is not important, from the standpoint of animal nutrition, because animals can be supplied water directly, to make up any deficiency. While this is true, we must not overlook the fact that all animals are benefited by receiving a certain amount of succulent food every day. Practical feeders understand the importance of foods of this nature, in keeping the animal's digestive organs in good condition.

Ash.—A reference to the table will show that the percentage of ash in most of the foods is relatively small, but the ash plays a very important part, especially in the nutrition of young, growing animals, because it represents the mineral portion of the fodder, which goes to build up the bony structure of the animal. When the ash in any food falls below two per cent. it may be said to be low, especially for young, growing animals.

Crude Protein.—The heading, crude protein, takes in a group of substances which we need not enumerate, but which are all similar in composition. They all contain the element nitrogen, and hence crude protein is said to be the nitrogenous part of a food. Protein is usually spoken of as a flesh former, because it plays a very important part in building up the muscles, or lean meat, as well as the ligaments, skin, hair, wool, etc., of animals. It is also essential for milk production. There are two classes of animals which especially require food fairly rich in protein, and these are young growing animals and those which are producing milk. This is a very important fact which should never be lost sight of by the feeder in making up rations for various animals.

Carbohydrates.—It will be noted, in the table, that carbohydrates are divided into two groups, namely, fibre, and nitrogen-free extract.

Fibre represents the woody portion of the fodder. It is difficult to digest, especially for hogs. Horses, cattle and sheep can digest fibre to better advantage than hogs, though, in any case, the actual food value of fibre is small, and its presence in large quantities in any fodder is always a serious objection. All fodders of vegetable origin contain fibre, but a glance down the column under this heading will show a very great variation in the amount of fibre contained in different foods.

Nitrogen-free Extract is more easily dissolved and hence is much more digestible, and of much higher value than fibre. Under this heading come such substances as starch, sugar, etc.

Carbohydrates, as a whole, are used to keep up the heat and energy of the animal body and to form fat.

Fat.—Under this heading are included many substances more or less oily in nature. A glance down the column under this heading will show that some foods contain only a trace of fat or oil, while others, such as flaxseed, contain a very high percentage. The fat in the food is used to keep up the heat and energy of the animal, and to aid in the production of fat in the animal body. It will be seen, therefore, that the fat of the food performs functions similar to those performed by carbohydrates, but fat is more effective than carbohydrates, and seems to have certain independent influences which are difficult to define. In many cases a fairly high percentage of fat seems to make foods more acceptable to animals, and also to have a marked effect upon the condition and general thrift of the animals. There are exceptions to this rule, however, such as, for example, cottonseed meal, which is higher in fat than linseed meal but which does not give as good results so far as the condition of the animal is concerned.

The table which follows has been adapted from tables which appear in that most excellent book "Feeds and Feeding," by Henry and Morrison:

COMPOSITION OF FOODSTUFFS

FOODSTUFF	Water %	Ash %	Crude Protein %	Carbohydrates Fibre %	Carbohydrates Nitrogen, free extract %	Fat %
1. CEREAL GRAINS.						
Barley and its Products.						
Barley	9.3	2.7	11.5	4.6	69.8	2.1
Brewers' grains, dried	7.5	3.5	26.5	14.6	41.0	6.9
Brewers' grains, wet	75.9	1.0	5.7	3.6	12.1	1.7
Malt sprouts or combings	7.6	6.1	26.4	12.6	45.6	1.5
Buckwheat and its Products.						
Buckwheat	12.1	2.1	10.8	10.3	62.2	2.5
Buckwheat middlings	12.0	4.8	28.3	4.8	42.7	7.4
Buckwheat bran, high grade	11.2	4.2	22.3	7.1	49.4	5.8
Buckwheat bran, low grade	10.1	3.1	10.7	33.5	39.9	2.7
Buckwheat hulls	10.3	2.1	4.4	43.7	38.5	1.0
Corn and its Products.						
Corn, dent	10.5	1.5	10.1	2.0	70.9	5.0
Corn, flint	12.2	1.5	10.4	1.5	69.4	5.0
Corn bran	10.0	2.4	9.7	9.8	62.4	5.7
Germ oil meal	8.9	2.7	22.6	9.0	46.0	10.8
Gluten feed, high grade	8.7	2.1	25.4	7.1	52.9	3.8
Gluten feed, low grade	8.8	1.1	17.8	6.9	59.7	5.7
Gluten meal, high grade	9.1	1.1	35.5	2.1	47.5	4.7
Gluten meal, low grade	8.2	1.5	27.3	9.2	43.4	10.4
Emmer.	8.7	3.7	11.9	10.1	63.7	1.9
Oats and their Products.						
Oats	9.2	3.5	12.4	10.9	59.6	4.4
Oat bran	6.4	6.1	12.2	18.3	52.3	4.7
Oat dust	6.6	7.0	12.6	18.7	49.9	5.2
Oat middlings	7.3	3.2	16.3	4.6	61.8	6.8
Oat hulls	6.8	6.0	4.0	29.2	52.3	1.7
Rye and its Products.						
Rye	9.4	2.0	11.8	1.8	73.2	1.8
Rye bran	11.4	3.5	15.3	4.0	62.7	3.1
Rye middlings	11.4	3.7	15.7	4.6	61.2	3.4
Wheat and its Products.						
Wheat, all analyses	10.2	1.9	12.4	2.2	71.2	2.1
Flour wheat middlings	10.7	3.7	17.8	4.7	58.1	5.0
Standard wheat middlings	10.5	4.4	17.4	6.0	56.8	4.9
Wheat bran, all analyses	10.1	6.3	16.0	9.5	53.7	4.4
Red dog flour	11.1	2.5	16.8	2.2	63.3	4.1
2. LEGUMINOUS SEEDS AND THEIR PRODUCTS.						
Cull beans	12.8	3.3	22.1	3.7	56.7	1.4
Field pea	9.2	3.4	22.9	5.6	57.8	1.1
Pea bran	9.9	5.9	12.2	35.3	35.6	1.1
Pea hulls	7.2	3.6	6.9	43.6	37.5	1.2
Peanut cake, without hulls	10.7	4.9	47.6	5.1	23.7	8.0
Peanut cake, hulls included	5.6	4.5	28.4	23.4	27.0	11.1

COMPOSITION OF FOODSTUFFS—*Continued*

FOODSTUFF	Water %	Ash %	Crude Protein %	Carbohydrates: Fibre %	Carbohydrates: Nitrogen, free extract %	Fat %
3. OIL-BEARING SEEDS AND THEIR PRODUCTS.						
Cocoanut meal	9.6	4.9	20.9	11.2	45.3	8.1
Cotton seed meal (choice)	7.5	6.2	44.1	8.1	25.0	9.1
Cotton seed meal (prime)	7.8	6.6	39.8	10.1	27.4	8.3
Cotton seed meal (good)	7.9	6.4	37.6	11.5	28.4	8.2
Cold pressed cotton seed cake	7.9	4.2	26.1	24.0	30.1	7.7
Cottonseed feed	8.3	4.9	24.5	21.4	34.6	6.3
Cottonseed hulls	9.7	2.7	4.6	43.8	37.3	1.9
Flax seed	9.2	4.3	22.6	7.1	23.2	33.7
Linseed meal (ground oil cake)	9.1	5.4	33.9	8.4	35.7	7.5
Soybean meal, fat extracted	11.8	5.4	41.4	5.3	28.7	7.4
Sunflower seed cake	10.0	4.2	34.8	10.9	21.8	18.3
4. MILK AND ITS PRODUCTS.						
Cow's milk	86.4	0.7	3.5	......	5.0	4.4
Buttermilk	90.6	0.7	3.6	......	5.0	0.1
Skim milk, separator	90.1	0.7	3.8	......	5.2	0.2
Skim milk, gravity	90.4	0.7	3.3	......	4.7	0.9
Whey	93.4	0.7	0.8	......	4.8	0.3
5. SLAUGHTER-HOUSE BY-PRODUCTS.						
Dried blood	9.7	3.3	82.3	......	3.8	0.9
Tankage, over 60% protein	7.4	10.5	63.1	3.6	2.5	12.9
Tankage, 55% to 60% protein	7.5	13.6	58.1	4.9	2.9	13.0
Tankage, 45% to 55% protein	7.5	19.7	51.7	3.0	4.2	14.0
Tankage, below 45% protein	6.5	22.6	40.4	3.7	9.9	17.0
6. MISCELLANEOUS CONCENTRATES.						
Beet pulp, wet	90.7	0.4	0.9	2.1	5.7	0.2
Beet pulp, dried	8.2	3.5	8.9	18.9	59.6	0.9
Distillers' grains, dried (corn)	6.6	2.6	30.7	11.6	36.3	12.2
Distillers' grains, dried (from rye)	7.2	3.9	23.1	10.9	47.1	7.8
Molasses, beet	25.3	5.2	3.5	......	66.0	......
Molasses, cane, or blackstrap	25.8	6.4	3.1	......	64.7	......
7. DRIED FORAGE.						
Alfalfa hay, all analyses	8.6	8.6	14.9	28.3	37.3	2.3
Clover hay (red), all analyses	12.9	7.1	12.8	25.5	38.7	3.1
Clover hay (alsike), all analyses	12.3	8.3	12.8	25.7	38.4	2.5
Clover hay (white sweet)	8.6	7.2	14.5	27.4	40.1	2.2
Corn fodder (medium in water)	18.3	5.0	6.7	22.0	45.8	2.2
Corn stover (medium in water)	19.0	5.5	5.7	27.7	40.9	1.2
Millet hay (Hungarian)	14.3	6.3	8.3	24.0	44.3	2.8
Oat hay	12.0	6.8	8.4	28.3	41.7	2.8
Prairie hay, western	6.5	7.7	8.0	30.5	44.7	2.6
Timothy hay, all analyses	11.6	4.9	6.2	29.9	45.0	2.5
8. STRAW AND CHAFF.						
Barley straw	14.2	5.7	3.5	36.0	39.1	1.5
Buckwheat straw	9.9	5.5	5.2	43.0	35.1	1.3
Oat straw	11.5	5.4	3.6	36.3	40.8	2.4
Oat chaff	8.2	11.5	5.9	25.7	46.3	2.4
Rye straw	7.1	3.2	3.0	38.9	46.6	1.2
Wheat straw	8.4	5.2	3.1	37.4	44.4	1.5
Wheat chaff	14.4	7.2	4.2	28.0	44.8	1.4

COMPOSITION OF FOODSTUFFS—*Continued*

Foodstuff	Water %	Ash %	Crude Protein %	Carbohydrates		Fat %
				Fibre %	Nitrogen, free extract %	
9. ROOTS AND TUBERS.						
Carrot	88.3	1.2	1.2	1.1	8.0	0.2
Mangel	90.6	1.0	1.4	0.8	6.1	0.1
Potato	78.8	1.1	2.2	0.4	17.4	0.1
Sugar beet	83.6	1.1	1.6	1.0	12.6	0.1
Swede turnip	89.1	1.0	1.2	1.4	7.0	0.3
White turnip	90.5	0.9	1.4	1.1	5.9	0.2
10. MISCELLANEOUS GREEN FORAGES.						
Apple	81.8	0.4	0.5	1.3	15.6	0.4
Apple pomace	76.7	1.0	1.6	4.6	14.5	1.6
Cabbage	91.1	0.8	2.2	0.9	4.7	0.3
Pumpkin, field	91.7	0.9	1.4	1.3	4.2	0.5
11. SILAGE.						
Corn silage, well matured	73.7	1.7	2.1	6.3	15.4	0.8
Corn silage, immature	79.0	1.4	1.9	5.8	11.3	0.6

It will be a disappointment, no doubt, to a number of people, to learn that there is apparently no method by means of which we can form an exact estimate of the relative feeding values of different fodders. It is true there is a method which is moderately accurate, but is somewhat limited in its application, and is probably too complicated for our purpose at the present time. All that will be attempted in the present discussion is the presentation of the subject of stock feeding in such a manner as to give some helpful hints to those who are really interested in the subject.

Before taking up any discussion on foodstuffs let us not forget what was said near the beginning of this article, namely, that the presence of a large proportion of crude fibre in a fodder is always a serious objection, because it tends to decrease, in a very marked degree, the food value of the fodder in question.

Another point which we must bear in mind is the fact that most of the home-grown feeds, which are produced most cheaply and in greatest abundance, are inclined to be poor in crude protein. Protein is rather more expensive to produce than carbohydrates, and it is also more expensive to purchase. Owing to the fact, however, that there is a general deficiency of protein in the bulk of our home-grown feeds, it becomes important for us to pay particular attention to the protein content of foods we wish to purchase. Any foodstuff which is high in protein and low in fibre is likely to be much more useful to us than one which is only moderate in protein and possibly high in fibre, and we must bear in mind that the foodstuff which can be bought at the lowest price per ton is not necessarily the cheapest for us to buy. Something which costs more per ton, but which gives us much more of what we really need, and less of what we do not need, may be very much better value than some low priced feed.

CEREAL GRAINS.

A glance at the table will show that the cereal grains and their by-products have been grouped together. It will also show us that the cereal grains, as a whole, are characterized by only a moderate percentage of crude protein. For example, barley has 11.5 per cent., buckwheat 10.8 per cent., corn 10.1 per cent., emmer 11.9 per cent., oats 12.4 per cent., rye 11.8 per cent. and wheat 12.4 per cent. of crude protein. If we compare these percentages with the percentage of protein in many of the by-products of these same grains, we can easily see that the grains themselves are rather low in crude protein. As to fibre: wheat, rye and corn are very low in fibre. Barley has only a moderate amount of fibre, but buckwheat, emmer and oats run somewhat higher, owing to the heavy fibrous coating which encloses the grain.

Barley and Its Products.—Barley, as a rule, has not been regarded with any very great favor by feeders, but of late, since prices for all kinds of feed have gone very high, barley is being much more largely used, and the price has gone up accordingly. For hogs, beef cattle, and even dairy cows, barley is worth more per ton than buckwheat, emmer, or oats, and approaches in value very closely to corn, wheat or rye as a food for stock, especially for hogs. When fed alone it is not particularly palatable, and best results are obtained by feeding it in combination with other feeds. For hogs, the addition of wheat middlings to the barley adds very much to its palatability and its value. For cattle, bran combines well with barley.

Dried brewers' grains constitute a very important by-product from barley, and it will be noticed that the brewers' grains contain a high percentage of protein. It is true that they are also high in fibre, but the large percentage of protein which they contain more than compensates for this defect and makes brewers' grains worth more per ton than wheat bran.

Malt sprouts or malt combings are also high in protein and constitute a valuable food when properly used. They are extremely dry, as a rule, and are not very palatable. In using malt sprouts only a small quantity should be fed, and it is better to soak the sprouts in water before feeding. Brewers' grains and malt sprouts are probably best suited for dairy cattle though they may be fed to almost any class of stock, including horses, providing judgment is exercised in mixing other kinds of feed with these products. They are probably least suitable for hogs.

Oats and Their Products.—For a cereal grain oats stand up fairly well in regard to protein, but the great objection is they are high in fibre. For a cereal they contain a high per cent. of fat, and almost all classes of stock relish oats. Oats also contain a fairly high per cent. of ash, and consequently they make a most excellent grain to feed young growing animals. They are bulky in character and hence it is seldom that any injury is caused to animals through feeding oats. They are not particularly valuable for fattening except to include in mixtures to give bulk and palatability to other concentrates. Oats are regarded as the main concentrate for horses, though, with the use of judgment, other grains may be substituted for oats, even for horses. In the United States corn takes the place of oats almost entirely in many districts and seems to give very good satisfaction. No doubt a mixture of corn and oats would be better than corn alone. In other parts we find barley successfully taking the place of oats for horse feeding, and in some cases dried brewers' grains have been successfully substituted for a considerable portion of the oats in the rations of working horses. As a matter of fact, oats are not absolutely essential in successful horse feeding, if the feeder will bear in mind the fact that he should take weight instead of bulk into consideration when making up rations for his horses. Oats do not weigh so much per bushel or per gallon as corn or barley, and this fact must be remembered when heavier grains are substituted for lighter ones, and the bulk of the ration must be reduced accordingly. While this is true, oats will always continue to be popular with the farmer for reasons already stated, but when the price of oats reaches two cents per pound it is doubtful whether we can get as good value from this grain as we could from some others, and it is time to cast about to see whether there is not something else which could take the place of at least part of the oats in the rations fed. Corn at two cents per pound furnishes much more feed than oats at two cents, and it has already been noted that barley, at the same price per pound, is cheaper than oats. Rye also furnishes more nutrients per hundred pounds and a great deal less fibre, and, frequently, damaged wheat can be obtained at very little more per ton than oats, in which case it makes a much cheaper ration.

Of the by-products from oats notice first oat hulls, which are very low in protein and very high in fibre. As a matter of fact, oat hulls are not as good feed as good oat chaff. On the other hand, oat middlings are fairly high in protein and low in fibre, and if they can be procured of a composition similar to that given in our table, oat middlings would be worth a high price per ton; but the trouble is that those who sell oat middlings are inclined to mix a good many of the comparatively worthless hulls with the middlings, reducing its value very materially. The other by-products, oat bran and oat dust, contain a moderate amount of protein and a high percentage of fibre, indicating the presence of considerable quantities of oat hulls. Oat by-products should not be purchased except from reliable dealers and under guarantee as to percentage of protein and fibre. If care is not exercised it is possible to buy too much worthless material in these products.

Wheat and Its Products.—Wheat, of course, is altogether too high in price to be considered as a feed for stock at present. Its actual feeding value is similar to that of corn, and usually a little higher than that of barley. Sometimes frozen wheat can be obtained which is just as valuable for feeding purposes as first class wheat, providing, of course, that the frost has not caught the wheat at too early a stage in its growth and that the grains have reached a fair degree of maturity.

Wheat bran, though widely known, is frequently underestimated as a feed for stock. It will be noticed that bran contains more protein than wheat or even any of the cereal grains. The main objection is its rather high percentage of fibre, which reduces its value materially. It is seldom that bran makes a satisfactory ration alone, giving best results when used in combination with other concentrates. When oats are two cents a pound and bran is not more than two cents a pound, it will usually be found profitable to use bran in place of part of the oats in the ration of a horse, and when bran is less per ton than oats it may well replace oats altogether in the ration of other farm animals. Bran shows to good advantage in the ration of the dairy cow, but it may be used in the ration of fattening animals, especially along with corn or barley, and it will usually be found that the combination will give better results than when bran is not used. Bran is not satisfactory for hogs unless it may be matured breeding stock, and even for this purpose middlings (shorts) are preferable.

It will be noticed that wheat middlings are higher in protein and lower in fibre than bran. As a rule middlings command from $2 to $3 per ton more than bran, a difference which is quite justifiable on the basis of their composition. A great deal depends, however, upon the use to which the feed is to be put. As already intimated, bran is not very satisfactory for pigs, and the younger the pigs the less satisfactory it is. On the other hand, wheat middlings make one of the most satisfactory rations we can obtain for young pigs, and for such a purpose as this there would be a very wide difference indeed between the value of bran and middlings. On the other hand, if we were feeding cows, we would probably be willing to pay very little more for middlings than we would for bran, because the bran will give nearly as good results as could be obtained from middlings and the difference in value would probably not amount to more than $1 or $2 per ton. Wheat middlings, like bran, may be used in mixtures for almost any class of stock.

Red dog flour, which is a low grade flour, has quite a high feeding value as is indicated by its fairly high percentage of protein and low percentage of fibre. Red dog flour should be worth as much per ton as any of the cereal grains themselves. Care must be exercised, however, in feeding this flour. It should always be mixed quite largely with some more bulky feed, because its heavy floury nature will cause it to form into a pasty mass in the animal's stomach interfering with digestion if it is fed alone.

Buckwheat and Its Products.—The table shows buckwheat to have a lower percentage of protein than oats and nearly as much fibre. In nitrogen-free extract, however, buckwheat excels oats, so that for fattening purposes possibly buckwheat may be worth quite as much if not slightly more than oats. For milk production, however, buckwheat would not be so satisfactory as oats. Buckwheat may be fed in mixtures to hogs, but of course it is not worth as much per ton as barley.

The by-products of buckwheat are not well known in this country. Note that buckwheat hulls have very little value for feed, whereas buckwheat middlings, if at all true to name, have a very high value, and would be especially valuable for the purpose of increasing the amount of protein in the ration of dairy cows. High grade buckwheat bran also has a high value and, if true to name, is worth considerably more than wheat bran, but, as in the case of the by-products from oats these by-products should only be obtained from reliable firms and under guarantee as to composition, because they are liable to be loaded up with a great deal of nearly worthless hulls.

Rye and Its Products.—Rye has a feeding value similar to that of wheat and possibly slightly higher than barley. It is not high in protein, but is very low in fibre and is high in nitrogen-free extract. At the same price per ton it would be better value, probably. than any of the other cereals, except possibly wheat and corn, and it should be worth quite as much as corn.

The by-products of rye are practically unknown in this country as yet. It will be noted that they are somewhat similar to wheat bran though they are lower in fibre and higher in nitrogen-free extract.

Emmer.—Emmer is not very well known in this country though some recommend it quite highly as a crop. Compared with barley, it does not measure up very well, being very little higher in protein, lower in nitrogen-free extract, and decidedly higher in fibre. For feeding purposes barley is worth more per ton than emmer.

Corn and Its Products.—It will be noticed that there is very little difference in composition between dent and flint corn, and practical tests indicate that there is little or no difference in their feeding value. Corn is low in protein and in ash. These two facts render it unsuitable to use as a sole ration for young growing animals. Pigs fed exclusively upon corn do not make satisfactory growth and sometimes become deformed owing to deficient development of bone and muscle. On the other hand corn is low in fibre, high in nitrogen-free extracts, and, for a cereal, it is high in fat. In addition to this it is relished by almost all kinds of animals. As a ration for fattening stock, fed in suitable combinations, it cannot be beaten, but it is always advisable to combine with corn some kind of food rich in protein, and, in the case of young, growing animals, rich in ash also. For dairy cows it is not particularly suitable, though it may be fed in moderate quantities, provided foods rich in protein are fed with it. For hogs it can be improved very much by adding about ten per cent. of a food such as tankage or linseed meal. Even the addition of wheat middlings will be found to make a marked improvement in its value. Its value for horses has already been mentioned and it can be quite successfully substituted for oats, or at any rate for the greater part of the oat ration for horses. Sheep are also fond of it and it makes a good fattening ration for this class of stock, especially when fed with clover or alfalfa hay, which help to correct its deficiencies in protein and ash. It has been stated by some authorities that corn is the best and the worst feed for animals. That is to say, when corn is properly combined with other feeds it makes one of the very best feeds for animals, but when it is not understood it makes one of the worst.

The best known by-product of corn in this country is gluten feed, which is a by-product from the manufacture of starch from corn. It contains all that is left of the corn after the starch is removed, except the germ. It will be noted in the table that there are two grades of gluten feed. High grade gluten feed is a very valuable product, containing a high percentage of protein and only a moderate amount of fibre. The low grade gluten feed is not worth so much by a good deal, and buyers should be on the watch in this connection and should see to it that a satisfactory guarantee as to composition accompanies the feed. Gluten feed is especially valuable for dairy cows for the purpose of increasing the protein content in their ration, and for this purpose it ranks with such feed as linseed meal, though not quite equal to linseed meal in value. It is not counted a satisfactory feed for pigs or sheep and may be regarded as especially suitable for dairy cattle.

Gluten meal is also of two grades, the highest grade being particularly valuable for dairy cattle. As a matter of fact gluten meal is seldom sold in this country although sometimes the term is applied to gluten feed. Gluten meal proper consists exclusively of the gluten of corn which is the residue in the manufacture of starch.

Germ oil meal is the residue from corn germs after the oil has been extracted. It will be noticed that it still contains a high percentage of fat, and a fairly high percentage of protein, and would be a very useful feed in dairy rations especially. Its value would be similar to that of gluten feed.

Corn bran, which consists mainly of the outer hull of the corn kernel, has not a high feeding value and is seldom sold alone.

LEGUMINOUS SEEDS AND THEIR PRODUCTS.

Beans.—Beans are out of the question at the present time as a feed for stock except it may be cull beans. The table shows beans to have a very high percentage of protein and a fairly low percentage of fibre, with only a moderate amount of nitrogen-free extract. Cull beans have a high feeding value, but the trouble is they are not very palatable to most animals. Sheep will eat them freely, but for pigs the beans must be cooked. Cattle will eat them under protest if mixed with other kinds of meal.

Field Pea.—The field pea is also out of the question as a feed for stock in this country at present. It will be noted that peas are similar in composition to beans and have about the same value as a feed, with the difference that most classes of stock are fond of peas whereas beans are generally disliked.

There are two by-products of peas from the mills which manufacture split peas for soup, namely, pea bran and pea hulls. It will be noted that both these by-products are low in protein and extremely high in fibre as compared with wheat bran. A strange fact is that pea bran is selling on some markets at the same price per ton as wheat bran, whereas wheat bran is worth considerably more, as the composition plainly indicates.

Peanut Cake.—It is quite possible that peanut cake will never become prominent on our markets, but, owing to the extremely high price for all kinds of feeds at present, it is hard to say just what may appear on Canadian markets, and hence this by-product has been included in the list. It will be noted that peanut cake, made from hulled nuts, is extremely rich in protein and fairly low in fibre. It is also high in fat. In other words, it is an extremely rich concentrated food, and ranks with the highest grade cottonseed meal in value. It will also be noted that peanut cake made from seeds from which the hulls had not been removed is very much lower in protein and very much higher in fibre. Cake of this nature ranks in value with the lower grades of cottonseed meal.

OIL BEARING SEEDS AND THEIR PRODUCTS.

Cocoanut Meal.—This product is very little known in Canada, but it is being introduced in some parts and hence is worthy of consideration. Compared with wheat bran it has considerably more protein, but it is also somewhat higher in fibre. In fat it is considerably higher than wheat bran. On the whole, therefore, cocoanut meal should be worth several dollars a ton more than wheat bran, especially as a feed for dairy cows.

Cottonseed Meal.—Regarding cottonseed meal it must be remembered that it is valuable for a specific purpose, and that is for increasing the protein content of a ration. Cottonseed meal is not suitable for all classes of stock and for any class of stock it should be used in moderation. Dairy cows or fattening cattle will take two pounds per day, per head, without any injury, and horses will take one pound a day without danger. It is true these quantities are frequently exceeded, but when a person is feeding three pounds or more of cottonseed meal to a cow per day he is venturing upon dangerous ground. For calves and pigs cottonseed meal had better not be used at all. It is true these animals may be fed very small amounts of cottonseed meal in their ration, but in this country we do not need to use it, and hence it is not worth while running risks.

The table shows that cottonseed meal is not, by any means, a constant term. That is to say, there are numerous grades of cottonseed meal on the market. It will be noticed that the percentage of fibre increases in the lower grades. In cold pressed cottonseed cake and in cottonseed feed the per cent of fibre is nearly as high as the percentage of protein. A good brand of cottonsed meal, containing forty per cent. or more of protein, is worth nearly twice as much per ton as cold pressed cottonseed cake or cottonseed feed. In fact, the two last mentioned grades of feed are not worth a great deal more per ton than wheat bran. It is true they contain much more proetin and fat, but their percentage of fibre is so high that it cuts down their value very materially. Those who are buying cottonseed meal should pay careful attention to the percentage of protein and of fibre, and not be misled into thinking that because the feed in question has a fairly high percentage of protein it is necessarily a valuable feed. It may have so much fibre that its feeding value is seriously reduced.

The composition of cottonseed hulls is given merely to indicate where the high percentage of fibre comes from in the lower grades of cottonseed meal.

Flaxseed.—Flaxseed, at present, is so sigh in price that it is not used to any extent for feeding purposes. In some cases where it is grown at home small amounts are used. It will be noted that flaxseed is extremely high in fat as well as fairly high in protein. The fat is extracted giving us linseed oil, and the residue is known as linseed meal or oil cake.

Linseed Meal.—This by-product of flaxseed contains a high percentage of protein and a fair amount of fat. It does not contain so much protein as high grade cottonseed meal, but it does not possess any of the dangerous properties of cottonseed meal, and when fed to stock it tends to bring about a general thrifty condition in the animal. Owing to this fact most feeders prefer linseed meal to cottonseed meal though it is lower in protein. As a source of protein for dairy cows cottonseed meal is more economical, and it is only on the ground that linseed meal can be fed to any class of animals, and tends to promote thrift, that we can justify paying quite as much per ton for this product as for high class cottonseed meal. It is useful for increasing the protein in the ration of young pigs, calves, colts, fattening cattle, dairy cows, sheep, lambs, and of practically every class of stock.

Soy Bean Meal.—This product is not widely known in Canada, though an effort has been made to establish a market for it in this country. It belongs to the same class of fodders as high grade cotton seed meal. It does not possess the poisonous properties of cottonseed meal and hence can be more widely used. It is not likely, however, that the price will ever become sufficiently reasonable to promote its use in this country.

MILK AND ITS PRODUCTS.

Cow's milk can scarcely be called a feed for stock except for very young calves. It constitutes a perfectly balanced ration for the young growing calf and it is difficult to get a substitute. It will be noted that there is no fibre in any of this group of substances.

Skim Milk.—Skim milk is similar to whole milk except that the fat has been removed. When fed to calves something must be given with the skim milk to take the place of the fat which has been removed. It is usually best to feed the young calf whole milk until it can be taught to eat a little grain, such as oats, corn, or a mixture of these with bran. As soon as the calf learns to eat, skim milk may be gradually substituted for whole milk.

Skim milk is highly valued for young pigs. It is easily digested and very palatable, two important considerations. Danish authorities estimate six pounds skim milk equal to one pound mixed meal, while American authorities usually give skim milk a somewhat higher rating. When everything is considered, however, a person would be safer in using the Danish standard than he would if he allowed a higher value for skim milk. It is true that sometimes as low as four pounds of skim milk will prove equal to one pound meal, but this is exceptional and it would not be safe to purchase skim milk on this basis. For pigs, sour milk seems to give just as good results as sweet milk, and, in fact, better results in most cases.

Buttermilk.—May be counted equal to skim milk, and whey about one-half the value of skim milk. This is probably a rather low valuation of whey, but it is better to keep on the safe side.

SLAUGHTER HOUSE BY-PRODUCTS.

Dried Blood.—This is an extremely concentrated feed as the analysis shows. It contains no fibre and over eighty per cent. protein. Of course a feed such as this can only be used in very small proportions, possibly less than ten per cent. of the total ration. It would be very easy to lose a good deal of the value of such a product unless it could be handled with extreme care.

Tankage.—Tankage is a prepared by-product from the large abattoirs and is coming rapidly into prominence, especially as a feed for hogs. It shows to best advantage when fed with other feeds which are poor in protein, such as corn, and it also plays an important part in supplying young pigs with a liberal amount of protein, especially when skim milk is not available. As a substitute for skim milk for young pigs it has given pretty satisfactory results, and possibly comes nearer to taking the place of skim milk than any other product on the market. Owing to the high percentage of protein in tankage, it is necessary to feed it with care or there will be waste of protein. When feeding tankage to young pigs it is seldom advisable to feed more than one pound tankage to nine pounds meal. It will be noticed that tankage varies in its percentage of protein and the price varies accordingly. When older pigs are fed on mixed grain, tankage may not prove profitable, but it will show up to best advantage with young pigs or with pigs of any kind which are being fed on corn. In certain tests at this College tankage at $50.00 per ton proved more economical for pigs than skim milk at 10c. per cwt.

MISCELLANEOUS CONCENTRATES.

Beet Pulp.—Wet beet pulp belongs to the same class of foods as roots though it is scarcely equal in value to either mangels or turnips. It approaches these feeds very closely, however, in value and is well worth consideration when available.

Dried beet pulp, however, is more similar to some of our cereal grains in composition, though it is somewhat lower in protein and higher in fibre. Its value is probably about two thirds of the value of wheat bran.

Distillers' Grains, Dried.—It will be noted that distillers' grains vary with the kind of grain which has been used, those derived from corn showing a higher percentage of protein than those derived from rye. Distillers' grains, on the whole, are similar to brewers' grains though perhaps slightly higher in value.

Beet Molasses.—Beet molasses may be used in mixtures as a feed for stock, but this product is not palatable and can be used only in small quantities. From its composition we would conclude that it is equal to cane molasses in feeding value, but it seems to possess certain injurious properties making it a dangerous food for some animals, especially calves or pigs, and enabling the feeder to use it in only small proportions.

Cane Molasses.—The actual feeding value of cane molasses, according to experiments, is similar, pound for pound, to that of corn. It will be seen, therefore, that it is easily possible to pay too much for molasses, and especially for compounds containing molasses for which great things are often claimed by manufacturers. There is one feature of cane molasses which gives it a peculiar value and that is its palatability, and the fact that it seems to promote thrift to a remarkable extent in the animals to which it is fed. Consequently, molasses can often be used to good advantage in making other feeds palatable and hence in stimulating the appetite of animals. Generally speaking, it is better to buy molasses by the barrel than to buy it in so called "molasses feeds."

DRIED FORAGE.

Alfalfa Hay.—If compared with the hay from grasses such as timothy hay, prairie hay, etc., it will be noticed that alfalfa hay has a very much higher percentage of protein. As a result when alfalfa hay is fed to stock, it is not so necessary to feed concentrates rich in protein as it is when timothy hay or hay similar in character is fed. It will be noted that the percentage of protein in alfalfa hay is similar to, and, in fact, higher than the percentage of protein in many concentrated feeds such as cereal grains and many of their by-products. Against this, however, we must take into consideration the fact that alfalfa hay, like all other bulky fodders, contains a high percentage of fibre and hence its value is reduced as compared with the concentrated feeds which contain a much lower percentage of fibre. It is a fact, however, that when first class alfalfa hay is fed to dairy cows it will not be found necessary to feed concentrates to any considerable extent, except in the case of cows which are fairly large producers of milk. It is the fact that alfalfa hay is capable of saving concentrates to a large extent that renders it such a valuable bulky fodder on the farm. Alfalfa hay may be fed to any kind of stock, but is especially valuable for cattle and sheep. Even hogs relish a little fine, leafy alfalfa hay and matured sows will eat considerable quantities.

Clover Hay.—Clover hay, both red and alsike, are very similar in composition and approach within measurable distance of alfalfa hay in feeding value. Stockmen, however, prefer red clover hay to alsike hay, and either one of these kinds is capable of reducing the amount of concentrates necessary to produce a given result in feeding stock though not quite to the same extent as alfalfa.

According to the analysis white sweet clover is very similar to alfalfa in composition, and, when stock have become accustomed to eating it, will probably give nearly as good results if well cured and not too coarse.

Corn Fodder and Stover.—Corn fodder of good quality cut and cured with the ears remaining on the stalks makes a fodder approaching very closely in value to timothy hay. If not well handled there is danger that the fodder may contain a very high percentage of water and have its value reduced considerably. Both corn fodder and stover are very variable in composition, depending upon conditions under which they are kept.

Corn stover is simply corn stalks after the ears have been removed, and it will be noted that its value is considerably less than that of corn fodder.

Timothy Hay.—Compared with clover and alfalfa, timothy hay is low in protein and fairly high in fibre. It is true it is somewhat higher in nitrogen-free extract, but its low protein content is the serious disadvantage. Most farmers prefer timothy hay for horses, and it is probably safer than most other kinds of hay for this purpose. It is usually more free from dust than most other hay and if horses are allowed very liberal rations of hay it does not seem so liable to cause injury. For cattle it is not so satisfactory, and when fed to cattle a more liberal meal ration must be given, and meal containing a larger percentage of protein than when alfalfa or clover hay is fed. For sheep it is entirely unsatisfactory and should not be used for this purpose, either clover or alfalfa being exceptionally well suited for sheep feeding.

The other kinds of hay mentioned in the table are all similar in composition though they are slightly higher in protein than timothy hay.

STRAW AND CHAFF.

The noticeable feature of the composition of straw is the extremely high percentage of fibre. As a result, when we feed animals largely upon straw they have to handle a very large amount of what may be called inert or comparatively useless material. While this is true, it is also true that straw may be used as part of the bulky ration to good advantage when other bulky fodders are scarce or very high in price. Idle horses may be carried through the winter upon straw as their bulky fodder with a light allowance of grain, and cattle or sheep may be made to utilize a considerable amount of straw. It must be remembered that if straw is used in the ration of dairy cows or fattening cattle, it will be necessary to feed a good deal more meal than when hay is fed, so that sometimes what we may gain in saving hay may be more than lost through the extra amount of concentrates used. For store cattle or dry cows straw can be used to much better advantage than for cows which are milking or cattle which are being fattened.

Of the different kinds of straw mentioned in the table it will be noticed that buckwheat supplies the most protein, but it is so extremely high in fibre that it is seldom regarded as a satisfactory feed for stock except in extreme cases. Everything considered, oat straw is the most satisfactory for all classes of stock.

The table shows barley straw to be practically equal to oat straw so far as composition is concerned, but barley straw is not so palatable as oat straw and the awns or beards of the barley render it objectionable.

Wheat straw and rye straw are both rather low in feeding value and should not be used for feed if oat straw is available.

Notice the relatively high value of chaff as compared with straw, both in the case of oat chaff and wheat chaff. The plan of separating the chaff from the straw at the time of threshing, which used to be more common than it is at present, has a good deal to commend it.

ROOTS AND TUBERS.

These foods belong to what are known as succulent foods; that is to say, all the members of the group contain a very high percentage of water. The high percentage of water reduces the value of one hundred pounds of any of these foods, but the solid material which they furnish is usually very digestible and very palatable. In addition, these succulent foods tend to keep the digestive organs of the animal in better condition and consequently they have a value outside of their actual feeding value. All practical feeders recognize the importance of succulent foods as a means of keeping animals in healthy, thrifty condition.

Of the roots mentioned in the table, sugar beets have the highest feeding value, being especially high in nitrogen-free extract as compared with the other kinds of roots. Mangels and swede turnips are similar in value, the advantage, if any, being in favor of the turnip. White turnips or fall turnips drop a little below swede turnips, and carrots have a slightly higher feeding value than swede turnips.

Roots are valuable for all classes of stock including horses. Most feeders prefer carrots for horses though almost any kind of roots may be fed if judgment is exercised. Care should be taken not to feed many roots to a horse not accustomed to them and in all cases the roots should be sound. Decaying or mouldy vegetable matter is extremely dangerous to horses.

Mangels are usually preferred for dairy cattle as they are not so likely to taint the milk as are turnips. Many feeders prefer turnips to mangels for fattening cattle though experiments indicate very little, if any, difference in value. For sheep, turnips are undoubtedly safer than mangels and consequently are to be preferred.

The potato, which is a tuber and not a root, has a higher feeding value than the roots mentioned. Potatoes, however, cannot be grown profitably for stock feeding and it is only cull potatoes which are used for this purpose. For pigs, potatoes must be boiled before they are acceptable.

Danish experiments indicate that it requires about seven and a half pounds mangels or four pounds of sugar beets to be equivalent to one pound of mixed meal in hog feeding. No doubt the same comparison would hold true in the case of fattening cattle, but in the case of dairy cattle, where the proportion of protein is very important, very little difference in value will be found between sugar beets and mangels. Some other experiments have shown a much higher value for roots that that shown in Danish experiments, and in some cases less than five pounds of mangels have proved equal to one pound of meal. On the average, however, possibly the Danish estimate is not very far astray.

Potatoes may be said to have approximately the same feeding value as sugar beets, but in the case of pigs the expense of cooking the potatoes would have to be taken into consideration.

In the British Isles very heavy rations of roots are fed, but in this country from thirty to fifty pounds a day is usually considered a fair allowance for a cow, and four pounds a day a fair allowance for a sheep. In the case of pigs the roots are best pulped and mixed with meal, in which case about equal weights of roots and meal will prove satisfactory.

MISCELLANEOUS GREEN FORAGE.

The apple is not usually considered a feed for stock, but if its composition is compared with that of roots, or even of potatoes, it will be seen that the apple has considerable value and unmarketable apples should not be wasted. They may be used for almost any class of stock, though, as a rule, it is scarcely safe to feed quite so many apples to cattle as one would feed of roots.

The by-product of the cider mill, known as apple pomace, also has considerable value and is worth consideration when available.

Cabbages and pumpkins belong to the same class of fodders as turnips and mangels and there is not a very wide difference in their feeding value.

Silage.—Corn silage also belongs to our group of succulent foods, and hence plays a very important part in keeping animals in condition as well as supplying a large amount of comparatively cheap fodder. It will be noticed that silage from well matured corn is worth considerably more than that from immature corn. It will also be noted that corn silage does not contain so much water as roots though it contains a good deal more fibre. In spite, however, of its high percentage of fibre, good corn silage should be worth twice as much as roots.

Corn silage may be fed to almost any class of stock, though, owing to the fact that there may be some mould which escapes notice, it would probably be just as well not to feed it to horses. Some sheep feeders speak highly of silage for sheep and others very much prefer roots. Probably turnips are rather more satisfactory for sheep than corn silage though a good many sheep feeders use silage. Matured pigs will eat a certain amount of silage, but they waste a great deal and it can scarcely be called a satisfactory feed for pigs. Silage gives best results when fed to cattle and it is suitable for any class of cattle. For matured cattle about forty pounds of silage per day may be regarded as a fairly liberal allowance.

MIXED FEEDS.

There are on the market a good many ready prepared mixtures of feed for which extravagant claims are sometimes made. Many of these feeds are intended merely to provide a market for such substances as oat hulls, cottonseed hulls and similar materials, which, as has been shown, have a very low feeding value in themselves. Some of these mixtures are worth the money asked for them, but others are not, and the farmer must be wide awake to avoid being caught. The agent who sells the feed will probably emphasize the percentage of protein contained in it, but the farmer must remember that this is not the only consideration, and that the fibre content is a pretty sure indication as to whether the mixture is a high grade or low grade product. As already pointed out, a high percentage of fibre means a low grade product, and no farmer should purchase feeds with which he is not familiar without a guarantee as to both the percentage of protein and fibre.

Sometimes weed seeds are included in these mixtures, and some weed seeds such as worm-seed mustard and other mustards, are decidedly injurious to stock. It is well, therefore, to exercise caution in purchasing these feeds and to insist upon guarantees as previously stated.

CONCLUSION.

As was stated in another place it is not possible to give exact comparisons of the relative feeding value of the various foodstuffs for all the purposes for which they may be required. All that has been attempted in this bulletin is to give, in a somewhat crude but practical form, a few hints and suggestions regarding a number of feeds with which our farmers may come in contact, in the hope that such a presentation of the subject may be helpful in enabling the farmer to spend his money on feeds to better advantage.

THE LIVE STOCK SITUATION FROM THE MARKETING STANDPOINT

H. S. Arkell, Assistant Dominion Live Stock Commissioner, Ottawa.

The live stock industry has contributed to the industrial revenue of Canada an aggregate of exports, for the fiscal year ending March 31st, 1916, to the value of $105,919,190. This averages a return of over two million dollars per week. For the fiscal years ending March 31st, 1913, 1914 and 1915, the animal produce exports have totalled respectively $45,773,227, $54,612,072 and $76,956,002. Thus, within the period of the war, the exports of animals and animal products have doubled, while for the four-year period they have increased practically one hundred and fifty per cent.

The High Place of Agriculture. — Considering the value of the exports of animal produce with that of the exports of agricultural produce, the aggregate for the fiscal year ending March 31st, 1916, amounted to $372,394,380, as compared with a total export value for the same period, of manufactures, including munitions, of $250,052,223. In other words, the total export value of agricultural produce is practically one and one-half times as great as the value of the exports of manufacture, including munitions of war. Pressing the comparison still further, the aggregate of exports from all sources, including mining, fishing, lumbering, manufactures and agriculture, for the fiscal year 1915-16, amounted to $779,300,070. Of this the total export value of animal and agricultural products amounted to 48 per cent. For the fiscal years 1911-12, 1912-13, 1913-14 and 1914-15, the export value of animal and agricultural products amounted respectively to 53 per cent., 51 per cent., 57 per cent. and 54 per cent. In other words, during the last five fiscal years the exports of agriculture yielded an industrial revenue to the country of more than half, to be exact 52.6 per cent., of the total return from all sources combined. Again, the aggregate export trade for the first five months, April, May, June, July and August, of the current fiscal year, amounted to $443,-254,333, of which $222,176,467 represents the proportionate value of agricultural products, or slightly over 50 per cent. of the total exports. Bearing in mind the fact that the great increase in the export value of manufactured products may be attributed almost entirely to the manufacture of war munitions, the financial return yielded to the country by agriculture is all the more creditable. It will be observed that the latter industry has increased its exports in the same enormous proportion as compared with the other industries of Canada and continues, therefore, to hold a similar ratio from the standpoint of aggregate values in foreign trade, as it held prior to the commencement of the war.

The Possibility of Permanence.—The most significant feature of this increase as relating to the live stock industry lies in the fact that it reveals the possibility or, at least, suggests the opportunity, of the continuance of a permanent trade, following the declaration of peace. Apart from the export of such products as tinned meat, pork and beans, etc., which may be required only temporarily for war purposes, the export trade in live stock products centres round the sale of such staple food commodities as cheese, eggs, bacon and fresh beef. The following table will serve to indicate the greatly increasing value of the export trade in these products, as well as the substantial return to the country which each of them now yields.

Exports of cheese, eggs, bacon and fresh beef from Canada:

	Cheese.	Eggs.	Bacon.	Fresh Beef.
1913	$20,697,144	$58,176	$5,351,225	$160,877
1914	18,948,511	92,322	3,763,330	1,165,295
1915	19,247,603	1,206,518	11,812,186	2,060,430
1916	27,495,607	2,705,416	25,759,266	6,154,632
April to August, inclusive, 1916	15,000,653	293,053	13,568,242	1,155,195

Canadian cheese is standard for all countries competing for position in the United Kingdom and a permanent outlet for this product on the British market is fully assured.

Eggs for Export. — The export trade in eggs is new. Canada, for many years has had no surplus to sell. At the beginning of the war, however, Great Britain found her normal sources of supply unavailable and was obliged to turn to the United States and to Canada, which, in 1914, had a few surplus eggs to dispose of. From that date, production increased to such an extent in the Dominion that we were able to greatly extend our exports and, at the same time, by the joint efforts of the Government and of the produce trade, to so protect their quality that the reputation they have gained has resulted in a demand which has drained the country of practically all of its present available stock. Canada has been able to sell steadily as against American competition and at considerably better prices. There is reasonable ground for the belief that Canadian eggs have established a permanent place for themselves in the United Kingdom.

The Bacon Business. — The export bacon business represents perhaps the safest and most satisfactory trade in which we may engage at the present moment. That Canada is in a position to produce high-class Wiltshire sides has enabled her to take the place of Denmark, to compete with Ireland, and, in the matter of price, to outclass the United States in the war demand for this product. The significance of this statement will bear consideration. It means simply that Canada is in a position, if she can produce the necessary volume of hogs, to secure a grip on the British bacon market which should represent to her an annual revenue of millions of dollars in the years to come. Unquestionably, the Dominion will be faced with very serious competition after the war, but, if she makes good her hold at the present moment, she need have nothing to fear as her organization for this trade develops and improves. It is the view of those who have most carefully studied the situation that hog production in Canada is a safe business undertaking and should be developed into an industry out of which, by organization and systematization, may be developed, as in the case of Denmark, a great export trade.

Every Hoof Required. — The sale of fresh beef relates itself not only to the existing war demand, both civil and military, but, as well, to the need for replenishing, after the war, the depleted herds of Belgium and the decreasing stocks of France. The situation here suggested requires no elaboration. The need for all the country can produce, for every available last hoof, is more than evident. Further, the relationship between Canada and the United Kingdom is now such as to suggest the establishment of more favorable trade connections than have hitherto existed, out of which may very probably develop our ability to profitably sell our cattle or our meat to the United Kingdom. The world shortage in all meat products, particularly in cattle, practically insures an opportunity to this country to secure a market for its animal products to the extent of its limit of production.

Exports Exceed Imports. — There has been a growing uneasiness on the part of the Canadian people, possibly due to the very high prices for food commodities, as to the existing status of our live stock industry. The suspicion has arisen that we are falling very far behind in production. The statements which have been given, however, in reference to our export trade, should assist very materially in explaining the conditions which now obtain. Moreover, it may be pointed out that in 1913 the combined imports of eggs, poultry, bacon, beef, ham, mutton, pork, live stock, wool and lard, amounted to $2,366,303 more than the value of the exports in these commodities. On the other hand, in 1916, the exports exceeded the imports by $36,544,418. Making due allowance for a lower home consumption in 1916 as compared with 1913, it would, at least, appear that the live stock industry is reasonably holding its own. The turn of this whole argument, however, suggests that, in the interests of Canada, the live stock industry should do much more than simply hold its own. Normal production has made possible, under existing circumstances, a very satisfactory trade expansion. Normal production, however, will not answer the urgent demand of the Empire for meats and all food products during the period of the war. The urgency of the food question in Europe and even in the United Kingdom is daily becoming more and more apparent. We have continually imposed upon us the obligation of Empire necessity.

From another point of view, involving the commercial and economic status of the country, we shall do well to bear in mind the returns which agriculture can contribute. That the industry is rendering an efficient service, is already sufficiently confirmed. It must be borne in mind, however, that the exports of war munitions represents only temporary prosperity. Preparedness for the future suggests the essentially provident course of strengthening the position of agriculture in all our industrial propaganda, thus enabling this industry to yield its fullest possible quota through the utilization of the enormous natural resources of the Dominion.

Stability Depends on Live Stock Production. — Upon the development of the live stock industry depends the continuous stability of agriculture in Canada. We may therefore well do what we can in the days to come to coerce existing circumstances into a national movement having for its object a steady increase in live stock production and a corresponding expansion of our live stock trade. This will involve improved facilities of marketing. It will necessitate standardization of product for export purposes. We must take steps to secure a volume of supply which, while fully meeting the requirements of the country for home consumption, will assure a dependable and continuous surplus, without which permanent trade relationships can never be established. Our ability to organize production and to organize selling, whether from the farm or on the foreign market, will measure the extent of our success. Other agricultural countries have only prospered as they have been able to commercially systematize the development of their rural industries and disorganized agriculture in Canada will never be able to compete against the aggresive policy of other countries, the Argentine, Australia, the United States, or even newly awakened Russia, in the concentrated struggle for position on the European market after the war. The live stock industry, then, in taking stock of itself, is seized of the opportunity now presented to it, is measuring its forces to meet the call of Canada and of the Empire, and is asking the co-operation of the great commercial institutions of the country in a comprehensive movement to discharge its full responsibility in promoting the industrial advancement of the Dominion.

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Farm Poultry

With the Results of Some Experiments of Poultry Houses and Fattening Chickens

By W. R. Graham and F. N. Marcellus.

INTRODUCTION.

More interest in poultry and poultry products is shown from year to year. Many farmers a few years ago considered poultry as a necessary evil and not in any sense of the word as revenue makers. There are yet a considerable number of this class, but more people are finding that the keeping of poultry is profitable and enjoyable. We now find a large number of farmers keeping from fifty to one hundred hens, who are well pleased with the cash returns from their poultry. There are also a growing number of small farmers who specialize in poultry-keeping profitably, and further there are numerous persons in cities, towns and villages who are making money from poultry.

The writers in the following pages will endeavor to give in a concise form the results of their experience covering a period of more than fifteen years with poultry at this College.

SUCCESS or FAILURE in keeping poultry depends upon breeding, feeding, housing, rearing, sanitation, and general management. All of these factors must be carefully studied. We do not mean to infer that the keeping of poultry is extremely difficult, but we do wish to impress upon our readers that it is no business for a lazy or an indifferent person or one who is not prepared to plan the work carefully and then work to the plan. There are a larger number of individuals in the poultry flock than in most other flocks of live stock kept upon the farm, and the individual unit is frequently lost in the mass. The writers believe poultry production will be found both enjoyable and profitable if the person in charge will do his or her part well, but we would discourage people who are not prepared to work faithfully and systematically. By this we mean success is not likely to be obtained by careful feeding, etc., for five or six days, and then on the following days forget to feed or water, etc. Where poultry is kept in large numbers, success depends almost entirely upon efficiency.

The general farmer has nearly all the conditions for success and if given reasonable attention poultry-keeping should be one of the revenue producers of the farm.

BREEDS OF POULTRY.

The present high prices of eggs and meat have done much to popularize poultry on the farm, and consequently we are frequently asked as to "What is the best breed of poultry." It is impossible to answer this question, as some breeds are special purpose breeds and others general purpose breeds. There is undoubtedly more difference in strains of the same breed than there is between breeds.

It is not the purpose of the writers to discuss all breeds of poultry in this bulletin, but simply to mention the general characteristics of some of the more popular ones. We shall endeavor to classify these breeds more or less on utility lines rather than according to the usual classification as adopted in various poultry publications. It may be taken as a rule that all breeds that lay brown or tinted shelled eggs will set, hatch, and rear their young, and all breeds which lay white-shelled eggs, with the exception of Dorkings, are non-sitters, and the eggs from these breeds have to be hatched artificially or by hens of other varieties. It will, therefore, be seen that the general purpose breeds lay tinted eggs and are good sitters and mothers.

General Purpose Breeds.

Plymouth Rocks. There are six varieties of this breed—three of which are common—Barred, White, and Buff. The Partridge, Columbian, and Silver Pencilled are not so common. The Barred Plymouth Rock is undoubtedly the most popular variety of fowl among farmers. The best bred-to-lay strains are good winter layers, fair summer layers, make first-class roasters, and fair to good broilers. It is one of the hardiest breeds. The standard weights are: Cock birds, 9½ lbs.; cockerels, 8 lbs.; hens, 7½ lbs.; and pullets, 6½ lbs. Bred-to-lay strains usually run slightly below the standard weights in all sections except cock birds.

Wyandottes. There are several varieties in this breed among which might be mentioned: White, Buff, Silver Laced, Golden Laced, Black Columbian, Partridge and Silver Pencilled. The most popular variety from a commercial standpoint is the White. This breed has practically the same characteristics as the Plymouth Rocks, but is more blocky in type and usually longer in the feather. The feathers are not carried so close to the body as the Rocks. They have rose combs, which by some is supposed to be an advantage in cold climates. Wyandottes make good broilers and good roasters. Some strains are good layers and they make good mothers. The standard weight of these birds is one pound less than those of the Plymouth Rocks.

Rhode Island Reds. There are two varieties of this breed, single comb and rose comb. As compared with the Plymouth Rocks and Wyandottes they are longer in appearance and not so massive. They were originated by the farmers of the State of Rhode Island, and are very popular in that State. They have also grown in popularity in this country to such an extent that they now rival the Plymouth

Rocks and Wyandottes. They are hardy, good winter layers, and fair summer layers. In color they are a rich, bright red, with black tails, and more or less black in the wings. During warm weather our experience has been that they are more given to incubating than the two breeds mentioned above. The standard weights of this breed are: Cock birds, 8½ lbs.; cockerels, 7½ lbs.; hens, 6½ lbs., and pullets, 5 lbs.

Orpingtons. This general purpose breed differs from those mentioned in that they have white legs and skin; the other breeds having yellow legs and yellow skin. The common varieties of this breed are: Buff, White, and Black. At the present time there are probably more Buff Orpingtons bred than any other variety, but the White may outrival the Buff. The Blacks are being bred more by the fanciers than by the farmers, for the reason that their black plumage and dark-colored legs are somewhat against them for market purposes. This breed is among the best winter layers; makes good roasters and broilers, but is probably more given to incubating during warm weather than either the Rocks or the Wyandottes. The standard weights are about one pound per bird above the Plymouth Rocks. For general farm use they might be more profitably bred with less weight, for the reason that the largest birds are usually somewhat leggy and rough in appearance when weighing 4 to 5 lbs. When one wants very large roasters, weighing from 7 to 8 lbs. each or more, the larger birds, of course, would be better.

Dorkings. This is one of the oldest English breeds, and is popular in some districts. They are a large breed, long in the body and short in the legs. By many they are considered to be weak in constitution, although our experience would not bear this out, entirely. They lay large white eggs, and are good sitters and mothers. They are white fleshed and white legged. Their peculiarity is that they have five toes. This is, at times, a disadvantage, especially when the fowls have to scratch in straw where there is more or less binder twine, which is apt to get around the extra toe, and thereby occasionally fastening both feet together. This is not a very serious objection. Where there is high, dry ground and plenty of range, and a person fancies the Dorking color or type, they are worthy of consideration.

Meat Breeds.

Brahmas. The feathered-legged breeds are not very extensively kept. The most popular of these is the Brahma. This breed is very hardy, and lays very large brown eggs. They are rather slow to mature and the feathers on the legs are not altogether desirable from a farmer's standpoint, in that they are apt to get wet and freeze easily. Brahmas make the best roasters, but are somewhat slow to mature, and the females, in our experience, have not been very good layers, although there are some females that do well. This breed is yellow skinned.

Langshans. Langshans are also of the feathered-leg breed, but have white skin. They are longer in the legs than the Brahmas and are not so heavy.

Games. By many the Game would not be considered a chicken suitable to farmers. The exhibition Games, as they are known in the Standard, are altogether too long in the legs and head, and too weak in constitution for the ordinary farmer, but the Cornish Games and what is known as the Old English Game are worthy of consideration. The Cornish Game is a very large, tight-feathered, full-breasted chicken, and probably carries more meat on its breast than any other breed. The objection to the Cornish Game is that it is a poor layer. The English Game, sometimes termed "Pit Game," is a hardy bird. They are fair layers and make fair roasters. The most serious objection to this breed from a farmer's standpoint is that there is a great tendency among the young cockerels to be very pugnacious. This is sometimes carried to such an extent that they kill one another. Other than this, they make a fairly good farm chicken, especially where the mothers are required to protect their young.

Special Purpose Egg Breeds.

During recent years, commercial egg farms have done much to popularize this class of fowl. Of all the breeds used for this purpose the Leghorn is the most popular, and of the Leghorn the Whites are being kept in the largest numbers. They are good layers during the natural laying season, but in the experience of the writers are liable to suffer more from the cold winter weather than are some of the heavier breeds. They are, otherwise, quite hardy. It is now a well-established fact that on the average a larger number of chicks can be hatched from a given number of eggs from Leghorns than with other breeds and their chicks are easily reared. The young cockerels make good broilers, but are of no use for roasters. Leghorns can no doubt be more successfully kept in large flocks than can the heavy breeds. Cases of commercial farm keeping from three to five hundred in a flock are common, although the fact remains that highest egg yields up to the present are secured from smaller sized flocks. Of the other varieties the Browns, Buffs, and Blacks are most common, but are more popular with the fanciers than with the farmers owing to the color.

Minorcas. There are three varieties of Minorcas. The Rose Comb Black and Single Comb Black are more commonly bred than is the White variety. This breed is larger than the Leghorn, and also lays a larger egg. They have very large combs and wattles.

Anconas. This breed might be termed a speckled or mottled Leghorn. They have all the characteristics of the Leghorn and are black and white in color. This breed is gaining in popularity among the practical poultrymen.

Hamburgs. There are several varieties of this breed. The Black is the most popular. They are inclined to lay an undersized egg. We have found the Blacks to be good layers, and to lay a fair-sized egg. They have rose combs and neat and active in appearance.

SELECTION AND BREEDING.

The object in selecting and breeding is to produce a uniform flock as to the characters desired, or in other words to reduce the percentage of undesirables to the minimum. There may be a vast difference in the objects of the breeders. One may wish a flock uniform as to shape and color; another may want birds that are producers of a large number of eggs; while with others the object may be meat production, or a breeder may desire all the above characters and many more. The more characters desired the slower, ordinarily, will be the progress.

The average farmer, or what is termed utility poultryman, measures a bird by its economical production of eggs and meat.

No matter what the object in view the one essential to all birds is that they have an abundance of constitutional vigor. What is meant by "vigor" is the ability to resist disease or to remain at all times physically fit. Vigor in poultry is as essential as the mainspring is to the clock. Birds low in vigor are nearly always disappointing in making profits or preventing serious loss.

The selection of birds depends upon one's ability to judge the performance possibilities of the specimen. There are certain outward characters that are usually associated with good specimens, but these characters as seen are not always positive. There remains but one way to know the true value of the specimen as a breeder, and this is the progeny test. Some of the best appearing specimens are very disappointing as measured by performance and also by the progeny produced. It is, therefore, evident that where one wishes to make sure and certain progress one must keep accurate records as to parents, age, growth, eggs produced, size and color of eggs, whether the eggs hatch well or poorly, etc. It is equally evident that only a limited number of persons are so situated as to be able to do this, and therefore the larger number must be guided by observation.

Our experience has been that most people are fair judges of vigor. They like the male that is active, proud, with a sprightly appearance; one that will take his own part, also crows rather loudly and frequently. Such birds usually show considerable red color in the side of the shanks, have a bright eye, rather short, well-curved beaks, and the legs are well set under them. Birds with long, narrow heads, and long necks and legs, are frequently, if not always, low in vigor. Usually the eye is somewhat dull and the shanks show but little or no red color. The points are not infallible, but are the best guidance we can offer at present.

Great interest is being taken in egg production, and many people wish to buy males who will produce high-laying pullets or wish to breed the same. Ability along this line is not so easily measured. It is generally true that good layers mature early or commence laying when from one hundred and fifty to two hundred days of age, and as the laying progresses, specimens that have yellow pigment in the shanks gradually lose this color, also that the yellow pigment in white ear-lobed females decreases very much during heavy laying, and furthermore, the pin bones widen and are frequently rather thin and pliable. Again, good laying hens in the late summer and fall wear their old feathers. Yellow-legged breeds are almost white in color of legs, while the hens with new feathers and spick and span appearance are the poor producers. These points are of material assistance in telling which hens have been the good layers. Where one desires to breed from hens that have been the best layers in the flock, and cannot or has not used trap nests, the healthy, robust females that are late to moult and who have lost the color from the shanks have been nearly always good layers.

How to select pullets that will be high layers is a much more difficult problem, and to date we have found no reliable method. It is true that by March, or breeding time, many of the best layers show the same characters as mentioned for hens, and frequently the best layers begin laying rather early in life, but not always.

Where one is breeding to maintain or increase the number of eggs produced great care should be taken not to breed from hens laying very small eggs or birds whose eggs hatch poorly. Pullets that begin laying early or those who mature the earliest in the flock appear to have a tendency to lay rather small eggs. This is not always the case, but it is frequent enough to put one on guard for size of eggs. Again, if one does not get a reasonable hatch, say fifty per cent. or better of the fertile eggs incubated, the males from such a hen should be used with extreme caution; furthermore, there is a vast difference in the living power and growth from the individuals in a mating.

Poultry has shown steady improvement for a number of years in nearly all characters, with exception of the hatching power of the eggs and living power of chicks. Our artificial conditions and selections appear to have been not very successful along these lines, possibly owing to the fact that selections along such lines entail considerable labor and usually are not given serious thought. The loss of eggs and chicks in the endeavor to renew the flock are very serious items.

It has been stated that the male has much more to do with the egg production of the daughter than has the female. Our breeding experiments indicate that this is probably true. It would appear that certain high-laying hens, when mated with a good male, can transmit the high-laying character to their sons, but with their daughters they have but little influence. It would, therefore, appear evident that the problem in breeding high-laying pullets is to test the male's ability in regard to this character, and to mate with him high-laying hens so as to secure good cockerels for future breeding. No doubt many good birds are bred by chance; on the other hand it would seem that if the males are to be depended upon very careful records must be kept. We have been working upon such problems for a number of years; first, with the object of determining whether the male was more important than the hen; and further, to supply breeders with a limited number of males of known parentage. According to theory of inherited egg production there are nine classes of males. In order to locate these males at all accurately one must be careful as to the season of hatching, methods of rearing, feeding, housing, etc., or in other words the conditions for egg production must be as near ideal as is within one's knowledge. Without these the results may be unsatisfactory. Careful breeding, where accurate records are kept, is difficult for many, hence the amount of time and money we have spent in testing and recording males and females. Progress is somewhat slow, owing to the fact that one has to learn by hard experience the best methods of attack and recording.

To illustrate the variation in males, below are given the egg production records of the daughters of four males, each representing a different class.

Our experience has been that males of the first class presented are very rare, and the second class (while more common) are not numerous. The third class of males presented we have found to be numerous among the sons of good laying hens. As regards the fourth class of males, we have not tested many, but usually breed one each season to maintain a limited number of rather poor laying hens. Such hens are of use to test males of the three other classes mentioned.

Male "A" was bred to twelve females, who produced sixteen daughters, fourteen of which laid thirty-five or more eggs each from November 1st to March 1st, or during the winter period. The two remaining daughters were late hatched, and produced during the winter respectively twenty-two and twenty-eight eggs, and to October 1st of the same year one hundred and sixty and one hundred and forty-five eggs. The sixteen daughters produced in the year two thousand nine hundred and sixty eggs, or one hundred and eighty-five eggs each. Our figures would indicate that a healthy hen laying less than one hundred and fifty eggs in twelve consecutive months is to be looked upon as a poor layer. This male should have all daughters laying over one hundred and fifty eggs, but late June hatched birds are uncertain in performance.

This is a very unusual male for breeding high layers. He was not a very good breeder as to numbers produced or hatching power of the eggs, and was, therefore, bred with caution.

Male "B" was bred to nine females and produced twenty-nine daughters, twenty-one of which laid over thirty-five eggs during the winter months. The eight remaining pullets produced from two to twenty-three eggs each during the same period. The twenty-one pullets produced an average of one hundred and ninety-eight eggs each during the year, and the eight remaining pullets averaged one hundred and twenty-three and one-half eggs each.

Bred to MALE "B."

C54—produced 4 daughters—3 were high winter layers and 1 low.
C100—produced 5 daughters—3 were high winter layers and 2 low.
C36—produced 5 daughters—3 were high winter layers and 2 low.
C29—produced 3 daughters—2 were high winter layers and 1 low.
C280—produced 1 daughter —which was a high layer.
C197—produced 2 daughters—both high layers.
B4—produced 2 daughters—both high layers.
C50—produced 3 daughters—2 were high winter layers and 1 low.
C320—produced 4 daughters—3 were high winter layers and 1 low.

29 daughters—21 were high winter layers and 8 low.

This male was also a good breeder of strong chicks.

Male "C" was bred to eleven females and produced twenty-eight daughters, twenty-one of which produced thirty-five or more eggs each during the winter period. The remaining seven pullets produced from seven to twenty-seven eggs during the winter period. The twenty-one pullets that performed well during the winter averaged one hundred and eighty eggs for the year, and the seven inferior laying pullets during the winter averaged one hundred and thirty-seven and one-half eggs for the year.

Bred to MALE "C."

C42—produced 2 daughters—all were high winter layers.
C176—produced 1 daughter —which was a low winter layer.
C19—produced 2 daughters—all were high layers.
C90—produced 1 daughter —which was a high layer.
C726—produced 3 daughters—all were high layers.
C174—produced 6 daughters—three high layers and three low.
C195—produced 4 daughters—all high layers.
C125—produced 1 daughter —which was a high layer.
C67—produced 4 daughters—two were high layers and two low.
C1378—produced 3 daughters—all high layers.
C1352—produced 1 daughter —which was a low layer.

28 daughters.

This male, when mated to certain hens, produced fifty per cent. low layers, while to other hens he produced all high layers, note C174 and C67. The hens with but one daughter are not of much value in rating a male.

This male was a good breeder of strong chicks.

Male "D." This male was bred to seven hens, whose ancestors were poor layers and the hens mated to him were of similar breeding.

From this mating fifteen daughters were produced, which were handled in the same manner, some in the same pens, as the daughters from the other males.

None of the daughters laid over fifteen eggs in the winter period; seven laid no eggs during the winter period. The best pullet in twelve consecutive months produced one hundred and seventeen eggs, and the average production of the daughters was seventy-six and one-half eggs each.

This male was not bred to high-producing hens, but some of his ancestors were, and the results were hens under the one hundred and fifty egg mark. One of the poorest of these hens was bred in 1916 to a good male, perhaps equal, if not better, than "A," and the five daughters from this mating to date, December 15th, have each laid over thirty-five eggs.

Among the high winter egg producing hens there appears to be two well-defined classes as breeders. The variations among the offspring cannot be noted from a male such as "A," but may easily be seen in males "B" and "C." That is, some hens mated to males such as "B" or "C" will produce all good laying daughters when mated to other equally as good laying hens produce a percentage of culls. The cockerels from the hen producing all high layers are the better ones to use as breeders, provided they are strong and vigorous.

Any chicken hatched out of season or that has been stunted in growth, or was sick, poorly housed, or badly fed, etc., cannot be expected to perform normal.

Early attention was drawn to the importance of using as breeders the offspring from hens whose eggs hatched well and whose chickens also lived. It is generally well known that range, feeding, housing, etc., have much to do with the living power of the chicks, and also the hatching power of the eggs, but there yet remains the fact that there is a vast difference in individuals under the same conditions. Below is given the hatching and mortality record of three females, half sisters, and who have had identical treatment so far as it is humanly possible to do, and who were in the same breeding pen and mated to the same male:

	Eggs Set	Infertile	Dead Germs	Eggs Hatched	Mortality Among Chicks
No. E63	36	3	14	19	1
No. E50	26	3	17	6	5
No. E95	46	6	6	34	3

These hens have produced over two hundred eggs each in their pullet year, yet one can see at a glance that one is a much more valuable breeder than the others. It is particularly desirable that close attention be paid to these points. The renewal of the flock is at times expensive, and the writers are of the opinion it would be better to go a little slower on increased egg production and try and improve the hatching and living power.

From the foregoing, it will be seen that the breeder's problem is to select birds as breeders that perform well as to egg production, hatching power of eggs and living power of chicks; those that are strong and vigorous and have well-muscled breast. Pay some attention at least to meat qualities. The appearance of the dressed carcass is helped by feeding, but there is much in breeding.

No matter how rigid the selection of breeders there will be more or less undesirable offspring. There are many things in the bird not visible that came from generations back, that, try as we may, some of these will be seen in the offspring. The longer and more rigid the selection the less will likely be the number.

Cross Breeding.

Our experience would be that it is seldom advisable to cross breed. There are instances when it may be advisable, but they are rare. If you should breed, do not breed the cross-bred males. For example of what is likely to happen, below is given a few of the many types, colors, etc., that came from a cross of Barred Rocks and Black Hamburgs, and then the cross-bred cockerels mated to the cross-bred pullets. The first cross produced a rather pretty flock of nice uniform chickens with rose combs and barred-colored plumage, but the succeeding generations were a great variety of shape, color, size and vigor. Breed, at least, a pure-bred male each year. Breeding cross-bred males is dangerous.

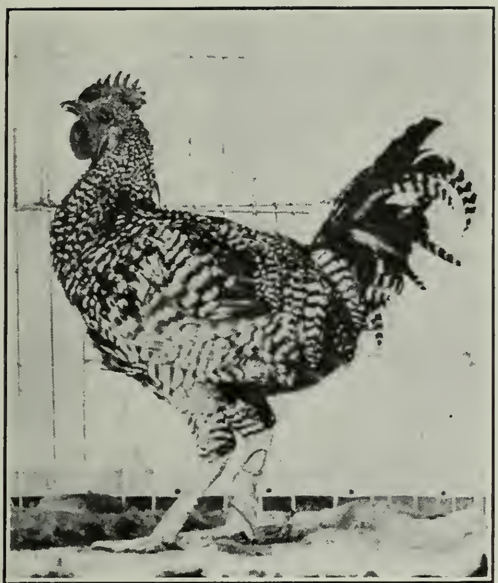


Fig. 1.—One of the many types found, the result of a mating of cross-bred fowls.

Fig. 2.—Another type, the result of the breeding of cross-bred fowls.

Fig. 3.—Another type, the result of breeding cross-breds together.

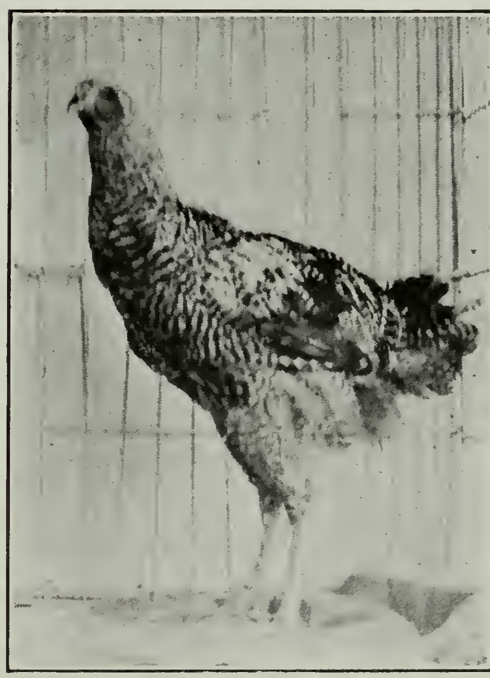


Fig. 4.—Usually when cross-breds are bred together about 25 per cent. of the offspring is very poor, or like this one.

EGG PRODUCTION.

It is generally considered among poultrymen that the production of eggs is the most profitable branch of the business. It must also be conceded that for most people a crop of chickens must be reared annually, and the surplus males and old hens sold, at a profit if possible.

Many people appear to believe that the secret of getting eggs, particularly in winter, is in the feeds given and the method of feeding; others believe the whole problem is in the breed or strain, while others think the housing is the problem to solve. All these are important, but the main reason for poor results, in the opinion of the writers, is a lack of careful work, months before the eggs are wanted. While you are collecting the high-priced winter eggs, one should be making careful plans to secure the crop of pullets for next season.

The factors are feeding, housing, age of stock, strain, possibly breed, the attendant, cleanliness and the weather. All of these may be more or less controlled, with the exception of the weather, and it is perhaps the least important factor.

Some troubles are overcrowding in houses, the stock of mixed ages, that is there are two-year-olds and upwards, yearlings, early pullets and late pullets, also surplus cockerels, and many times dirty, moist houses, wet or dirty litter, etc.

Where eggs in winter are wanted, the early hatched pullet is, without doubt, the one to depend upon. Yearling hens and those older are very rarely good producers during November and December. They are uncertain, even in January and February, and really do not begin to lay well until March. Where the egg production falls below fifteen per cent. during the winter months, one is not making much profit. The age at which most pullets begin laying is from six to seven months, some lay at four and one-half to five months, and others not until eight or nine months of age. This means that if a fifty per cent. egg yield is wanted in November the pullets should be hatched during March or April; May hatched pullets will lay a little but, as a rule, not forty or more per cent. daily.

The attendant has responsibilities. There should not be any neglect on his or her part; careful, constant work and a keen interest in the welfare of the birds. Be regular, and do not neglect the work. A bird that has stopped laying is very hard to start. As they mature, they commence laying; it is the attendant's work to keep them going.

In other portions of the bulletin are discussed housing, feeding, disease, and so forth.

To sum up, in general, the requirements for high egg production are clean, dry, comfortable houses, that are free from direct draughts over the birds, and that are well lighted; the feeding consists of a variety of grains, green food, animal food, grit and shell, which is clean, sweet and wholesome, and is given to the birds regularly and in such quantities that they have all they want to eat before going to roost at night; that the supply of drinking material is clean and abundant; that the attendant is regular in his or her work and is interested in the same; that the birds are bred from good laying ancestors, and that they are hatched and reared well, and are free from disease.

The question of the cost of feeding a hen and the number of eggs that she must produce in order to pay her way are interesting. We have collected data on this question for a number of years, and in general it would indicate that one hundred eggs will pay for the food consumed at market price, allowing thirty cents for labor and ten cents to cover the deaths in the flock. These figures vary a little from year to year according to the market prices of feeds and eggs. Should the death rate be higher than ten or twelve per cent., ten cents would not be sufficient to cover the loss.

The amount of food consumed varies with breeds, and also is in sympathy with the number of eggs produced. Our figures show that the general purpose breeds, such as Plymouth Rocks, Rhode Island Reds, and Wyandottes, consume from eighty to ninety pounds of grain annually, averaging nearly seven pounds of grain each month. Breeds such as Leghorns or Anconas eat from sixteen to twenty per cent. less, or in other words large birds eat more than small ones, and also birds eat most when laying heavily. The amount of food required cannot be stated in ounces for each day, as birds' appetites vary, similar to human beings; but they should always have sufficient food. The writers are of the opinion that there are more hens too lean to lay than there are too fat. Most very fat hens are poor layers, and are better put on the market rather than fed sparingly to try and condition for laying.

Collective Results for 138 Pullets from October 1st, 1909, to September 1st, 1910.

Males	Females	Breed	Eggs Laid	Cost	Average Eggs per Bird	Lbs. Grain consumed	Lbs. Milk consumed
2	23	R.I. Reds	3,318	$29 06	144.2	1,662	2,070
2	23	B. Rocks..................	3,341	27 90	145.2	1,585	2,070
2	23	R. I. Reds................	2,599	25 81	113	1,451	2,027
2	23	B. Rocks..................	3,654	28 44	158.8	1,626	2,027
2	23	B. Rocks (weak)..........	2,182	25 18	94.8	1,374	2,289
2	23	B. Rocks (strong)	2,742	29 62	119.2	1,655	2,401
12	138		17,836	$166 01	....	9,353	12,884

Average cost per dozen eggs for eleven months 11.16c.

Average cost of feeding each bird per month for eleven months 10.06c.

Average number of eggs per bird for eleven months 129.2.

Average amount of food consumed per bird (males included) in eleven months: Grain, 62.35 lbs. or 5.66 lbs. per month; milk, 85.89 lbs. or 7.8 lbs. per month.

Collective Results for 341 Hens and Pullets from October 1st, 1910, to September 1st, 1911.

Males	Females	Breed	Eggs Laid	Cost	Average Eggs per Bird	Lbs. Grain consumed	Lbs. Milk consumed
2	55	B. Rock Hens	5,961	$ 74 92	108.3	4,357	4,787
4	92	B. Rock Pullets	11,928	124 02	129.6	7,042	9,195
5	60	B. Orpington Pullets......	6,401	81 26	106.6	4,805	4,597
6	111	White Leghorn Pullets....	13,504	118 49	121.6	6,739	8,704
2	23	Black Minorca Hens and Pullets................	1,726	32 34	75.0	1,874	2,118
19	341		39,520	$431 03		24,817	29,401

Average cost per dozen eggs for eleven months 13.08c.

Average cost of feeding each bird per month for eleven months 10.88c.

Average number of eggs per bird for eleven months 115.8.

Average amount of food consumed per bird (males included) in eleven months: Grain, 68.9 lbs. or 6.2 lbs. per month; milk, 81.6 lbs. or 7.4 lbs. per month.

Collective Results for 266 Pullets from November 1st, 1912, to October 1st, 1913.

Males	Females	Breed	Eggs Laid	Cost	Average Eggs per Bird	Lbs. Grain consumed	Lbs. Milk consumed
5	105	B. Rock Pullets..........	13,750	$134 54	130.9	7,860	8,323
1	20	W. Wyandotte Pullets	2,247	27 99	112.3	1,670	1,472
1	19	R. I. Red Pullets	2,352	27 26	123.7	1,618	1,499
1	22	B. Orpington Pullets......	2,335	31 70	106.1	1,819	2,214
6	100	W. Leghorn Pullets.......	13,306	107 01	133.0	6,340	5,955
14	266		33,990	$328 50	....	19,307	19,463

Average cost per dozen eggs for eleven months 11.5c.

Average cost of feeding each bird per month for eleven months 10.6c.

Average number of eggs per bird for eleven months 127.7.

Average amount of food consumed per bird (males included) in eleven months: Grain, 68.9 lbs. or 6.2 lbs. per month; milk, 69.5 lbs. or 6.3 lbs. per month.

The following are the averages for the three years:

Average cost per dozen eggs for eleven months 12.1c.

Average cost of feeding each bird per month (males included) eleven months 10.6c.

Average number of eggs per bird for eleven months 122.6.

Average amount of food consumed per bird (males included) eleven months: Grain, 67.6 lbs. or 6.1 lbs. per month; milk, 78.1 lbs. or 7.1 lbs. per month.

Below is given figures as to amounts and kinds of feed consumed by various flocks during the seasons of 1915-16:

BARRED ROCK PULLETS

	No. of Birds	Grain consumed per bird							
		Wheat	Wheat and Corn	Crushed Oats	Bran	Bone Meal	Milk	Grit & Shell	Eggs Laid
May hatched.	100	30.15	10.38	40.66	......	......	65.08	1.89	130.5
April "	160	30.88	18.10	21.02	2.19	1.03	98.09	3.09	152.1
March "	160	32.15	20.9	24.78	2.9	1.2	98.29	3.54	165.
Average........		31.06	16.46	28.82	1.696		87.153	2.84	149.2

A study of profitable egg production is interesting, and below is given the average wholesale selling price of good eggs in Toronto, less two cents per dozen, which is deducted to cover carrying charges, breakages, etc. In figuring the value

Fig. 5.—Percentage egg production by months of three groups of Barred Rock pullets hatched during the months of March, April and May.

Fig. 6.—Percentage egg production by months of two groups of White Leghorn pullets hatched during the months of March and April.

of eggs produced from pullets we deduct five cents per dozen for eggs produced during September and October, owing to the pullets' eggs at this season being small; in other words, we try to give the buyer one and one-half pounds of eggs for the market price of one dozen eggs.

September, 1915	25	cents	April, 1916	20.5	cents
October, 1915	32	"	May, 1916	22.75	"
November, 1915	43	"	June, 1916	24.5	"
December, 1915	50	"	July, 1916	27	"
January, 1916	36	"	August, 1916	28.75	"
February, 1916	25	"	September, 1916	33.5	"
March, 1916	23	"	October, 1916	38	"

A glance will show that the value of eggs produced will depend much upon the months in which they were laid. This naturally leads to a study of the number of eggs laid by various pens. We do not purpose to answer all questions, but we are presenting the percentage egg yields by months of Barred Rock pullets hatched in March, April and May; also White Leghorn pullets' egg yields by months hatched in March and April. These figures should not be interpreted as possibilities of the two breeds, as the strain or selection work might show as great a difference between strains of the same breed. This much, however, appears yearly as a breed character—that Leghorns lay better in the warm weather, and are much more inclined to decrease rapidly in zero weather. "Why?" is another question. The size of the bird may be a consideration, and the writers would suggest to Leghorn breeders a trial on limited number of birds increasing the weight from one-half pound to one pound heavier than that given in the standard.

The March-hatched birds in both varieties were put into laying quarters on September 1st, or at an age between five and six months; the April-pullets were put into the laying pens on October 1st and the May pullets on November 1st. The breeding was very much the same, so that variations due to individuals' sires and dams, while not entirely eliminated, could not be considered very seriously.

Individual matings show that with us May pullets are slower to mature than March or April hatched pullets. No doubt when small flocks receive special care and attention a much better showing would be made by May-hatched chickens. In round numbers we rear one thousand birds in each month, using three separate fields, hence the late birds are not injured by mixing with the earlier ones.

The Barred Rock chart means that the March-hatched pullets produced in twelve consecutive months four dollars' worth of eggs, the April-hatched pullets three dollars and sixty-three cents' worth of eggs, and the May-hatched pullets two dollars and ninety-one cents' worth of eggs.

The Leghorn chart means that the March pullets produced three dollars and twenty cents' worth in eggs, and the April pullets three dollars and six cents in eggs. The total eggs laid by both Leghorn groups is practically the same; the difference in value is due to the season the eggs were laid and the wholesale price of eggs.

These figures are given in the hope that they may suggest, particularly to the specialized poultryman, the necessity of carefully recording his daily, weekly, or monthly records of producing costs and profits. The keeping of poultry as a specialized business means if success is to be obtained a daily or at least weekly record of the loss and profit statement. Success or failure depends much upon these accounts. Yearly statements usually show losses, leaks, etc., too late.

MEAT PRODUCTION.

Most poultry in the end finds its way to market. When one considers that every other chicken reared is a cockerel, and that at least ninety per cent. of these are sold as market poultry, the importance of this branch of the business requires attention.

There can be no doubt that the selling of thin or unfinished chickens is a national waste; and, moreover, when one considers that our large packing houses find it profitable to fatten these thin chickens, there is left no reason why the producer should not do so. The packer buys the feed from the dealer, pays rent for the building, which is frequently located in the city, where rent is high, employs some high-priced labor, and adds to these the overhead expenses; there is but one conclusion, and this is that money is not lost in finishing and fattening chickens.

Feed does much, but the breeding does more. The appearance of the breast or the development of the breast muscles depends more on breeding than on feeding. Hence select sires with long, well-muscled keels or breast bones; not too deep. This is easily done if you will take a few birds and handle them alive, and decide which ones are the best for killing, then dress them, and you will soon be able to select live birds with a considerable degree of accuracy.

A plump, well-muscled chicken always dresses to good appearance. Bare-breasted, crooked-keeled, and thin-legged chickens, no matter how fat, are hard to sell as compared to the well-muscled birds. Every time one breeds an inferior bird just so sure are you that you may expect a percentage of the offspring to be undesirable.

There are so many male birds from which to make a selection that one is surprised to find many bare-breasted males in use.

We cannot urge too strongly the use of pure-bred, strong, vigorous males with good breast development. Even with Leghorns, when the cockerels can only be sold at profit as broilers, the above is in a degree as true as with the larger breeds.

In these days of a shortage of meat the world over, one cannot pass by the question of meat production in poultry.

Figs. Nos. 7, 8, 9, 10, 11 are photos of hens that laid two hundred eggs or better in their pullet year; and Figs. Nos. 12, 13, 14, 15, 16, 17, 18 sons of such hens.

There will be noticed a great difference in shape or type, also that many of them stand somewhat upright and carry rather high tails. Scarcely any of them are what would be called symmetrical.

We have found them to be well muscled on the breast, economical feeders, and hardy. The value of the bird for food is measured by the amount and position of the flesh, not by the arrangement of the feathers and the general outline of the bird. To judge their value one must get below the feathers.

CONSTRUCTION OF POULTRY HOUSES.

The poultry house or pen is essentially an important factor in determining success or failure in the poultry business. Type of house is not so important, as we find poultry thriving and yielding good returns from houses which are distinctly different in type. It is, therefore, very difficult to lay down any hard and fast rules relative to type. The tendency at the present time is towards cheaper houses, with better ventilation. The hot-house style of housing poultry during the winter

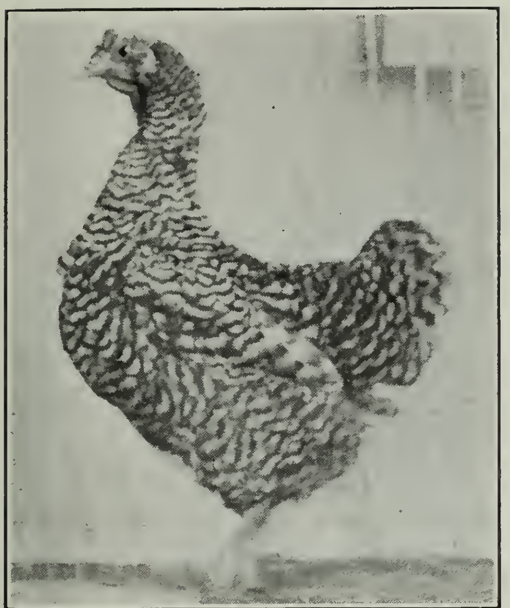


Fig. 7.—A 200 egg hen.

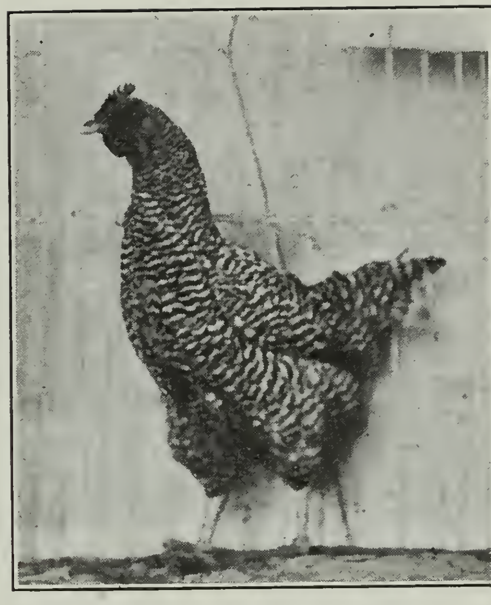


Fig. 8.—A 200 egg hen.
Note the difference in type between
7, 8, 9, 10 and 11.

Fig. 9.—A 200 egg hen.

Fig. 10.—A 200 egg hen.

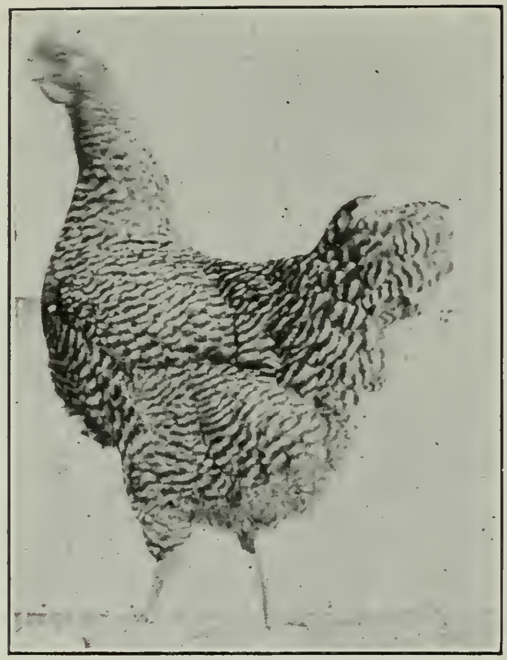


Fig. 11.—A 200 egg hen.

Fig. 12.—A son of a 200 egg hen. Note the difference in type of 12, 13, 14, 15, 16, 17 and 18.

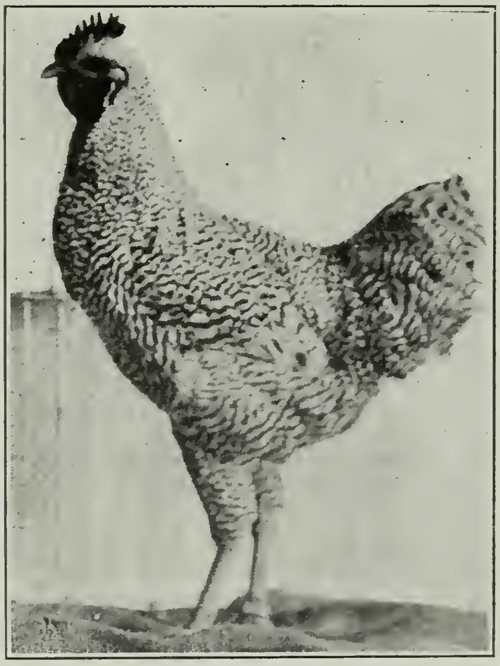


Fig. 13.—A son of a 200 egg hen. Note the high tail nad upright carriage of the body.

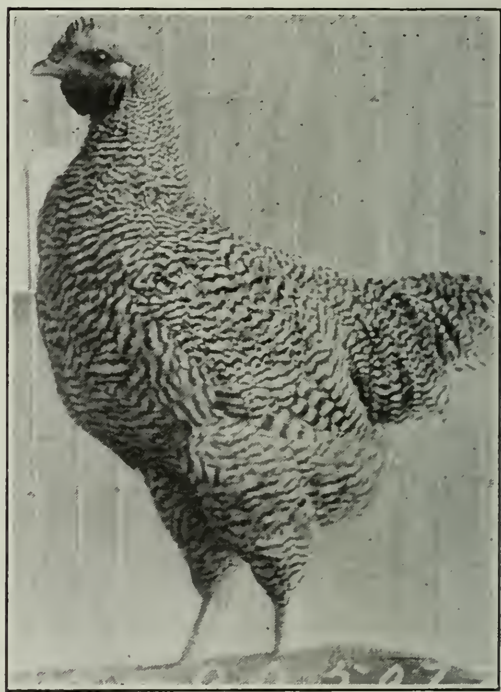


Fig. 14.—A son of a 200 egg hen. Note the low carriage of the tail.

Fig. 15.—A son of a 200 egg hen. Note the very bright eyes and high carriage of tail; also flat breast. Withal this bird was extra well fleshed.

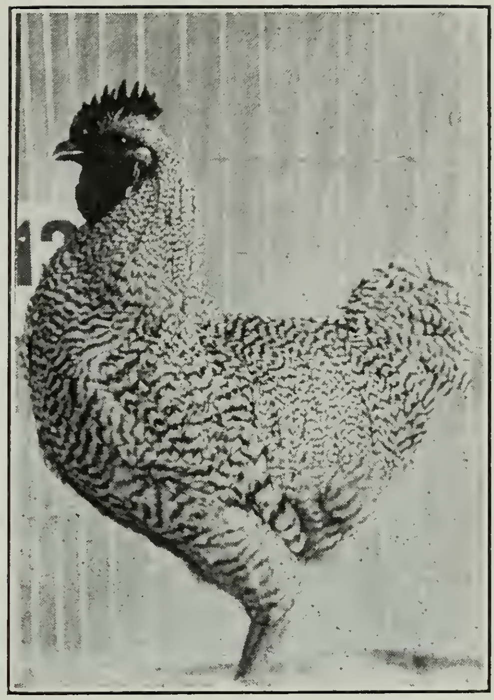


Fig. 16.—A son of a 200 egg hen. One of the very nervous types.

Fig. 17.—A son of a 200 egg hen. A slow developing bird, but very full in the breast.

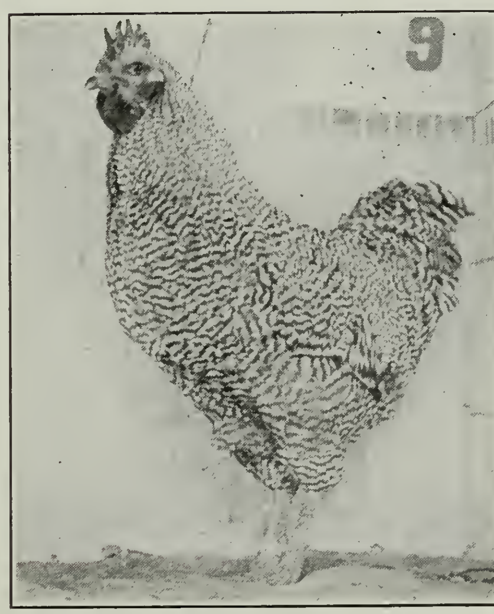


Fig. 18.—A son of a 200 egg hen. One of the real good ones as a combination of meat and eggs. Note the length and width of body and the good vigor.

has not been satisfactory, many houses being damp and the air in them anything but fresh and agreeable. Disease has been quite common, and results in many cases have been disappointing.

Every poultry house should be well ventilated. It should be dry and free from draughts. The sun's rays are very beneficial to fowls, especially during the winter months, hence the house should be well lighted; at least one-third of the south or west side should be of glass or otherwise opened to the sun. It is preferable to have it face the south or south-east. It is best to have the house located in a sheltered

Fig. 19.—Backyard poultry house, suitable for city, town, or village.

situation when possible, as fowls do not like strong winds. As dryness in and about the house is very essential to success, it is advisable to select a location that is naturally well drained.

Bill of Material.

20 pieces 2 in. x 4 in. x 12 ft. rough hemlock—studs, rafters, girts.
4 pieces 2 in. x 4 in. x 10 ft. rough hemlock—plates and sills.
4 pieces 2 in. x 4 in. x 16 ft. rough hemlock—collar ties.
180 feet 1 in. rough hemlock—roof boards and strip on collar ties.
1 1-3 sq. shingles or prepared roofing.
230 feet face measure ⅞ matched sheeting for outside walls, pine.
27 feet ⅞ in. matched flooring, 8 ft. or 16 ft. lengths, pine; drop board.
8 pieces, ⅞ in. x 6 in. x 12 ft. pine, dressed two sides, cornice.
100 feet run ⅞ x 2½ pine, dressed two sides, casings, etc.
60 feet ⅞ in. hemlock, sheeting for inside; for north end.
2 pieces, 2 in. x 3 in. x 10 ft. pine, roosts.
1 sash, 2 ft. 11 in. x 3 ft. 6 in. x 1⅜ in.—9 lots 10 in. x 12 in.
2 sash, 2 ft. x 2 ft. x 1⅜ in.—4 lots 10 in. x 10 in.

Cost of lumber without floor, $28.00.

Bill of Material for Wood Floor.

80 feet face 1 in. matched flooring, pine.
6 pieces, 2 in. x 4 in. x 8 ft. hemlock joist.
2 pieces, 4 in. x 4 in. x 12 ft. runners.

Cost—$5.00.

Cost of cement floor and foundation, $15.00.

College Poultry Houses.

For a number of years we have been trying various styles of houses. The first houses constructed were well built, tight and warm. They were fitted with stoves or hot-water pipes, so that the fowls could be kept at a comfortable temperature. This plan was not satisfactory, mainly for the reason that it was difficult to keep the fowls in good health, and furthermore, the eggs were low in hatching power. The cost of heating was also considerable; in fact, the entire equipment was too expensive to be successful as a business.

It was noticed yearly that the surplus stock held in the cheap houses was much healthier than those fowls kept in warm houses. During the past eight years we have been trying to evolve a house that could be cheaply constructed, that would keep the fowls in good health, and at the same time get a fair egg yield from the fowls so housed.

Several years ago, four houses, representing different styles of popular poultry houses, were constructed. These houses were stocked with birds representing, as nearly as possible, the same strains of the breed. The breeds used were White

No. 4. No. 3. No. 2. No. 1.

Wyandottes and Buff Orpingtons, the one a rose-combed breed, the other a single-combed breed.

The houses are of equal size as regards floor space. Each house is 24 feet long and 12 feet wide. The house is divided by a wire and board partition, making two pens, each 12 feet square. The pens will accommodate from 20 to 25 birds each, or about 50 to the house. Fig. 20 shows fairly well the appearance as regards windows, etc., of the house. The roosting quarters of each house are very similar in construction. A dropping-board is used, which is constructed of matched dressed lumber. The board is placed at the back of the building, and is about three feet above the floor level. The dropping-board is three feet wide. The roosts are made of dressed 3 x 3 scantling, and are placed six inches above the dropping-board.

House No. 1 is made of matched boards, which are dressed on one side. The front and ends of the house are single-ply. The back is sheeted on the inside, building paper being used under the boards so as to make the wall tight or free from draughts. The windows in the house slide back and forth, so that the ventilation can be adjusted to the weather conditions.

Trap-nests are used in all the houses, and are placed at the ends of roosts in section marked "Cock Pen, Fig. 21." In this way the entire floor space of the pen is left for the birds as a scratching pen.

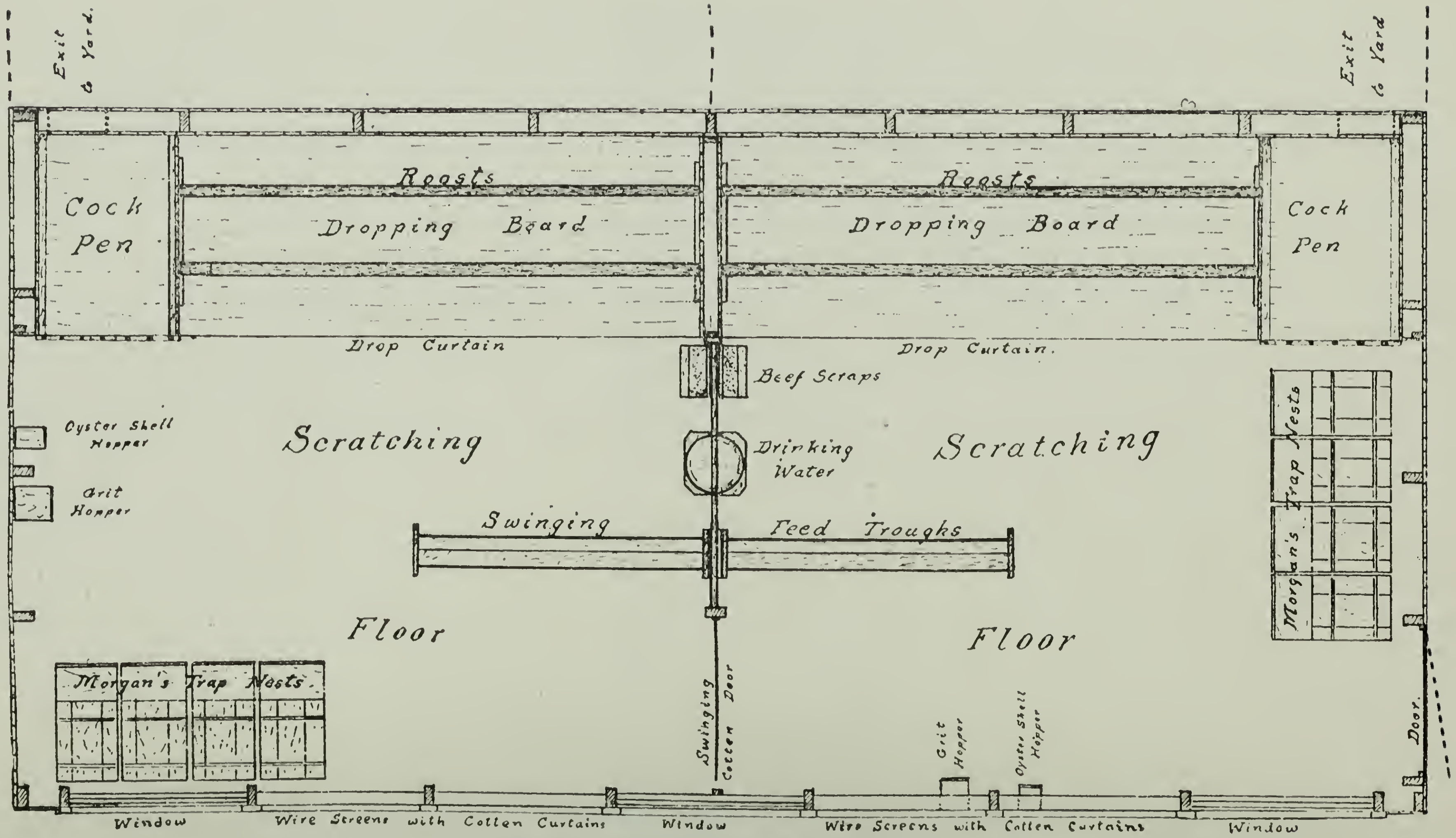


Fig. 21.—Ground Plan of House No. 2.

The general arrangement in the other Houses is much the same.

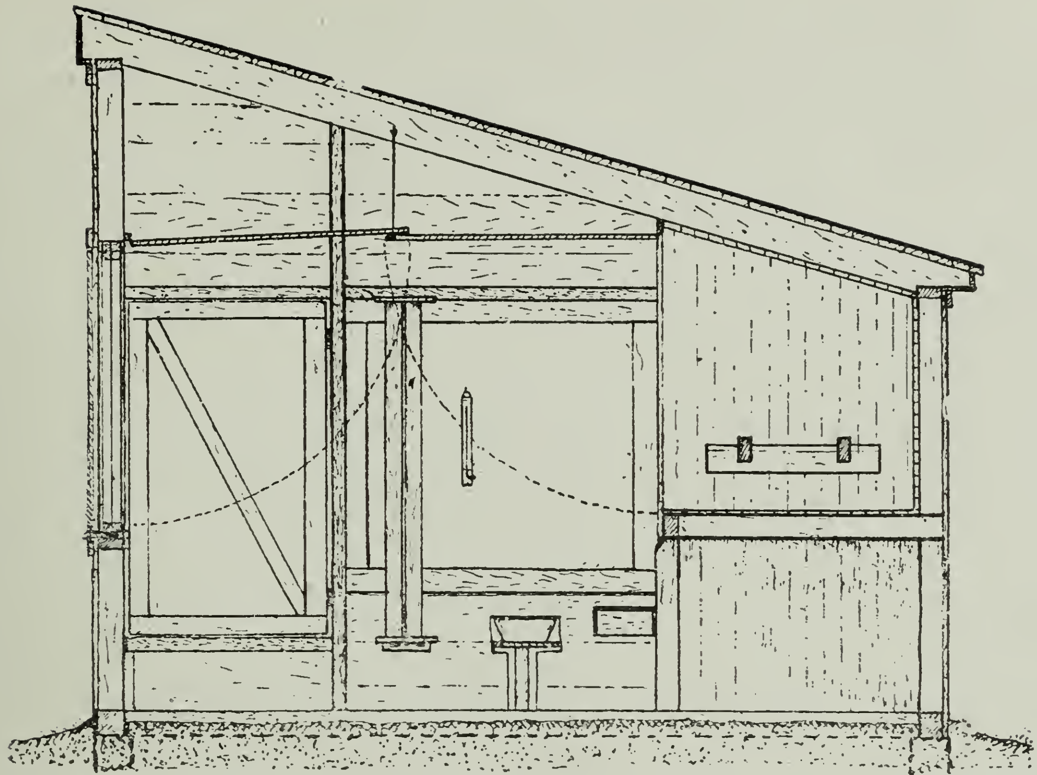


Fig. 22.—Cross section of House No. 2, showing the curtains in position for the day, etc.

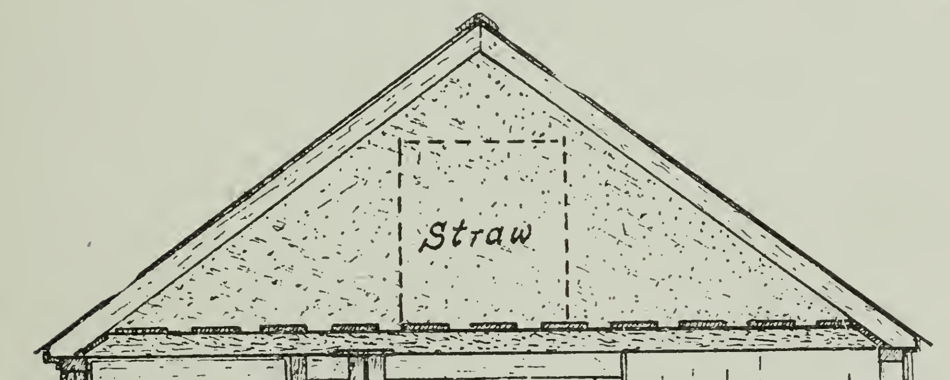


Fig. 23.—Cross section of House No. 4.

The second house is what is known as the "Maine State" house. This house is practically open to the weather on the front or south side. There are canvas curtains, which can be dropped as a protection against wind and snow on stormy days. On other days these canvas curtains are to be rolled up, and the fowls allowed to exercise in the fresh air. The ends of the house are single-ply matched lumber; the back wall of the house is matched lumber lined with paper, and is sheeted again on the inside. This is done in order to make a warm roosting coop.

The third house is the warmest house of the four, and is built of matched lumber and lined with paper. There is a dead-air space between the inside and outside walls. The building is made as tight as possible, the windows, doors, etc., all being made to fit tightly.

Many houses built on this plan are moist inside. To do away with the moisture we have a straw loft. The straw is placed on boards, which are from four to six inches apart. These boards are placed on a level with the roof or ceiling. The straw absorbs the moisture and keeps the house dry.

The fourth house is one of the extremely airy ones, being made of boards that are dressed on one side and the cracks battened; about half of the front is open to the weather, but may be closed on stormy days by large doors. There is not any special protection for the roost, the chickens roosting in this house in exactly the same temperature as they worked in during the day. This house, needless to mention, is much cheaper than the other styles.

The following record shows in a concise form the difference in the percentage of egg production in favor of the cold or fresh air house during the five years for the months of December, January, February and March; the first year being December, 1904-05, 76 per cent.; 1906, 8 per cent.; 1907, 11.8 per cent.; 1908, 15.6 per cent.; 1909, 12.4 per cent.

The house with the cloth front and the one with the movable windows compare favorably with the cold house. There is probably not enough difference in the actual egg production to warrant a statement that either of these houses is very much inferior to the cold house. They are about three degrees warmer than the coldest house and about fifteen degrees colder than the warm house.

These figures must not be taken to mean that hens will lay better in a cold house than in a warm one, but that fresh air is essential to health, and health is a factor in egg production. When one tries to retain the animal heat of the body to maintain the heat of the house, one necessarily allows but little air circulation, hence the air becomes foul or stagnant, which is not healthful.

The above results indicate that the free admission of fresh air is a very essential factor in house construction.

House No. 3 in Fig. 20, which gave the poorest results for each of the five consecutive winters, was operated quite successfully the sixth and seventh winters by introducing more fresh air, that is to say one-half of the windows were removed until about December 1st, and when these were put in, the openings (about one foot square), where the fowls go out into the yard at the north side, were left entirely open. These, except during mild days, appear to supply sufficient air to keep the birds doing nicely. This statement is made as a means of helping any person who may have a similar house, and who wished to continue using the same.

Our experience is that all four houses, while fairly satisfactory, especially No. 4, are not all that may be desired, for the reason that they must be adjusted according to weather conditions—that is to say, on bright, sunshiny days, the doors, movable windows, or cloth screens should be opened for nearly all the day; or, again, for but an hour, depending upon the sunshine and temperature.

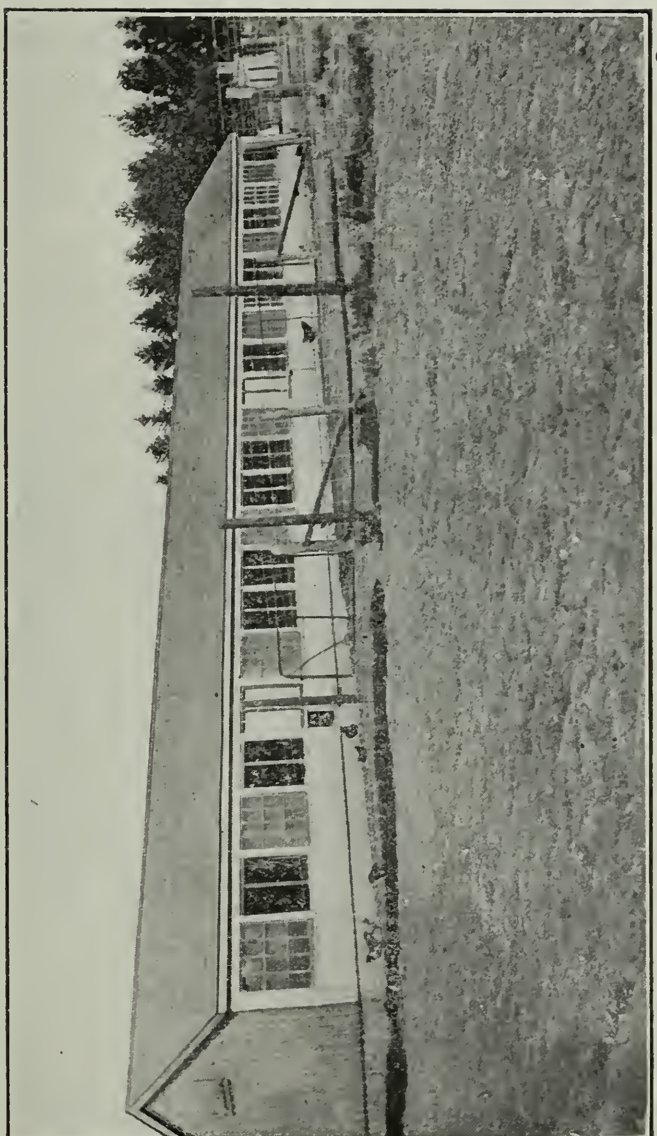


Fig. 24.

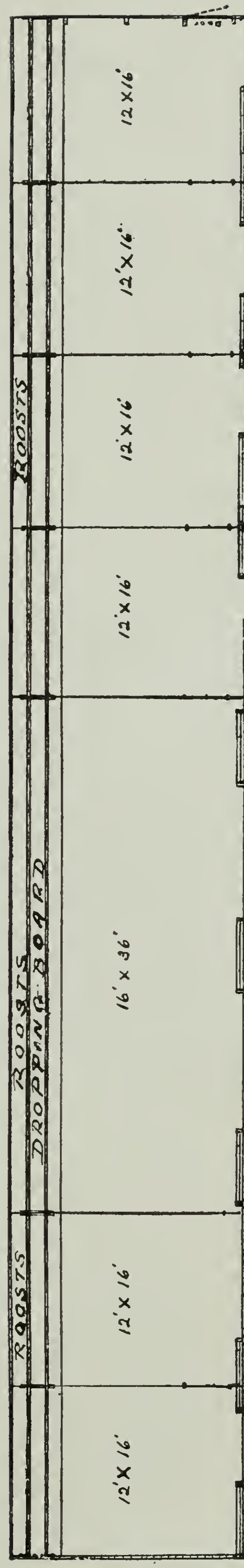

ROOSTS
ROOSTS
DROPPING BOARD
ROOSTS
12'X 16'
12'x 16'
16'x 36'
12'x 16'
12'x 16'
12'x 16'
12'x 16'

Fig. 25.

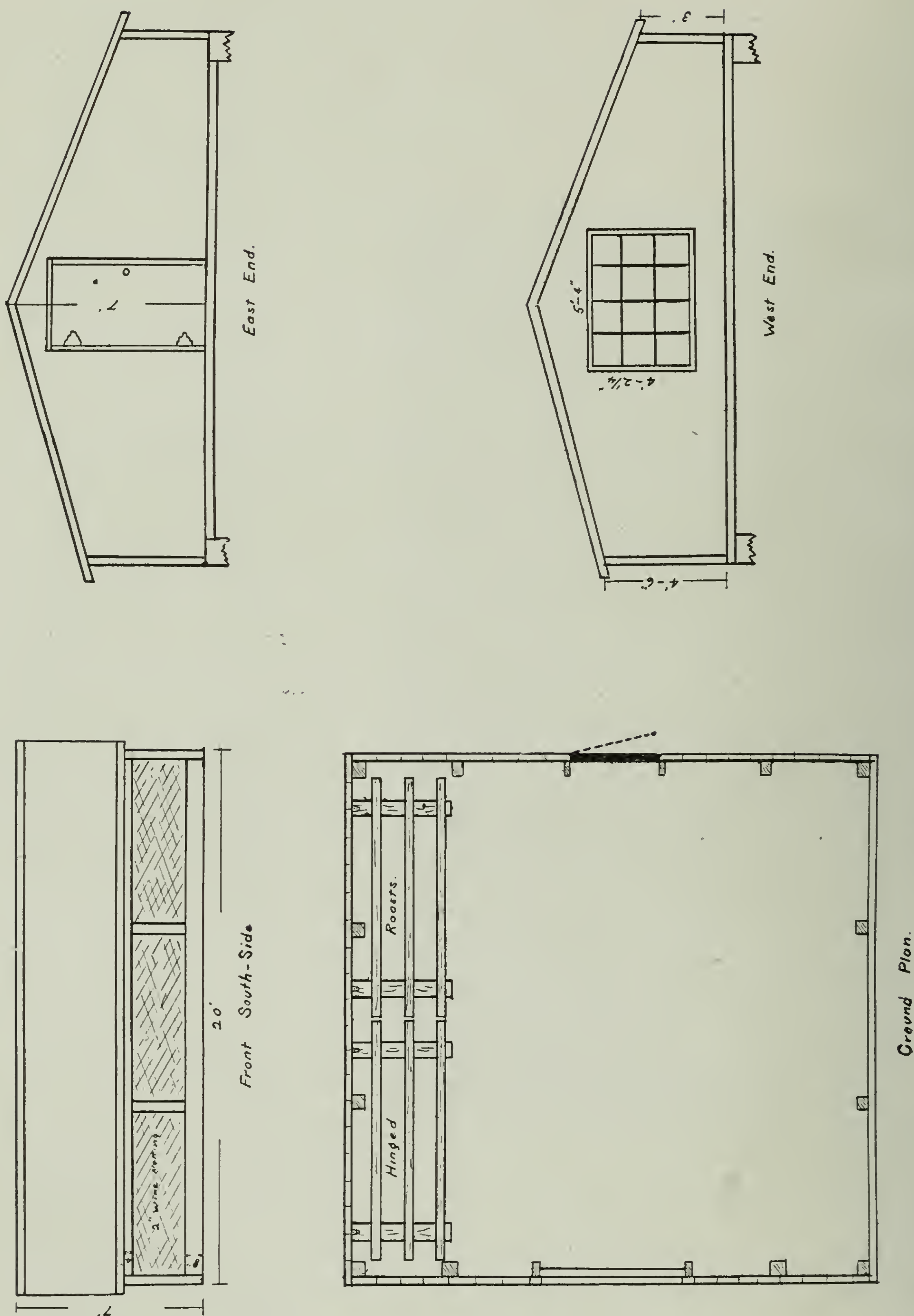


Fig. 26.—Open Front Poultry House.

The slope or shanty roofs on houses Nos. 1 and 2 have not been as satisfactory as the pitched roofs on houses Nos. 3 and 4. The roofs on the latter houses are more durable and the houses themselves much cooler in summer, and furthermore, the straw lofts in these houses are very effectual in preventing dampness in the houses; no frost collects upon the walls or ceilings.

We have tried several houses with curtain fronts, and we are pleased to say they work fairly well when used in a house as in Fig. 24, which is practically the same style of house as No. 4 in Fig. 20, but these require adjusting according to the weather, and if they are not kept brushed, the dust and dirt will gather to such an extent as to prevent free ventilation, so that they will not ventilate very well. Our experience has been that such cloth screens should be of the cheapest cotton; heavy cotton or duck scarcely ventilates at all. There is yet another objection to these cloth screens, in that the hens, especially the lighter breeds, become notionate about trying to lay or roost upon the screens.

To the person who is breeding the tender varieties, or those with large combs, some means must be taken to keep them fairly warm, or their combs will become

Fig. 27.—Open front poultry house.

badly frosted. The females of such breeds as Leghorns or Minorcas will stand a temperature considerably below zero without frosting their combs.

The question naturally arises—can a house be constructed which is nearly self-operating, that will keep the birds in health, and at the same time ensure a fair egg yield?

Our experience has been that the fowls thrive best in low-down houses especially during the winter. We have four houses with the fronts entirely removed, except a two-foot wire netting, which keeps the fowls in, and the sparrows, etc., out. These houses, for this climate, must be low down, especially in front, to keep out the snow and a portion of the wind. It is the writers' opinion that Figs. 26-27 will meet the needs of the average farmer, where he wishes to keep from seventy-five to one hundred hens. The house looks too cold, but the birds do well. They possibly could be made to lay more eggs during the months of January and February with cotton screens properly adjusted to meet the weather conditions; but few farmers would be there at the exact time to do the adjusting, hence we use it entirely open.

The large window in the west, essential for light, should be hinged at the top so that it may be opened during the summer months, otherwise the house will become too warm in summer.

Bill of Material for 20 x 20 House.

6 pieces 2 in. x 4 in. x 14 ft. hemlock sills; if set on post use 4 in. x 4 in.
12 pieces 2 in. x 4 in. x 14 ft. for studding, girts, plates, etc.
24 pieces 2 in. x 6 in. x 12 ft. for rafters and ridge tree.
600 feet of matched hemlock for roof and drop board.
5 square roofing.
250 feet 1 ft. x 10 in., dressed one side, for boarding ends and back.
7 pieces 1 in. x 4 in. x 14 ft., pine, dressed one side, cornice.
8 pieces 1 in. x 8 in. x 14 ft., pine, dressed one side, cornice.
25 lbs. nails—5 lbs. 4 in. nails; 3 lbs. 2 in. nails.

It will be noticed that no dropping-boards are used in this building. During the winter the manure freezes almost as soon as it is made, hence no odor or bad results, and if cleaned, say every two months, it will answer very well. We would rather have this condition than dropping-boards covered one foot deep with manure, as we frequently see them.

A number of houses of this style are in operation in various parts of the province, and they are giving fair results. In some of the colder sections, such as in the district north of Barrie, the house appears to be too open for severe winter weather. In such cases we would suggest using movable cotton screens on two sections of the front. The illustration shows three sections, one of which should always be open. During the winter months the centre screen may be closed nearly all the time and the end screen moved to either side, depending on the direction from which the wind is blowing. We have seen similar houses, two-thirds of the front of which were covered with a cotton frame, which could be thrown on the roof during bright, warm days and let down over the front during the cold nights and stormy days.

In a few cases, open front houses have been built only twelve or fifteen feet deep and twenty or more feet across the front. This is not advisable, owing to the fact that should there be a direct wind blowing into the house the birds cannot get back far enough to be out of the draught. This house is built to accommodate not less than one hundred birds, and will work well with as many as one hundred and twenty-five during winter weather. If a smaller house than the twenty by twenty is desired it should be built, say, twenty feet deep and ten feet wide rather than ten feet deep and twenty wide. The width across the front should never exceed the depth.

Snow will occasionally blow into the house, but we have had very little trouble in this respect. Having the building deep, low, and narrow tends to prevent this. A rather small opening in front will not allow the wind and snow to blow far back into the house, and the depth allows the birds to keep out of the wind. If there is continuous rainy or damp weather for several days the litter will become damp and must be removed at once. Both walls and floor must be kept dry or the birds are likely to suffer from disease of some kind. There should be no opening except that in the front, or there is likely to be a draught through the house, and this should be avoided.

The following is the egg production for 100 April-hatched White Leghorn pullets from November, 1912, to June, 1913 (inclusive). These pullets were housed in an open front house (see Figs. 26 and 27).

		Total Egg Production.
Pullets laying in November	— 71	795
" " " December	— 68	889
" " " January	— 65	753
" " " February	— 74	554
" " " March	— 92	1,765
" " " April	— 99	2,023
" " " May	— 94	1,863
" " " June	— 91	1,688

NOTE.—The winter of 1912-13 will be remembered as exceptionally mild. We have seen the temperature as low as nine degrees below zero inside the house during other winters. Some males' combs will freeze at such temperatures, and, moreover, the egg production is slightly affected for a few days.

In conclusion, we are free to admit that the open front house apparently keeps the stock in better health, brighter in plumage, and it requires less labor

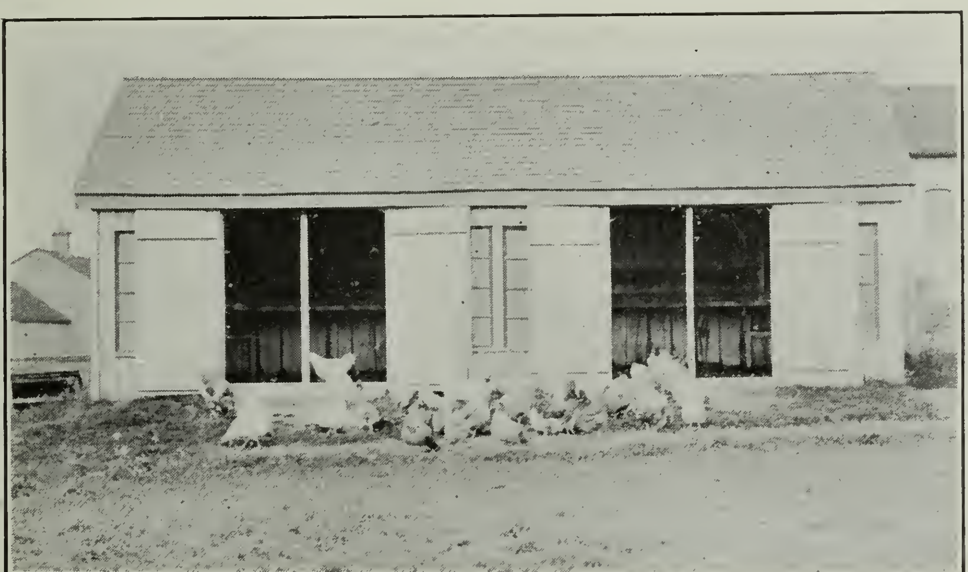


Fig. 28.—House suitable for converting into a 20 ft. x 20 ft., or 20 ft. x 24 ft. House 4, Fig. 20.

than any house we have yet used. It is not perfect, and no doubt could be improved upon for special painstaking poultrymen, but this class is very limited, and the house as now used comes most near to meeting the average man's position.

Those who would prefer something different in type from the foregoing might find it in Fig. 28, by changing the dimensions. The house as shown in cut is 12 ft. x 24 ft. This could be changed to 20 ft. x 20 ft., or 20 ft. across the front and 24 ft. deep from front to back. In altering the house to accommodate it to the above dimensions the door is removed from the near end and the double doors from the front. The centre windows are moved to the place occupied by the double doors, one to each set of doors, and also move the two windows near the ends in to meet those moved from the centre. Then place a single door in the centre of the front. Secure an old window shutter, and place this in the upper half of the door to provide ventilation for the pen. It would also be advisable to place a window of the same size or larger than those in front in the west end of the house and another in the east end. These would increase the amount of light admitted to the pen, and if hinged at the top, could be hooked up to collar joist in summer, thereby getting more circulation of air through the pen in the hot weather and keep the pen cooler.

Long, Continuous House.

No doubt some readers will wish for a plan of a long, continuous house, in which a large number of fowls may be housed under one roof, or where a number of different breeds can be kept in the same building.

Fig. 25 gives the ground plan of this building as now used. The partitions are temporary, made of cloth tacked to wooden frames, and can be moved or adjusted to suit almost any sized flock. This house was originally used for flocks of 50, 75, and 100 laying hens, with the idea of testing large and small flocks. The house was used in this manner for three seasons, with slightly better results from the flock of 50.

The plan as now given accommodates 25 fowls in each flock, with the exception of the large pen, in which can be kept 75 fowls of such breeds as Rocks or Orpingtons, or 90 of such as Leghorns. The large pen could, of course, be divided into the smaller pens.

For the purpose of carrying on more extensive breeding work, a long, continuous house was built in the fall of 1912. This building is 208 ft. long, 12 ft. wide, 8 ft. high in front, and 5 ft. high at the back. The house is single boarded with inch lumber; the cracks battened. It rests on a concrete foundation 8 in. wide at the bottom and 6 in. at the top; the floor also be of concrete 3 in. in thickness. Below the floor is at least 8 in. of small stones, on which was placed enough gravel to allow the laying of the floor. Our experience is that it requires at least 8 in. of filling, such as small stones, etc., beneath the concrete. The studs are 2 in. x 4 in. placed 3 ft. 6 in. apart, and the rafters 2 in. x 6 in. each placed 2 ft. apart.

For breeding work it is often advisable to mate small pens. This house is divided into thirty-two pens, each 6 ft. 6 in. wide, each pen accommodating about eight or ten birds. A dropping-board three feet from the floor is used. There are two roosts, four feet long, to each pen.

A portion of each partition is made movable, so that larger pens may be had should they be required. Four and one-half feet from the back they are of matched lumber and stationary, the balance being of two wooden frames covered with nine-ounce duck. These may be removed at any time, and a number of pens allowed to run together. If this is done, the solid portion of the partition at the back materially assists in checking draughts, which are common in long, narrow pens.

In the front of each pen is a door, and also a window consisting of sixteen lights, 8 in. x 10 in., as shown in Fig. 29. The upper part of the door is of wire netting covered with a movable frame in extremely cold or stormy weather. This style of house should prove useful to poultry breeders. During the winter of 1912-13 the cotton frames were not used the greater part of the time, and we had little or no trouble with frozen combs.

General Rules for Building.

It is necessary to allow from four to six square feet of floor space per bird; the amount actually required depending upon the size of pen and the type of construction. The larger and more open the pen, the less floor space required per bird. Roosting requirements differ with the different breeds. Brahmas, Cochins, and such other heavy breeds require ten inches of perch room per bird; Plymouth Rocks, Wyandottes, Reds, etc., require about nine inches; and Leghorns, etc., about eight inches. All perches should be placed on the level, as in Figs. 29 and 33. Perches where built ladder style will cause birds to crowd for the top perch, thereby causing trouble. Roosts should be made low or near the floor. There are several reasons for this. Birds of the heavy breeds cannot fly high up, and any bird is liable to injure the soles of the feet in jumping down from high perches.

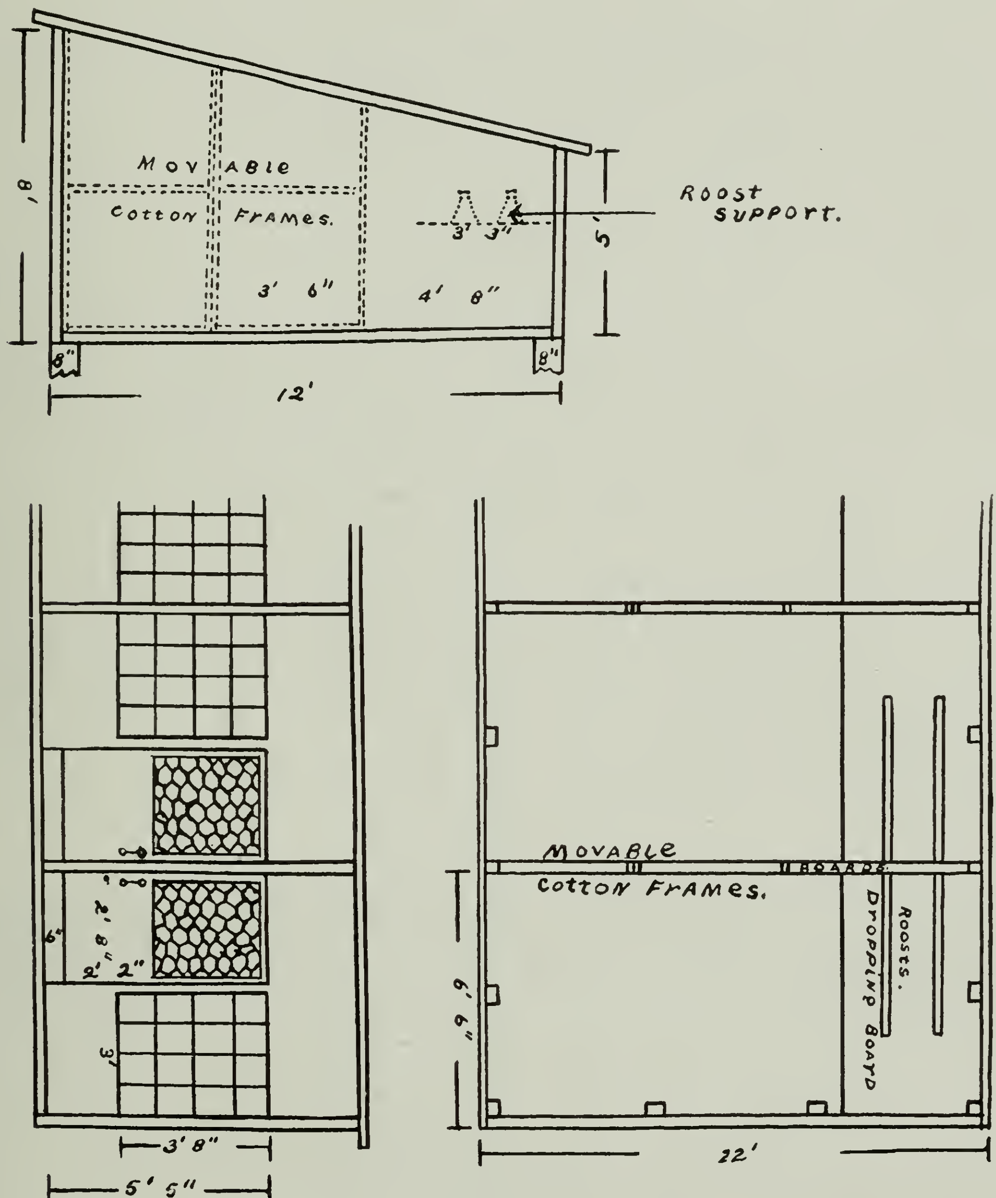


Fig. 29.

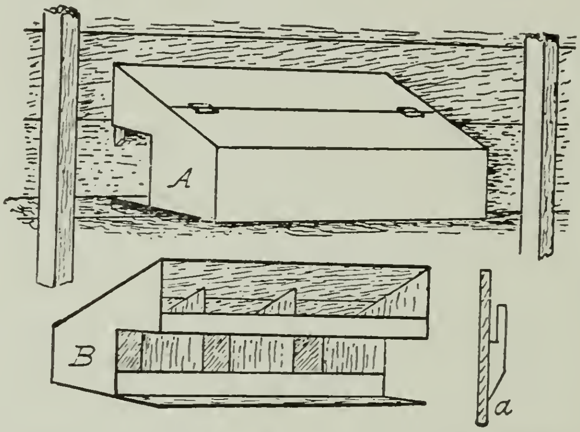
When dropping-boards are used they should be moderately low down to admit of easy cleaning. Dropping-boards should be made of matched lumber, and should be twenty inches wide for one roost and three feet wide for two, the first perch being placed ten inches from the wall and the others at fourteen inch centres.

Roosts 2 in. by 2 in. or 2 in. by 3 in. are preferred, the upper edges to be slightly rounded.

Cement floors are most sanitary, and are easily kept clean. The first cost is possibly high, but their durability commends them to general use. Ground floors are more in favor than wood and cost less. The greatest objection to the ground floor is the excessive amount of dust in the pen therefrom.

Cement floors for best results should be raised so that the surface of the floor is at least eight inches above the level of the ground. The intervening space is filled with cobble stones or coal cinders. A three-inch cement floor will be found heavy enough for the henhouse; two and one-quarter inches of filling and three-quarters of an inch of finish.

Nests. These should be provided at the rate of one nest to every four or five hens in the pen. All types and sizes of nests are used, but with open nests



Figs. 30 and 31.—Front and Back Views of Nests. (*Poultry Craft.*)

placed on the floor trouble may be experienced with the hens eating their eggs. This is overcome by providing nests which are partially darkened, as in the case of Figs. 30 and 31. Raising nests off the floor permits the use of the entire floor space for scratching purposes. All nests should be from twelve to fourteen inches square and not over six inches deep.

Trap-nests. This is a necessary evil where pedigree breeding is to be conducted. Whether it would be advisable for a man to trap-nest his stock will depend

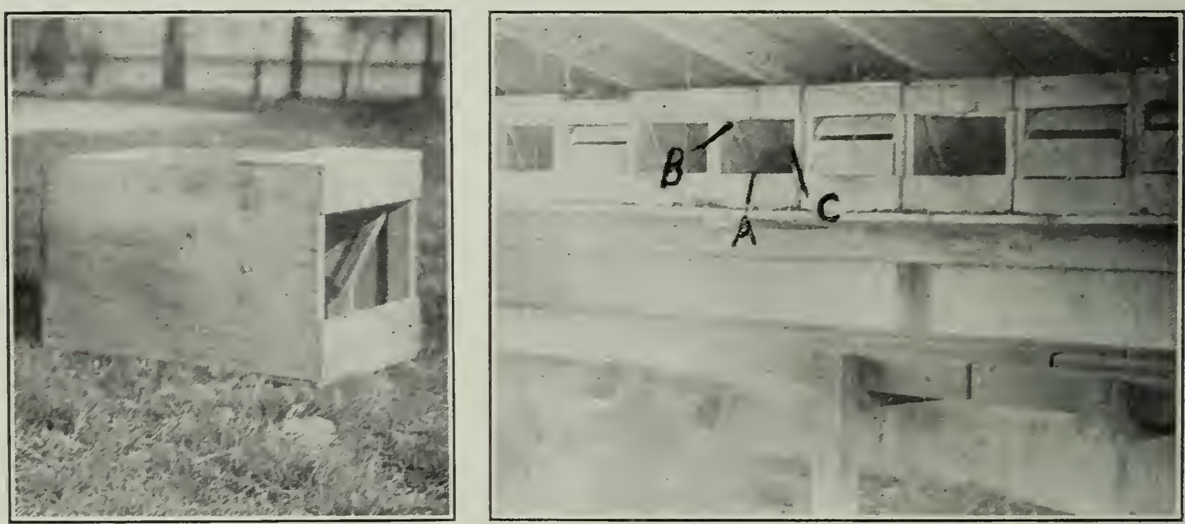


Fig 32.—Trap Nest. Fig. 33.—Trap Nest arranged above the roosts.

upon his object, and the time and expense he is willing to incur in attaining the same. The price of trap-nests vary from eighty cents to one dollar and eighty cents each. The cost of operating the same would be approximately fifty cents per bird per year, which would include the necessary record keeping. Where trap-nests are used they must be visited at one and one-half to two-hour intervals during the day. This is especially important during the hot summer weather, as otherwise birds are liable to die, due to suffocation.

Trap-nests are for the most part patented. The nest which we have used for a number of years, and which we believe is as efficient as any on the market,

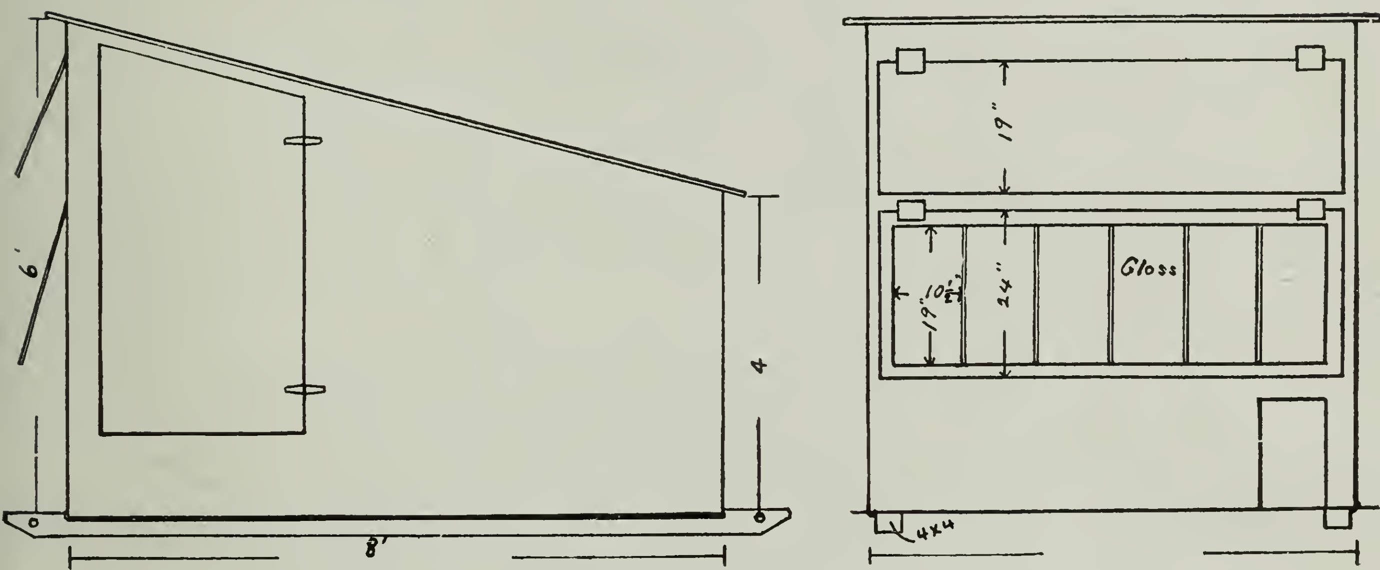


Fig. 34

is the one shown in Figs. 32 and 33. This nest represents in a general way the type of all trap-nests. It is made up of two compartments, with a trap or door on the front end, which closes automatically with the bird's entrance into the nest, keeping the bird captive until released by the attendant.

The nest is constructed of three-eighths inch material, 24 in. long, 12 in. wide, and 13 in. high. A four-inch board is placed across the bottom of the nest

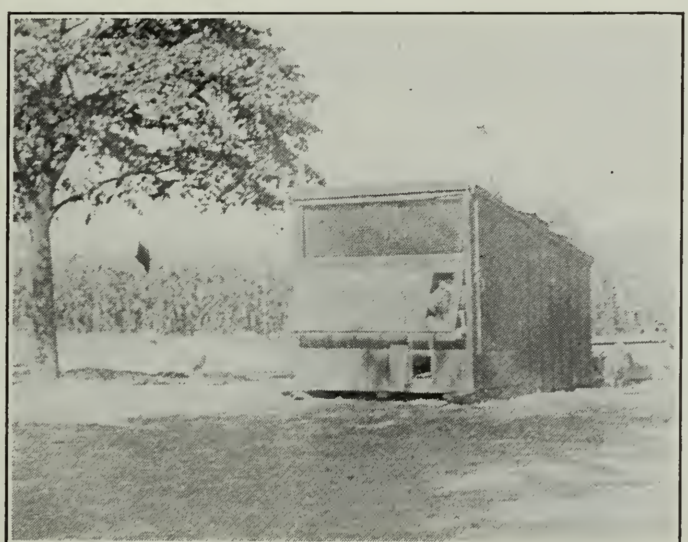


Fig. 35.—Colony House in Fig. 34.

twelve inches from the front, which divides the lower part of the nest into two compartments, the back one containing the nesting material and the front the trap. The trap is eight inches from A to B, and seven and three-quarter inches from A to C. The trap is so adjusted in its attachment in nest that when it is tilted back into nest, resting within three inches of top of centre partition, it is just overbalanced.

The back of the bird coming in contact with it as she steps over centre partition raises the trap sufficiently to tilt it forward, thus closing the trap.

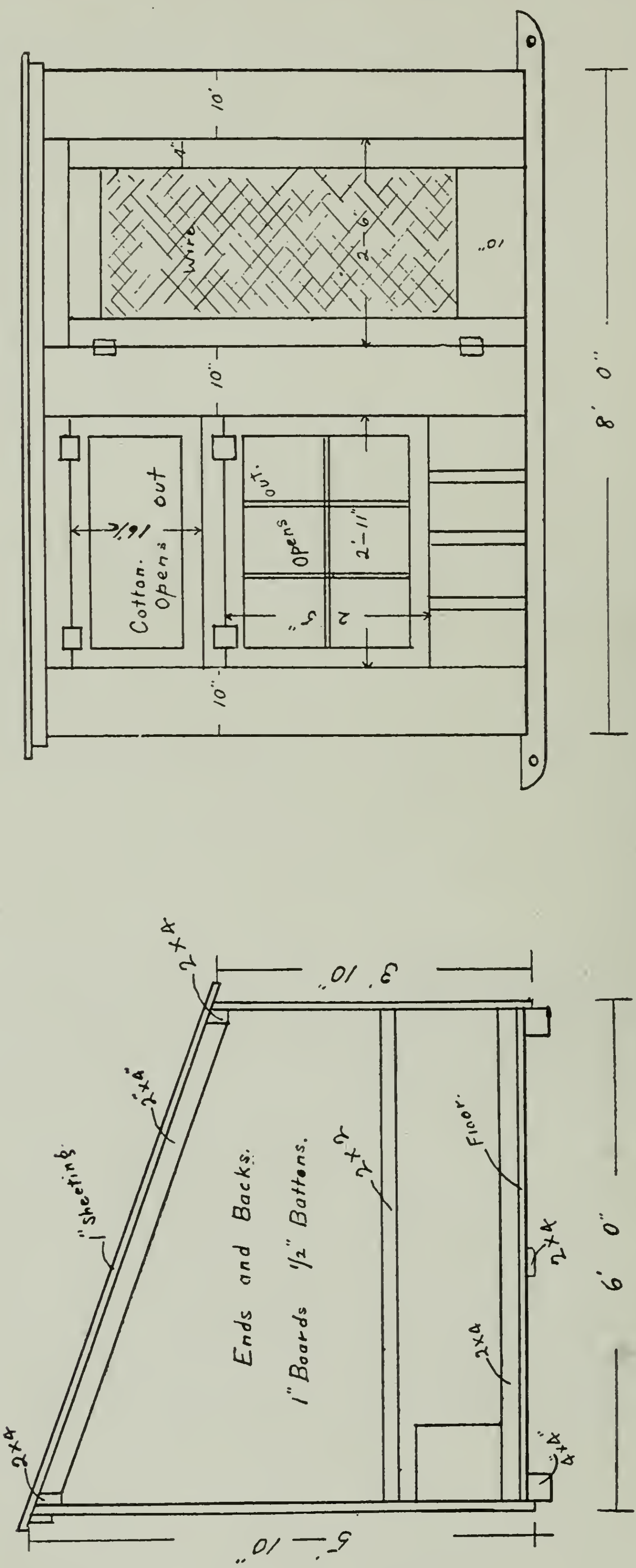


Fig. 36.—Bill of Material for Colony House.

Drinking utensils of some form or other are necessary, and the more simple in construction the better. The writers have found open pens as efficient as any, the size depending on the size of the flock to be accommodated. They should be made of some material which is smooth and as free from seams as possible, to facilitate cleaning, as frequent cleaning of drinking utensils is necessary to prevent them from becoming slimy. In large flocks we have used steel hog troughs, holding from twenty to thirty quarts, with good results.

In our experience the largest egg yields are obtained from flocks containing twenty to thirty birds. Some succeed with sixty to seventy-five in a flock, but they are in the minority. Considering, however, the cost of housing, labor, etc., the most economical returns will be secured from flocks of about one hundred birds.

Colony Houses.

There is a constant demand from people living in towns and cities for plans of houses suitable for housing six to twelve hens. In some instances they wish these houses so constructed that they can be moved easily from place to place.

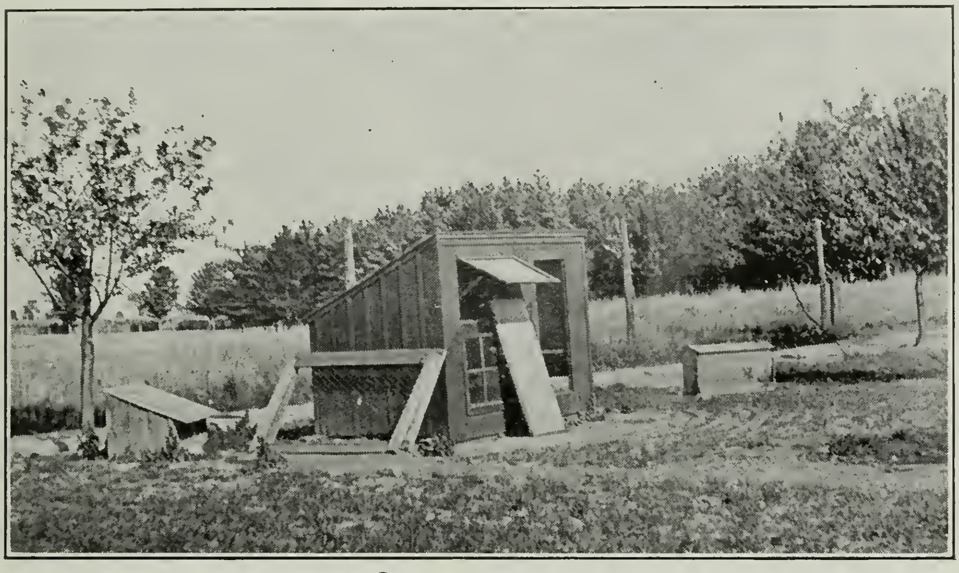


Fig. 37.—Colony House in Fig. 36.

The man who is using artificial means of brooding and raises over one hundred chicks, is finding the portable colony house a valuable adjunct to his equipment, as it enables him to place his young chicks on fresh ground every year.

The plans herewith submitted are adaptable to these conditions, and have been used by the writers for the purposes mentioned above. The houses are of sufficient size to accommodate one hundred chicks to a two-pound weight, or fifty chickens to four or five pounds; but for winter use we would not advise putting in more than a dozen laying hens. (See Figs. 34, 35, 36, and 37.)

Bill of Material for 6 ft. by 8 ft. Colony House.

2 pieces 4 in. x 4 in. x 10 ft., runners.
3 pieces 2 in. x 4 in. x 7 ft. 10 in., plates and centre runner.
2 pieces 2 in. x 4 in. x 5 ft. 10 in., end sills.
2 pieces 2 in. x 2 in. x 5 ft. 10 in., roost supports.
50 feet 1 inch matched flooring.
50 feet 1 inch roof boards.
100 feet run, ½ in. x 2 in. battens for ends and sides.
140 feet 1 in. x 10 in. outside boarding: door, etc.
½ square shingles.
1 sash, 6 lbs., 10 x 12 glass.
1 cotton screen, 2 ft. 11 in. x 16½ in.
1 door, 2 ft. 6 in. x 5 ft. 6 in.
1 cotton screen, fits on doors.

In Fig. 38 is shown a cut of a window adjusted for ventilation purposes. The window is 6 in. from the ceiling and 18 in. from the floor. It is hinged at the bottom and the opening at the top is adjusted with a cord. Burlap is placed along the sides of the open window. A low-grade open burlap should be used. This does not interfere with the light, is not attended with draughts, and gives good

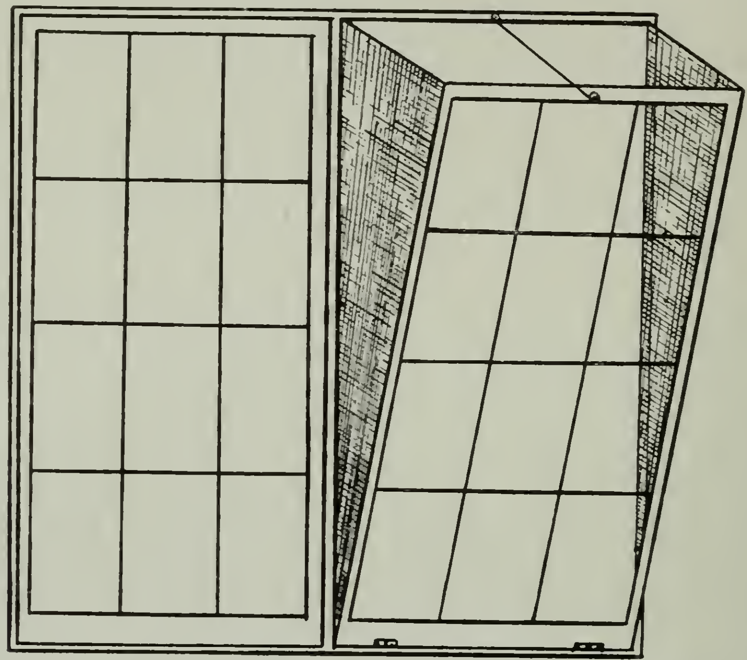


Fig. 38.—Window arranged for Ventilation Purposes.

ventilation. In presenting the above, it is done with the object of presenting a suggestion for the alteration of some house now in use which is not giving satisfaction, at present due to lack of ventilation, as indicated by frost on walls and ceiling. The alteration can be made at a very small cost. and might be preferred by some to curtains.

FEEDS AND FEEDING.

A fowl requires a variety of deeds. While it is true that the whole grains and the milling by-products from the same form the major portion of the bird's ration, it is absolutely essential that they receive also green feed, animal food, drink, grit, and shell-forming material. All these foods must be clean and wholesome, and furthermore, a portion of them should be given in some form so as to induce the birds to take exercise, so that the fowls will keep healthy. The drinking material, which should be given at regular and frequent intervals, may consist of water or milk. The supply must be clean, as dirty water, dirty or slimy drinking dishes, etc., will do more towards making a flock unhealthy and diseased than possibly anything else. Most attendants are inclined to forget to clean the drinking vessels and to keep them well filled at all times.

Grains.

The value of the different grains for feeding poultry varies both with the chemical composition and the physical properties of the same. For instance we find some grains which, considered from their chemical composition, are excellent feeds, but due to the high percentage of fibre, etc., are not satisfactory for feeding in the whole state. Fibrous material is only very slightly digestible by fowl, owing to the structure and actions of the organs of digestion, hence their low feeding value.

Wheat is, without doubt, the most popular whole grain in use by poultry people of Ontario, and is one of the best. It is relished by all classes of poultry. The price of wheat as compared with that of other grains during the past few years, makes it necessary to mix other grains with it. It is very doubtful whether it is advisable at any time to feed only one kind of grain constantly, as a variety is better; some birds like one grain, while others relish another. Plump, soft wheat is usually more palatable for the birds than hard wheats, but the latter may have slightly higher feeding value.

Shrunken wheat, where caused by drouth or frost, has higher feeding value than plump grain, and as it is not suitable for milling purposes can often be economically used for feeding purposes.

Wheat screenings are the refuse from the better grades of wheat, and vary greatly in feeding value. Cleaned wheat screenings are now on the market, but their value for feeding is not yet established.

Wheat bran is used largely as an ingredient of a mash. It is not credited at present with having as high-feeding value as it was once generally thought to have. Its greatest value is in giving bulk to the ration, preventing impaction of crop and stomach, and aiding the digestive juices in their action on the food. Wheat bran is also more or less laxative.

Middlings and shorts vary greatly in composition, hence their feeding value varies. They are useful for making mash mixtures, particularly for fattening. They are good to check looseness of the bowels where an excess of vegetables is given.

Low-grade flour is often a cheap and economical food to use in mashes for stock birds or for fattening chickens. It is more or less constipating, resembling middlings and shorts in its action.

Corn is not used as extensively in Ontario as it is in the Central and Eastern States. In those parts it forms the major portion of the whole grain ration. Corn is more of a heating food, and while very satisfactory for feeding even in large quantities during cold weather, is likely to cause excessive broodiness, especially in the heavy breeds, if fed heavily during the warm weather. It is used whole, ground, and cracked, the meal being used principally in mash foods. Cracked corn is used for young chicks and fowls when scattered in the litter. Whole corn is too large and conspicuous, and when in the litter does not usually give sufficient exercise. In the opinion of the writers corn can be used in those sections of Ontario where it is grown extensively, much more freely than it has, heretofore, been.

Oats should be a first-class poultry food, but owing to the large percentage of hull, which in Ontario and Western Oats varies from twenty to forty per cent. of the whole grain, are not relished by the birds when fed whole, and for this reason are somewhat indigestible. When rolled, hull and all, they are an ideal food as a dry mash and are relished by fowls better than any other dry mash we have yet used.

Oat flour, oat middlings, or ground oats, are a by-product from the oatmeal mills. They do not contain any hull, and are extensively used for fattening chickens.

Barley is most valuable for feeding when finely ground and used as an ingredient in a fattening ration. It contains rather too much hull for feeding in the whole state, and unless very well threshed so as to remove entire beard, it is not advisable to use without grinding.

Buckwheat is very popular as a whole grain in sections where it is extensively grown. It is sometimes difficult to get fowls to eat it at the first feeding. This is easily overcome in a few days if its feeding is continued and other foods withheld. After they once become accustomed to its appearance it is much relished by them. It somewhat resembles corn in its fattening properties, and, therefore, it is better for winter than for summer use.

Ground buckwheat, ground hull and all, is an excellent food to use in a fattening ration.

Rye and peas are not suitable for feeding extensively as whole grains, but may often be used economically if ground and used as ingredients in a mash for fattening purposes. Large quantities should not be used of either as they are each strongly stimulating.

Animal Foods for Fowls.

The most expensive foods given to fowls are the animal foods. These are used as a substitute for the worms and insects that form a portion of the natural summer food of fowls upon free range. Flocks confined to small runs require to be fed more or less animal foods during the winter, and during very long, dry spells in the summer; even where the range is unlimited it frequently pays to feed a little animal food.

Animal foods usually assist very materially in the production of eggs in winter. By some people these foods are considered as a forcing food, that is to say, they will induce heavy laying, which in some instances may be followed by serious sickness, or possibly the injury may be only very slight; in fact, unnoticeable, except that the eggs from birds so fed may be of very low hatching power.

It is generally believed, and we think rightly so, that good egg yields cannot annually be secured without the use of such foods as green cut bone, beef scrap, or cooked refuse meat, etc. Many believe that the larger the amount of these foods fed the greater will be the egg production. There is good ground for doubting this statement, in that these foods are expensive, and the extra eggs may cost more than they are worth. Moreover, here is where serious injury may be done to the hen's digestive and reproductive organs.

Milk is available on many farms, and it is claimed that as an egg producer this food is equal in value to any of the meat foods. Our experience has been that sour milk for fowls has a slightly greater value than sweet milk, and is certainly much more easily obtained.

A few years ago we planned an experiment, with the idea of studying what effect various animal foods would have upon egg production and the hatching power of eggs.

Below is given the results of the first three years' work, that of 1909-10 being carried on with Buff Orpington pullets, that of 1910-11 with Rhode Island Red hens and pullets, and 1911-12 with Leghorn pullets.

There were twenty-five females and two males in each pen, and all were housed in the same building. The grain and green food used were the same in each pen.

The animal foods are reckoned at the following prices:

Buttermilk, 20c. per 100 lbs.; Beef Scrap, \$3 per 100 lbs.; Green Cut Bone, \$3 per 100 lbs.

Experimental Feeding With Buff Orpingtons.

The following are the results for seven months, from October 1st, 1909, to April 30th, 1910:

Pen No.	Animal Food used	lbs. Whole Grain	lbs. Dry Mash	lbs. Animal Food	Total Cost	Total Eggs Laid	Cost Dozen Eggs	Percentage of Eggs hatch'd
1	Buttermilk............	720	233	1,453	$18.16	2,040	10.68	55.0
2	10% dry mash beef scrap	840	337	34	19.85	1,670	14.28	50.5
3	Beef scrap in hopper...	900	216	141	22.21	1,664	15.84	33.0
4	No animal food........	900	224	....	17.99	1,496	15.48	59.5
5	Green cut bone.........	900	196	127¾	21.37	1,654	15.48	40.5

Experimental Feeding With R. I. Reds.

The following are the results of eight months, October 1st, 1910, to May 31st, 1911:

Pen No.	Animal Food used	lbs. Whole Grain	lbs. Dry Mash	lbs. Animal Food	Total Cost	Total Eggs Laid	Cost Dozen Eggs	Percentage of Eggs hatch'd
1	Buttermilk............	973	535	1,765.5	25.60	1,762	17.43	57.0
2	10% dry mash beef scrap	898	535	61.5	23.06	1,320	20.96	56.4
3	Beef scrap in hopper....	907	510	106.0	23.92	1,625	17.66	51.66
4	No animal food........	802	405	....	17.70	730	29.09	66.25
5	Green cut bone.........	784	411	182.5	22.44	1,359	19.81	64.5

Experimental Feeding With White Leghorns.

The following are the results for seven months, October 1st, 1911, to April 30th, 1912:

Pen No.	Animal Food used	lbs. Whole Grain	lbs. Dry Mash	lbs. Animal Food	Total Cost	Total Eggs Laid	Cost Dozen Eggs	Percentage of Eggs hatch'd
1	Buttermilk............	785	319	1,453	$19.46	1,508	15.5	68.2
2	Beef scrap in hopper...	750	205	81	16.76	1,158	17.3	69.2
3	No animal food........	925	126	....	15.77	602	13.4	74.2
4	Green cut bone.........	781	287	98	18.96	1,193	19.4	68.6

Comments on Above Tables.

With all three breeds, buttermilk produced the most and the cheapest eggs.

Where beef scrap was fed in a hopper or where the birds could eat all they desired, the Leghorns and Rhode Island Reds did much better than the Orpingtons.

No animal food in all instances gave the best eggs for hatching and the lowest egg yield.

From the results so far obtained it would appear to be a disastrous practice to undertake feeding Leghorns on no meat food ration, or meat food in very small quantities, for the reason that they developed feather eating to such an extent that some of the birds were killed and the males were a sorry sight; in fact, had to be frequently removed from the pen. This was true to a limited extent with the Rhode Island Reds, but was not so of the Orpingtons.

Green Foods.

When fowls have free range, they eat a considerable amount of grass, or other green foods. It would appear, therefore, to be desirable that where birds are confined, either in small runs during the summer, or in houses when the ground is covered with snow in the winter, some effort should be made to supply this food.

Many foods are available, such as waste cabbage, mangels, turnips, rape, clover hay or clover leaves, and green food grown especially for the purpose.

Early in the fall we use cabbage or rape; or at times where the runs have been sown to fall rye or wheat, the fowls are allowed to feed upon these. Where rape is extensively fed it frequently will cause the whites of the eggs to have a greenish cast, which renders them unmarketable. This food is relished by the fowls, but must be fed carefully. Cabbage at times will flavor the eggs slightly, and if frozen may cause serious digestive troubles. Both rape and cabbage make good green foods, but good judgment must be exercised in their use.

Mangels are a very succulent food, and are relished by the birds during the winter. They can be fed either pulped or whole. When they are fed whole, we usually stick them on a projecting nail, at a convenient height, upon the wall of the pen. When these are fed freely they frequently scour the fowls. For this reason during some seasons we are obliged to feed them not more than twice a week.

Turnips may flavor the eggs. They are not as palatable as mangels; in fact some birds will not eat them at all, but at the same time they have considerable food value.

Clover leaves, either steamed or dry, are relished very much, and upon the whole are a most reliable winter green food. One hundred hens will eat from a peck to a bushel of clover leaves daily. This food upon the farms is cheap and easily procured, and should be fed more than it is.

The growing of green food, *i.e.*, sprouted grains, is becoming quite popular with many, but we have never received sufficient results to warrant our growing it extensively, except for little chicks, although in some cases we have had good results from feeding to laying hens.

The ordinary plan is to soak the grain—oats are preferred—twenty-four hours in a pail or can. The ordinary greenhouse flat is useful for the purpose of sprouting, or any box three to four inches deep and one foot wide by two feet long. The bottom of the box should be perforated so as to provide drainage, otherwise the grain will rot. After soaking the grain for the time specified, spread in the boxes or flats, about two inches deep, and place boxes in a warm place, about seventy degrees or slightly higher, and where there is plenty of light. Sprinkle the grain regularly once a day until sprouted sufficiently to use. Most feeders allow the grain to grow two or three inches before feeding, which under ordinary conditions should take from ten to fourteen days.

Dry Feeding.

The tendency at the present time is to feed dry grain, and to use no wet mash foods. It has been claimed by some writers that mash foods, while tending to force growth, and possibly egg production, do not tend to produce good eggs for hatching purposes; that is to say, the mash is more or less of a forcing food. In the production of eggs, the number produced is probably as large, if not larger, where mashes are used, but the hatching power of the eggs in some instances is not as high. During the past two or three years we have not fed any wet mashes to our breeding birds, and have fed in place some sprouted grain, but mostly rolled oats in hoppers. As far as we can see at the present time the sprouting does not improve the feeding qualities of grain very much, with the one exception of oats. The palatability of oats is increased considerably. We have made the oats equally palatable by having them rolled or flattened, that is the hull and all.

Feeding when Wet Mashes are Used.

The general method of feeding is to give a mash of mixed ground grains, moistened with water or milk, in the morning; a little whole grain scattered in the straw covering the floor, at noon; and all the whole grain they will eat at night. This latter meal is usually fed in the straw. Some poultry men adopt the plan of not feeding the mash until evening. We have been practising this plan for some time and like it very well. The objection to the former plan is that the hen is likely to become gorged with food early in the morning, and thus take to the roost for the rest of the day, which is usually followed by hens becoming too fat, and the egg record becoming small; but, notwithstanding, many successful poultrymen use this method to advantage. The objection to feeding the mash at night is that it becomes quickly digested, and the bird has not sufficient food to last it during the long winter night; but this objection can be overcome by giving a little whole grain after the mash at night.

Some poultrymen feed their fowls but twice a day, morning and evening, and get very good results; but we favor feeding three times a day. Our plan is somewhat as follows:

Early in the morning the fowls are given half a handful each of whole grain. This is buried in the litter on the floor. Thus the fowls get exercise (a very necessary thing) in scratching for it, and at the same time keep themselves warm. At noon about two handsful of grain are given to a dozen hens in the litter. They are also given all the roots they will eat, either pulped or whole, as fowl relish mangels, sugar beets and turnips. Cabbage also—a very good green food—is sometimes given. About four o'clock in the afternoon they are fed a mash composed of equal parts of bran, shorts, oat-chop, and corn meal (during cold weather), and to this is added about ten per cent. of animal meal, if we have no cut green bone or cooked meat. These foods are thoroughly mixed together in the dry state, after which is added steeped clover, which has been prepared by getting a bucket of clover leaves, or cut clover hay, and scalding it with boiling water. This is done early in the morning, and the bucket kept covered with a thick sack throughout the day. This will be quite warm at night, if it has been kept in a warm place. There is usually sufficient liquid to moisten the meal that has been mixed. Our aim is to have about one-third of the ration, in bulk, of clover. After the mash a small amount of whole grain is fed in the straw. There is—and should be—a plentiful supply of good, *pure water within easy reach at all times.*

To those who keep but a dozen or so fowls, or to those who wish to economize in the feed bills, by using table refuse, such as bread, meat, vegetables, etc., the wet mash system is commendable, in that these cheap by-products, if clean and cooked, make excellent mashes, when dried off with shorts and bran or other chop. This kind of mash usually gives excellent egg yields, and the labor entailed is not a serious consideration, under the above conditions, but it is, at times, where birds are kept in large numbers.

Method of Feeding the Winter Laying Stock at the O.A.C.

We try to simplify our methods and use only common foods, and at the present time we are using as whole grains, wheat and corn. Buckwheat and barley, if available, locally, at economical prices, would be used to supplement the other grains mentioned. Wheat and corn are fed in about equal parts both morning and evening. The corn is cracked before mixing with the wheat so as to render particles of grain more uniform in size, and hence secure more balanced feeding by the birds. All grain is fed in the litter of straw or shavings on the floor of the pen, thereby inducing the birds to exercise. At noon we feed mangels, cabbage or clover hay as green food. Rolled oats are kept constantly before the birds in hoppers, as is also grit and shell material. Buttermilk or soured skim-milk is the only drinking material given when a supply is available, while at other times water is given.

Method of Feeding the Summer Laying Stock at the O.A.C.

At the present time our plan of feeding is to scatter whole grain in the litter, both morning and evening. The grain used is wheat almost entirely. Buckwheat, barley, oats and corn are occasionally used to supplement the wheat. Green food in the form of rape, grass, or green oat crop, grown in the runs or as a soiling crop, is constantly supplied. Sour milk or buttermilk, when available, is given as drink, while at other times water is provided.

INCUBATION.

This is a very interesting topic. Here we are dealing with the renewal of the flock. This has been to the larger grower a difficult problem, and to most farmers and small growers, comparatively easy. (It is apparently easy for the farmer to hatch and rear one hundred or more chicks, and very difficult to get hens to lay during the winter. The larger grower can usually get a fair production during the winter, if he can get the chicks out and well grown.) There are so many factors that may influence the hatch and the vitality of the chicks, that it is at times an impossibility to say why one fails and another succeeds.

The first essential to successful incubation is good, hatchable eggs. The hatching power of eggs is apparently influenced by the parent stock, not only in the present generation, but possibly for generations back. Granting this, we must, then, use only the strongest and best birds as breeders, and if a rigid culling is followed annually, it is our belief that gradually, but surely, the problem will become less difficult. Then, again, the methods of housing and feeding are factors. Birds kept in ill-ventilated, damp houses, or under any unsanitary conditions, are lowered in vitality or vigor, which of necessity must be more or less imparted to the germ of the egg. It has been shown under the discussion of foods that the hatch is influenced by the feeds.

The farmer's flock is usually strong and rugged; it has plenty of exercise in the fresh air, and, moreover, is seldom kept in such numbers that the ground about the buildings becomes seriously contaminated. There are, of course, some exceptions to the above statement. Fowls upon the farm are very seldom extensively fed upon meat, or what may be termed forcing foods. Then, again, the unlimited range and the great variety of foods available make the conditions upon the farm excellent for the production of good, hatchable eggs. If more attention was paid to the selection of the males, the results would be improved. The selling of the largest and earliest maturing males, and the breeding of the late hatched, immature, ill-nourished males, is not conducive to progress, to say the least.

The difficulties of the large growers are mainly due to bad housing, yarding, and feeding. Many houses are poorly ventilated, and the yards are small, and the fowls are on them constantly, and are, therefore, in an unsanitary condition; and, furthermore, the lack of a variety of foods and exercise, and the use of animal foods, are also more or less injurious. All these conditions are largely under our control, and many of the failures in the past appear to be directly due to a too intensified condition. It has been many people's idea to see how many hundreds could be kept on the least acreage of land.

Natural and Artificial Incubation.

Whether it will pay to buy the incubators and brooders depends largely on one's circumstances. Where chicks are wanted in considerable numbers, earlier than April 15th, an incubator becomes practically a necessity, as it is seldom that hens become broody in numbers until after the 1st of April. Again, where one wishes to hatch more than one hundred and fifty chicks, an incubator is, in many cases, cheaper and better than the natural methods. It is also a necessity where one is breeding from the non-setting varieties.

There are numerous illustrations of chicks being raised in large numbers by the natural method in the States of Rhode Island and Massachusetts, particularly in the former State. Where this method is followed, the chicks are hatched largely during the months of May and June; and where from five hundred to one thousand five hundred laying hens are kept, there is little difficulty in getting a sufficient number of broody hens. Those who are keeping large numbers of hens appear to be well satisfied with the natural method; but there can be no doubt but that the number of incubators in use is increasing from year to year.

The average hatch is probably one chicken from every two eggs set. This, of course, varies with the different seasons, also with the percentage of fertile eggs, and the strength of the germ. We have found during the months of February and March, when the ground is covered with snow and the fowls are closely housed, that the percentage of fertile eggs is small, and that the germs are very weak. Under such conditions we have very poor hatches and chicks that are very hard to rear. Much better eggs are obtained in December and early January, or when the fowls get out into the fresh air and are able to pick some grass. Thus it will be seen that, as a general rule, as the percentage of fertile eggs increases, the vitality of the germ increases, the percentage hatched is larger and the mortality among the young chicks smaller. For example, we would expect to get a much larger percentage hatch of the fertile eggs from eggs that were 90 per cent. fertile than from those that were sixty per cent. fertile; and, moreover, we would figure on raising a much larger percentage of chicks from the former eggs than from the latter, owing to the chicks being stronger and having greater vitality.

Setting the Hen. It is generally agreed that, in order to secure a good hatch, the hen must be placed where other hens are not likely to disturb her; for, as a rule, we seldom get good hatches when other hens lay in the nest with the sitter. Some farmers do not set a hen until one becomes broody on a nest where no others lay, which often necessitates late chicks. The difficulty can be overcome by making a new nest for the broody hen. Get a box about twelve inches square and six inches deep; put some earth, or an overturned sod in the bottom, taking care to have the corners very full, so that no eggs can roll out from the hen and get chilled; next, put on about two inches of straw or chaff; and then put a few earthen eggs into the nest. Place the nest in some pen where nothing can disturb the hen, and put her on after dark. Feed and water must be within easy reach, and a dust bath should also be convenient. If the hen is sitting quiet the next day, you will be safe in putting the eggs under her. In our experience we get 90 per cent. of the hens to sit by following this method.

It should be remembered that the hen will be in better condition if dusted with insect powder when set, and also a few days before the hatch comes off. This will usually keep the lice in check, especially if some tansy or mint leaves are used in making the nest.

Artificial Incubation.

During recent years many incubator experiments have been conducted here, as well as at other colleges, and some progress has been made. It is our purpose at this time, not so much to go into the details of these, but to give, if possible, the best methods we know that can be used by the average person.

Selecting an Incubator. There are many makes of incubators on the market that do fairly good work; they are not perfect, nor have they the hatching power of a normal hen, but then they are always ready to hatch eggs any day of the year, and by their use eggs can be incubated in large numbers. They do not get balky and cease hatching as some hens do—that is, unless the operator fails to do his part. Commercially they are a necessity. To the prospective buyer I would suggest the purchasing of a well-built machine, one that is double cased, and that is easily cleaned, and whose fixtures, such as the lamps, etc., are convenient. We do not know which is the best incubator made.

Recent scientific investigations indicate that it is probable, in some instances, that disease organisms, found in dirty incubators, cause serious harm. Our plan —no matter what the type of machine—is to thoroughly wash the entire interior of every machine before putting in the eggs for hatching. We use a ten per cent. solution of a tarry compound, such as creoline or zenoleum. This helps to clean the machine, and if applied hot, so much the better. We have obtained best results by using water or moisture during the entire hatch. I have seen good hatches from incubators where no moisture was used. We use a pan beneath the egg-tray, nearly the full size of the machine, and keep this pan covered with water, or wet sand, not more than one inch in depth.

Many incubator thermometers are not reliable, and it is, therefore, advisable each season to have the thermometers tested. Any druggist will have a registered thermometer, and can do the testing if the owner does not wish to.

The hatch is made or lost usually during the first week of incubation. Keep the temperature well up to 103 degrees, with the thermometer lying on the eggs, and maintain as even a temperature as possible.

Do not set dirty, washed, small or extra large eggs. The shell is porous and disease germs that may be on dirty eggs might infect a number of eggs. Do not turn the eggs when your hands are dirty, or immediately after handling lamps or kerosene.

The room in which the machine is operated should be clean and well ventilated. If possible, select a room that varies but little in temperature; in such a room it is easier to keep the hatching chamber of the machine at an even temperature. Where there is a strong odor of lamp fumes, or where there are decaying vegetables, or where moulds grow upon bits of boards or upon the walls, an incubator will not usually do good work. The lamps burn brighter, the eggs hatch better, and the chicks have more vitality when the air in the incubator room is pure.

Operating the Machine.

We have obtained the best average hatches and the best chicks, other things being equal, operating the machines at 103 deg. F., with the bulb of the thermometer resting on the top of an egg; not at the side of an egg nor at the bottom. This heat is maintained throughout the hatch. We are particular to set clean eggs, usually not over two days old, which have been held at a temperature between 55 and 75 degrees. The eggs are best put in the machine in the morning; then the gradual heating of the eggs goes steadily on during the day, and by night we know that the machine is not too hot or too cold. Moisture is used from the start; we are more particular about moisture the first week of the hatch than at any other period. No ventilation is given until after the ninth day of incubation. Our best hatches in nearly all instances are from machines operated at a very even heat, with plenty of moisture, and little or no ventilation up to the ninth day. After this period the eggs need plenty of air and the ventilators opened gradually until wide open at hatching time. The hatch appears to be made or lost during the first week of incubation.

We do not like to let the chicks off the trays or down in the nursery. If they pant, it is nearly always from a lack of air; in such cases we open the door slightly or sufficient to keep the chicks comfortable.

REARING CHICKENS.

Experience would indicate that the best results in rearing chickens are secured where a good soil is used. Light, sandy soil, while draining readily and thus keeping more sanitary than a heavy soil, will often not produce sufficient succulent growth for green food. A heavy, wet soil is to be avoided, as chicks do not thrive well and there is great danger of disease. A combination of high and low land is possibly nearer ideal, using the high land upon which to locate colony houses or coops and the low or bottom land to provide forage. If a never-failing stream flows through the bottom land, as shown in Fig. 39, the location would leave little to be desired.

Growing chickens require plenty of free range. While it may be possible to grow chicks to maturity under intensive conditions, there is a strong tendency to dwarfness and lowering of constitutional vigor, even although in time the chickens may attain full weight. Continued breeding from such stock and rearing under such conditions will, in a comparatively few years, so lower the vitality of the stock that the eggs will become unhatchable. Overcrowding at any and all times is to be avoided. Free range, with plenty of shade, such as a corn crop,

Fig. 39. A Good Location for Rearing Chicks.

orchard, shade trees, or artichokes, and plenty of tender green food and insects will do much towards insuring an economical and vigorous crop of chickens.

Chickens which are taken from the nest or incubator should be put on fresh soil, if at all possible. One should endeavor to so rotate the crops that chickens will not be on the same land year after year. During the first few weeks a chick is out it does not require a large run, but care must be exercised not to keep them confined in small runs long enough to check growth in the slightest degree.

Early hatched chicks will often do better if placed on a grass sod. Late hatched chicks should not be placed on old, tough sod, as the vegetation is so coarse and tough that the young chicks are unable to eat it. In the writers' opinion,

Fig. 40. Good Range for Chick Rearing.

chicks after the middle of May do best on cultivated soil or where their range includes such. The young weeds or plants growing in such a location are readily eaten by the young chicks. If the land is bare of vegetation, a little lettuce, rape, or sprouted oats will be greatly relished by the chicks, and prove very beneficial.

A corn field or cultivated orchard approach very nearly ideal as locations for raising chickens, as they provide shade, fresh, tender vegetation, and a considerable quantity of insect life.

Many people experience much greater difficulty in operating brooders than incubators, and hence prefer to raise the incubator chicks with hens. There are others who have an incubator, but do not care to invest in a brooder. In either case the writers would advise the use of broody hens.

Where it is intended to use broody hens to rear incubator chicks the best plan is to give the hen two or three eggs out of the incubator on the eighteenth day. When the hatch in the machine is completed, take fifteen chicks and give them to the broody hen at night. Little or no difficulty will be experienced in getting her to take them, even if there may be more than one color represented. Seldom will she take them satisfactorily if given to her in the day time. Hens which are to be used for rearing chickens should be well dusted with good insect powder before starting. There is possibly no more potent cause of mortality in hen-hatched chicks than lice.

There are many good brooders upon the market which are well described in the manufacturers' catalogues; hence a description here is unnecessary. The brooder lamp should always be constructed and arranged as to give little chance of fire.

If the brooder can be placed in a small portable house it is a good plan, as the brooder is thus protected from stormy, cold winds in early spring; also from the heat later on. The house protects the chicks from the weather better than a coop would, and serves as a roosting coop after they become too large to stay in the brooder.

This coop can be closed at night so as to keep out all animals that might destroy the chicks. The wire front is necessary to supply an abundance of air.

The movable front is a great convenience when the hen is running at large during the day.

The coop is two feet high in front, fifteen inches high at the back, and is two wide by three in length. The wire portion is one foot in width.

In brooding chicks, artificially, one of the most difficult features to control is the temperature. While it is true, that all brooders on the market at present are fitted with automatic regulators, they are not absolutely dependable. In cold weather there is constant danger of chilling of chicks, while in hot weather fires are liable to occur if the lamps are not watched closely. Only the best grade of kerosene should be used, and the lamps trimmed and cleaned frequently. In hot weather it is advisable to lower the flame in the morning and turn it up again in the evening to prevent fire. In the writers' opinion lamp brooders are not safe to use after the end of May.

We try to keep the temperature of the brooder between 95 and 100 degrees (at chick level) throughout the first week. A good guide is to have the brooder just warm enough so that at night chicks will sit around the outside edge of hover with their heads sticking out through the curtain surrounding it. Be careful not to get brooder too hot nor yet too cold, as either extreme is serious and affects the vitality of the chicks. This is very important, especially during the first two weeks. After the first week the temperature is gradually lowered, generally speak-

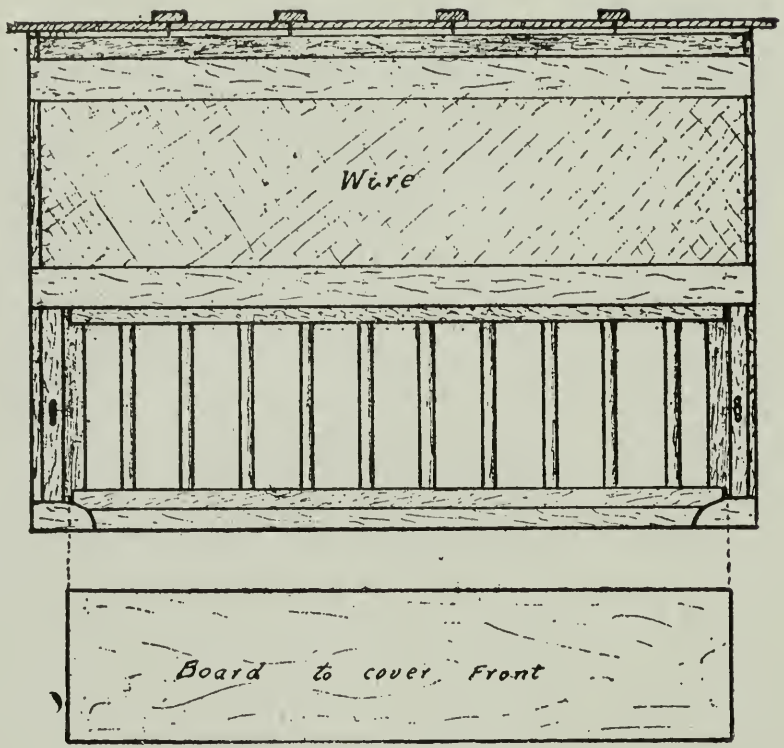


Fig. 41. Front of a Convenient Coop for Hens and Chicks.

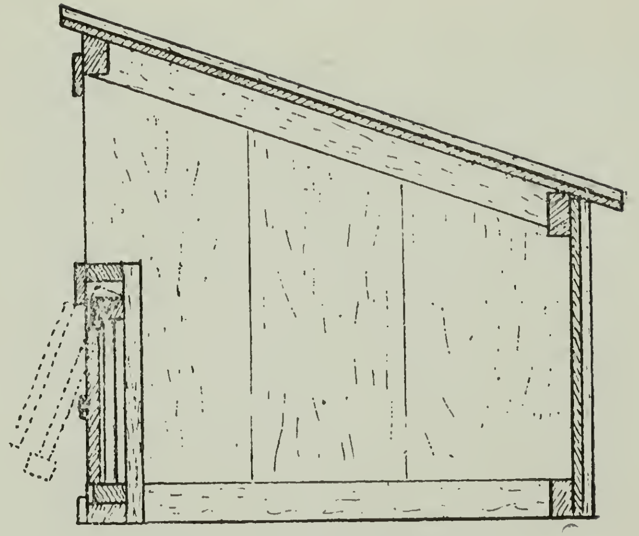


Fig. 42. Cross Section.

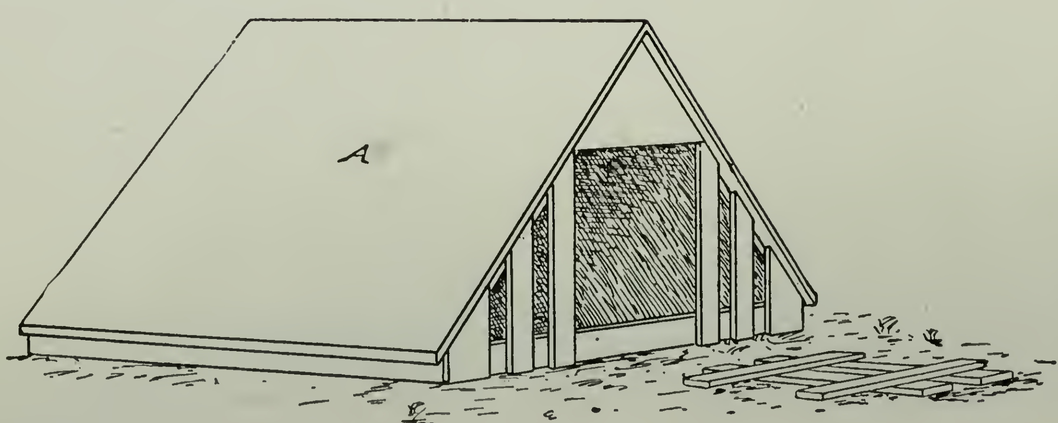


Fig. 43. Coop A.—Each side of roof 24 in. by 30 in.; bottom 2 ft. 4 in.

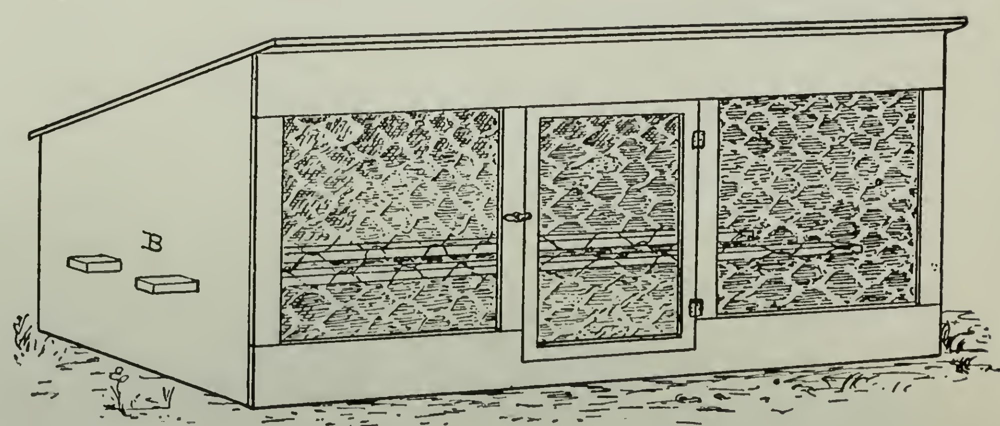


Fig. 44. Coop B.—Length, 6 ft.; width, 2 ft. 6 in.; height in front, 2 ft. 4 in.; height at back, 18 in.

ing about one degree a day. It is well to remember that when chicks are put in the brooder every fifteen chicks will raise the temperature of the brooder about one degree.

It is advisable to start the lamp of the brooder about twenty-four hours before the chicks are to be put in. The floor should be covered with clover chaff or other clean litter. Musty or mouldy litter or feed should never be used about the brooder or pan in which young chicks are to be placed. Lukewarm water is put in the brooder for drink before the chicks are taken from the machine. It is advisable to supply some fine grit or coarse sand, preferably of a bright, shiny appearance.

The use of the large coal-heated brooder is now becoming quite common. This consists of a small coal stove and a large cover or hover. These are made of different capacities, according to the manufacturers, from 500 to 1,000 chicks to the

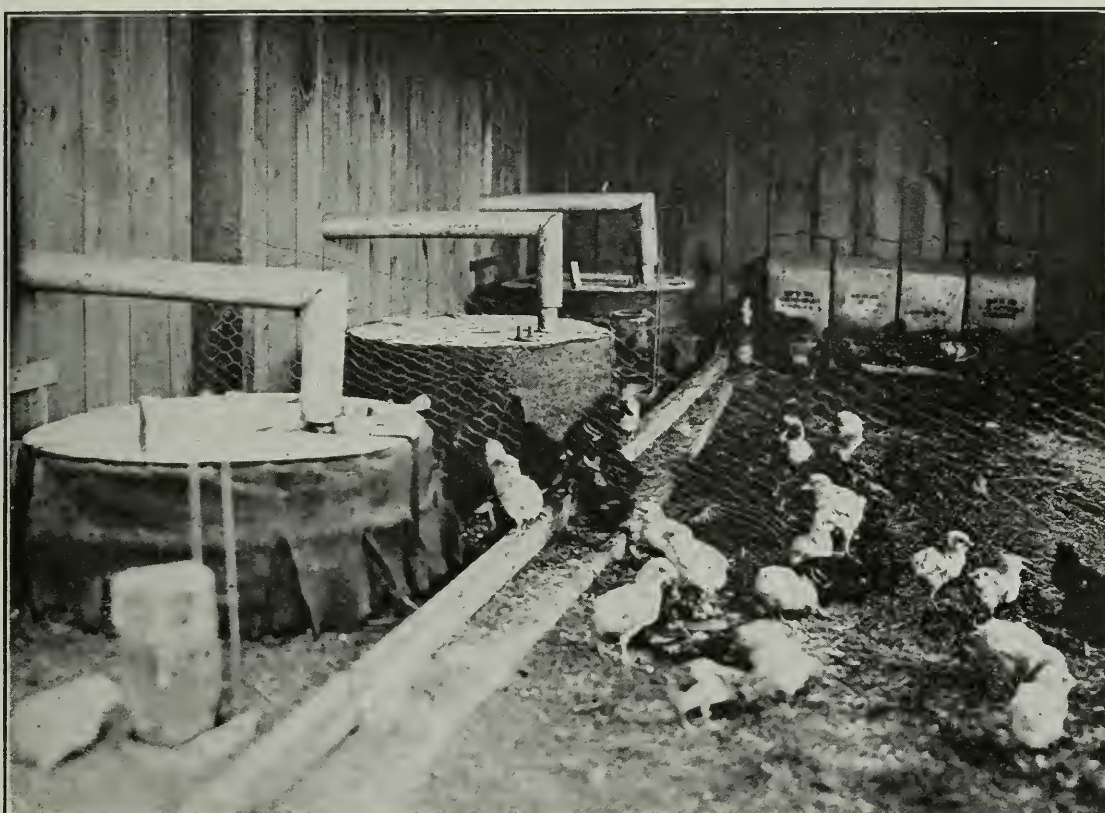


Fig. 45. This cut shows the Method of Brooding, etc.

brooder, depending on the make. It is the belief of the writers that best results will be secured if not over 400 are placed in each brooder stove.

There is no doubt that for the poultryman who is raising chicks in large numbers these coal brooders will be found economical to use. The expense for fuel is not so great as in the case of oil lamps, and the labor of caring for them is much less than the same brooding capacity of oil lamps. The brooding of chicks in large numbers, however, presents problems and difficulties not often encountered where brooding in small flocks. It is seldom that young chicks when brooded in large numbers do not begin crowding, which, if not attended to at once, will ultimately result in disaster. Many have difficulty in feeding chicks in large flocks, either running to one extreme or the other.

Chicks should not be fed until they are sixty or, better, seventy-two hours' old. Many make the mistake of feeding too soon. The young chick at the time it leaves the shell has sufficient yolk attached to the digestive tract to supply it with food for five or six days. Feeding before the yolk is absorbed causes indigestion and bowel trouble in many cases.

The most successful results are secured where chicks are fed small amounts at frequent intervals. For the first ten days or two weeks feed five times per day at two to three hour intervals. This is for early spring. As the hours of daylight lengthen to 7.15 or 7.30 o'clock p.m. it will be necessary to increase the number of feeds given above from five to six. A suggestive time-table for feeding would be—first feed at 7.00 a.m.; second, 9 a.m.; third, 11.30 a.m.; fourth, 2.30 p.m.; fifth, 5.30 p.m., and, where a sixth feed was given, 7.15 or 7.30 p.m. The object in having the first two morning feeds only two hours apart lies in the fact that the chicks are very hungry in the morning, and by feeding lightly at 7 a.m. and again at 9 a.m. there is not the danger of overfeeding, that there would be were a heavy feed given early in the day.

The writers have had the best success in starting young chicks on rolled oats or stale bread crumbs mixed with hard-boiled eggs (boiled for thirty minutes), in the proportion of six parts of the rolled oats or bread crumbs to one part of the eggs. The eggs are first finely ground, shell and content, and the proportions taken by measure. This is fed dry. After the first two or three days we begin to give an occasional feed of seed chick-food of one of the commercial grades or one made up as follows:

Cracked wheat	35	parts
Granulated oatmeal	30	"
Small cracked corn	30	"
Grit (chicken size)	5	"
Total	100	"

Very few of the commercial grades contain any grit, in which case it either has to be added to the feed or given separately.

Most people experience their greatest difficulty in regulating the amount to feed, and especially for the first three weeks. Some will under-feed, while, again, others will over-feed, both of which are serious. With the object of offering a solution to this question, feeding tests were undertaken to determine whether the feeding of definite amounts at stated intervals would give satisfactory results. Varying amounts of food were given, ranging from one ounce per day to ten chickens, to one ounce per day to fifteen chickens. It was found, however, that the optimum amount required was somewhere between these two points, and proved to be approximately one ounce per day to twelve chickens at the start of feeding. The time at which increase in amount given should take place varies with different lots of chickens, but will ordinarily be about the fourth or fifth day. The rate of increase in amount also varies greatly, and it is sometimes found necessary to discontinue the increase for a short time for some inapparent reason. The rate of increase must be slow, never exceeding one-quarter of an ounce per day to a flock of sixty chickens.

Best results were secured where the food was weighed for each feed. A measure may be used with a fair degree of accuracy, yet the fact that the feeds are for the most part of mash, the weight of the measureful would vary from time to time. Guessing at amounts leaves room for much gambling on results.

The chicks are started on the rolled oat or stale bread and egg mixture, fed five times per day, one ounce per feed, per sixty chickens. This rate of feeding is continued until the third or fourth day, when a small quantity of chick-feed is given at the 11.30 a.m. and 5.30 p.m. feeds in conjunction with the former mixture; the chick-feed serving as the increase. This is continued, gradually increasing the amount of chick-food, until by the twelfth day the flock of sixty chickens is getting five ounces of mash mixture and two ounces of chick-feed. At this time the mash mixture would be given the first two morning feeds and the first afternoon feed, while the chick-feed formed the last morning and last afternoon feeds. The use of the chick-feed is continued until the chicks are old enough to eat whole or coarsely cracked grains.

After the first week or ten days it may be found necessary to use some kind of filler for one feed—something which is bulky, easily digested, palatable, yet not highly nutritious. Cooked vegetable, such as mangels, turnips, sugar beets,

Fig. 46. Growing Chickens in the Cornfield.

cabbage, etc., dried off to a crumbly state with shorts or middlings, will be found very satisfactory and economical. Stale bread moistened in milk and mixed with one of the meals mentioned above is also good. These are given in such quantities as the chicks will eat, preferably at the 2.30 p.m. feed, removing any food which may be left. We have found it advisable to add from two to five per cent. of bone meal to the mash after ten days feeding, as it materially assists in the formation of bone in growing chicks and to some extent prevents leg-weakness. An occasional feed of powdered charcoal in the mash after the fourth day will assist in correcting digestive disorders and preventing diarrhœa.

Plenty of fresh drinking water must be supplied the young chicks. After the tenth day if sour milk or buttermilk are available they may be given as drink replacing the water. It is not advisable to give milk in any quantity previous to the tenth day, as the chick is in our experience liable to over-feed on it. All milk used should be sour before using.

When the chicks are one week old and confined to pens or houses where they cannot get *green food*, the same *must be supplied.* Lettuce is excellent; sprouted grains are very good, as is also root sprouts, cabbage, rape, etc. The green food is given to supplement the other foods used, and not to replace any of them. Its value is largely in its effect on the bowels and blood.

When feeding chick-food scatter it in the chaff on the floor of the pen. The little chicks will work away most of the day for it after they are one week old. It gives them exercise, which is a necessity in rearing chicks.

When the chicks are four weeks old the number of feeds per day are reduced to four, and when seven, to three feeds daily. The feed at this time may consist of whole wheat and cracked corn, fed morning and evening, and a mash food in the middle of the day. The mash may consist of equal parts of bran, shorts and corn meal, to which is added ten per cent. of animal meal or beef scrap. If we are anxious to force the chicks, we give two feeds of mash per day and increase the animal food a little.

Chicks hatched at a season of the year when they can range out of doors need not be fed as often or as carefully as described above after the first two weeks. During the winter season, where chicks are reared indoors, too liberal feeding often causes leg weakness, etc. In such cases, sweep away the snow and do your best to get the chicks out on the ground. Feed but very little hard grain and use mostly moist mashes. Use as much cooked or raw vegetables as the chickens will eat.

Close confinement, poor ventilation, and feeding of large quantities of hard or dry chick foods to winter broods of chicks have given us very poor results. Watch the chicks, and when you notice some of the largest getting weak on their legs reduce the hard feed and get them out of doors if possible.

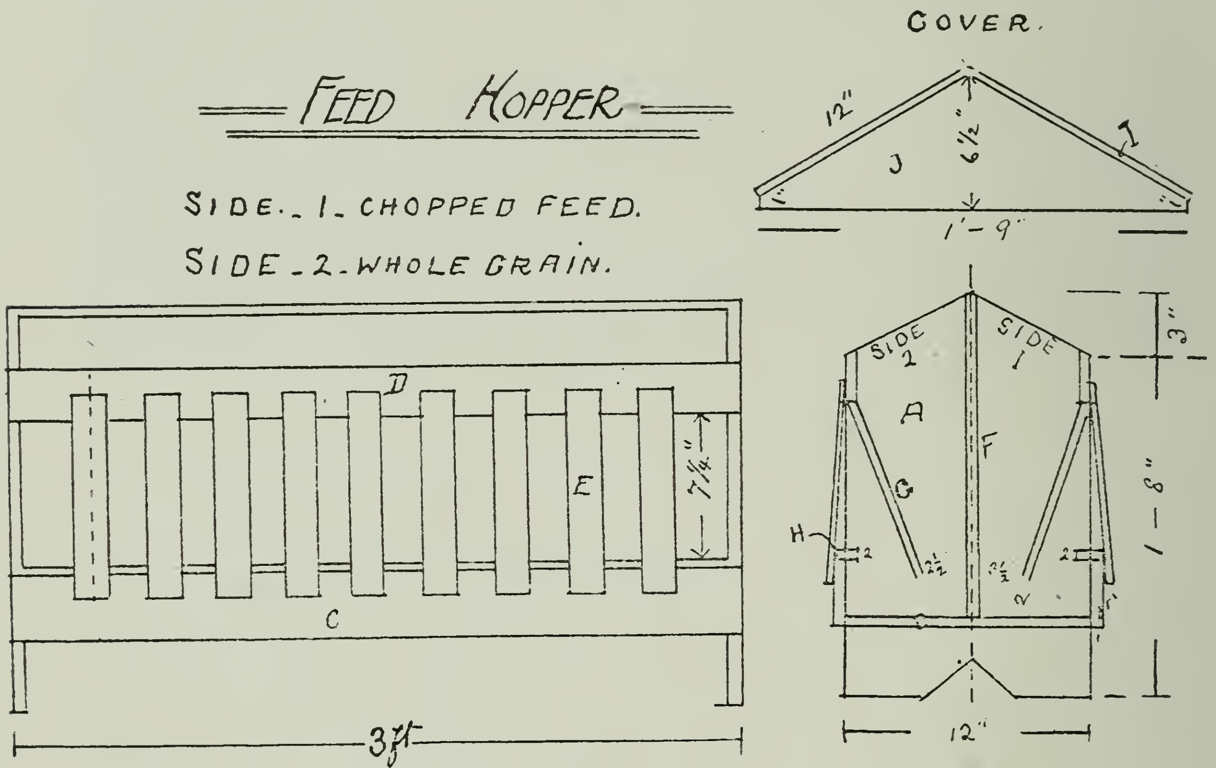


Fig. 47.

BILL OF MATERIAL.

A. 2 ends ⅞ x 12 in. x 1 ft. 8 in.
B. 1 bottom ⅞ x 12 in. x 2 ft. 10¼ in.
C. 2 sides ⅞ x 3¾ in. x 3 ft.
D. 2 sides ⅞ x 2½ in. x 3 ft.
E. 18 pieces ⅜ x 1⅝ x 10 in.
Side 1.—Chopped feed.

F. 1 division ½ x 16 in. x 2 ft. 10¼ in.
G. 2 divisions ½ x 9½ in. x 2 ft. 10¼ in.
H. 2 pieces ¼ x 1 in. x 3 ft.
I. 2 pieces ½ x 12 in. x 3 ft. 2 in. } Cover.
J. 2 ends ⅞ x 6½ x 1 ft. 9 in. }
Side 2.—Whole grain.

We have used for several seasons the hopper plan of feeding chicks during the spring and summer months with good success. We have tried placing a hopper or trough of chick-feed in a coop along with the hen and chicks, and keeping the supply constant in or near the coop, from the day the chicks were put out until full grown, with most satisfactory results. For the chicks brooded artificially we use very extensively the hopper method of feeding after about eight weeks of age, first with chick-feed and later with whole grain, and find it a very economical method of feeding. Where chickens have a good range about the fields of the average farm, we know of no better plan of feeding chicks. The hopper may be made of any size or shape so long as the supply of grain is constant and the supply large enough to last for about one week. A hopper which slopes from both sides will feed better than one with a slope to but one side.

Where the hopper plan is adopted on the farm, the labor problem is very much reduced. If the hoppers are always kept supplied with grain there will be much less danger of underfeeding and producing stunted chickens. Water or sour milk should be given daily in a clean dish. While good growth may be secured by feeding grain only from the hopper, better and more rapid growth will be obtained if a moist mash is fed once during the day.

Try to keep your chickens roosting in the open air as long as possible. Be careful, however, to note that the coops or houses which appeared to have plenty of room early in the season are not overcrowded when the chickens become more mature. Never overcrowd, and clean coops or colony houses frequently. Never house the birds in close, stuffy houses. If you do, they will be sure to go wrong, become weak, and be of little or no value, either as breeders or egg producers. When the portable hover is used in a colony house, the brooder is removed from the house as soon as they can be weaned from the heat, and the chickens roost in colony houses until they are ready for market.

There are many advantages in using several small movable colony houses for rearing chickens.

(1) There is no loss of time in teaching the chicks to go from a small coop to a larger one. Movable brooders are used inside the house, and when no more heat is required these are taken out. About this time, low, flat perches are put in the house; the chicks soon commence perching, and thus prevent crowding. One hundred chicks can be put in a house. This house will accommodate fifty chickens of about four or five pounds weight; or until large enough to be fattened or put into laying quarters. Usually some birds are sold as broilers, hence there is not much overcrowding.

(2) The chickens can be reared on a portion of the farm where a full crop, as well as a crop of chickens, can be grown. This usually means new land each season for the chickens, which in turn means stronger and better birds reared with less grain. It also may mean the destruction of many injurious insects. We use the corn fields, pasture fields, and orchards, or any similar condition under which a crop of chickens and an additional crop can be obtained from the land during the same season. Chickens grown on the same land year after year do not thrive as well as those grown on new ground each year.

(3) Should the chickens at any time become destructive they can be moved. We have raised chickens in tomato fields, and if they develop the habit of destroying ripe tomatoes, all that is necessary to avoid further trouble is to shut the chickens in at night, and next day draw the house to a new field and open the door. The chickens will come home to the colony house to roost.

(4) Where there has been considerable grain shelled on the field during harvest, the chickens can be easily moved to the field, and there they will gather the grain.

(5) Any vermin that might worry the chickens at night can be easily kept out by shutting the door.

(6) During rainy or bad weather, the chickens have a place for shelter. This is very important early in the spring and late in the fall.

Cost of Rearing.

We were able recently to keep an exact record of the birds grown in the pasture field, and of those grown in the orchard. The chickens in the pasture field were hatched during the first two weeks in May. Three hundred and forty-five birds were grown to maturity or to a size suitable for fattening. We began to remove the cockerels from the field to the fattening pens on August 25th. The pullets and cockerels held as breeders were all taken from the field by the 22nd of October. The breeds reared were Orpingtons, Wyandottes, Plymouth Rocks, Leghorns, etc. They consumed 4,304 lbs. of grain; of this about one-third would be dry mash;

Fig. 48.—Producing Two Crops in One Season—Apples and Chickens.

nearly 300 lbs. chick-feed, and the balance—wheat, corn and hulled oats—in the proportion of two and a half—two and one. There was five per cent. of beef scrap added to the dry mash. The birds were weighed when taken from the field, weighing 3,341 lbs., or one pound of chicken representing 3.2 lbs. of grain. Some of the breeding cockerels weighed over seven pounds, and the Leghorn pullets did to feed Leghorns, Minorcas, or birds of similar character. These breeds make a three and one-half pound weight, or when they would fatten most economically.

The chickens reared in the orchard varied more in age. The first were hatched on the 25th of April, and the last on July 6th. Most of the birds were hatched in May. We sold 218 as broilers from this lot during July. The later cockerels were removed to the fattening crates as was done with those grown in the pasture field. Most of the pullets were taken out about the 1st of October, and by the 1st of November practically all had been removed, with the exception of about 100; these were cockerels held as breeders, and the July chicks.

We raised in the orchard 733 chickens at a cost of 8,649 lbs. of grain. A pound of chicken equalled 3.34 lbs. grain, or nearly the same as the pasture field chickens.

The figures mean that a farmer can, in his fields, raise a four-pound cockerel for 13 or 14 lbs. of grain. This amount of grain, at $30 per ton, would be worth twenty-one cents. The cockerel would sell in the market for at least forty cents, and, if fattened, would be worth sixty cents. The data we have on hand would

Fig. 49. Colony Houses used for Rearing Chicks. Artichokes growing as Shade for the Chickens.

indicate that it costs about five to seven cents each to hatch the above birds, that is figuring eggs, oil and losses. Several years' figures show that 4 lbs. of grain will produce a pound of gain in live weight.

FATTENING CHICKENS.

The selling of lean chickens is wasteful, to say the least. Much more interest is being taken in this branch of the industry year by year, and in districts where buyers discriminate in prices between the well-finished and thin chickens, the progress has been very pleasing. There are many buyers who now pay a premium for good chickens. The demand for home consumption has increased to such an extent that the supply falls far short, and more than one wholesale dealer in our large cities is fattening the thin chickens sent to market. Some of the dealers have buildings which they are using each year where they are fattening hundreds of birds weekly. They know that the farmer or grower can do this work better and more cheaply, but if he will persist in sending lean chickens to market, and the consuming public demand fat chickens, some one must supply the demand. Some dealers have been trying the proposition in what might be termed a small way during the past two or three years. The business has, as we understand, been profitable, even where the milk was brought in by express and a high rental paid for the building used. Surely if the dealer can buy all the raw materials from the farmer or grower and make a profit, the producer should do as well or better.

There is ordinarily from three to seven cents a pound difference in the price paid for well-fleshed or fattened birds, to that paid for birds just off the range or fields. This means a difference of from fifteen to thirty-five cents on a five-pound chicken, depending upon the quality. Not only does the feeder make upon the gain made while the chicken is being fattened, but the original weight is increased in value by the improvement in quality. There is always a market for goods of prime quality, and the poor quality goes at begging prices when the supply is great.

It is not difficult to produce good chickens. Like other lines of live stock, the scrub sort are not desirable. Good, thrifty cockerels, either pure-bred, crosses, or grades of such breeds as Rocks, Orpingtons, Wyandottes, Rhode Island Reds, Game, Dorking, etc., make economical gains. It is usually not very profitable to feed Leghorns, Minorcas, or birds of a similar character. These breeds make medium broilers, but rather poor roasters. The birds usually make the greatest gain when about three to four months of age, or at a weight of three and one-half to four pounds. Should the market demand a chicken of more than five and one-half pounds in weight, then it will be required to allow the birds to range longer, and the gain, in our experience, will be hardly as profitable, unless the price paid is higher, at least one cent per pound.

The average birds make the most economical gains during the first two weeks of feeding. It does not pay to feed longer than three weeks, unless one is preparing birds for a specially select trade paying fancy prices.

Chickens can be taught to eat by lamplight, and where one's time during daytime is otherwise occupied, this feature is very convenient. After November 1st, or even earlier, we feed but few chickens during daylight. They are generally fed twice each day, and not more each time than they will consume quickly.

Construction of Fattening Crates.

Fattening crates are usually made 7 ft. 6 in. long, 18 to 20 in. high, and 18 in. wide. The crate is divided into three compartments, each holding from four to five birds, according to the size of the chicken.

The crate is made of slats, except the ends and partitions between the compartments, which are solid wood; those on the top, bottom and back running lengthwise of the coop, while those on the front run up and down. The slats are usually 1½ inches wide and ⅝ inches thick. Those in front are placed two inches apart to allow the chickens to put their heads through for feeding. The slats on the bottom are placed about ¾ in. apart, so as to admit of the droppings passing through to the ground. Care should be taken not to have the first bottom slat at the back fit too closely against the back. An opening between the first slat and the back prevents the droppings from collecting and decomposing. The slats on the top and back are usually two inches apart.

There is a small V-shaped trough arranged in front of the coop for feeding and watering the chickens. This trough is from two to three inches deep and is generally made of ¾ in. lumber.

Very fair coops may be made from old packing boxes, by taking off the front and bottom, and substituting slats in their places. (See Fig. 50.) During warm weather these crates may be placed out of doors. They need to be protected from the rain, which is easily accomplished by placing a few boards over them. In cold weather the crates should be placed in a house or shed where they are protected from raw, cold winds. When fattening chickens inside of a building, it is well to darken the building and keep the birds as quiet as possible.

After each lot of birds is killed, we paint the crates with some liquid lice-killer. Coal-oil and carbolic acid is very good. Use one gallon of coal-oil to one pint of crude acid. We have used some of the prepared mixtures with good results. If the birds (bought from different parties) are very lousy when put up, they should be well dusted with sulphur or good insect powder. The birds should be watered at least twice every day in warm weather. Grit should be given them twice a week.

During the first week feed lightly—never quite all the birds will eat. We prefer feeding twice a day during the entire feeding period. Chickens weighing

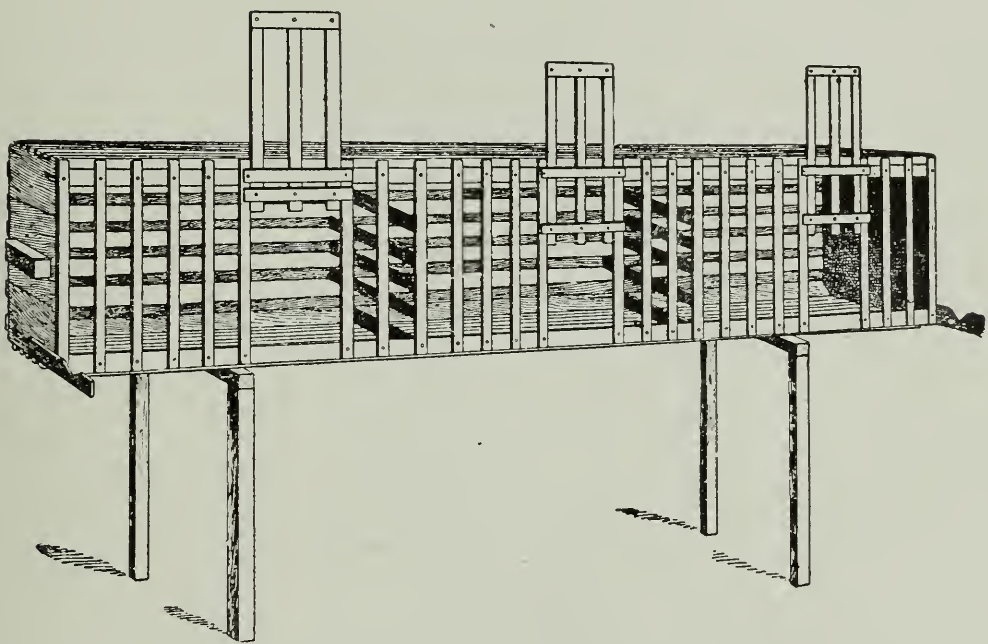


Fig. 50. Showing a Single Crate or Coop.

from three to three and one-half pounds each that are thrifty and of good breeding, appear to be the most profitable for feeding. Large chickens, weighing from five to six pounds, gain less and eat more than the smaller ones.

Should a bird become sick while in the crate we find that if it is given a teaspoonful of salts and turned out on a grass run it will usually recover.

Cramming Machine.

The crammer consists of a food reservoir, to the bottom of which is attached a small force-pump moved by a lever and treadle, which is worked by the foot of the operator.

Communicating with the pump is a nozzle, through which the food passes to the bird.

"A" is the food reservoir; "B" the pump; "E" the pump rod; "O" the lever, which on being depressed at the lettered end causes the pump rod "E," to which it is attached, to move downwards, and to eject the contents of the pump "B" out of nozzle "K." On relieving the pressure at "O" the lever and the parts connected therewith are drawn up by the spring "C" until the motion is arrested by a stop "M," which serves to determine the quantity of food ejected at each depression of the treadle.

The charge may also be varied by arresting the pressure at any point in the downward thrust of the lever "O."

The illustration (Fig. 51) shows one method of operating with this crammer, and this plan is now largely followed in some parts of Sussex, England.

Kind of Food Used in Cramming Machine.

Not all kinds of food can be used in the machine. The food must be in a semi-liquid condition in order to pass through the machine. This necessitates the use of some kind of grain that will stay in suspension in the milk, beef broth, or whatever liquid is used in mixing the grain. Finely ground oats, with the

Fig. 51. Cramming Machine for Forced Feeding of Chickens, Turkeys, etc.

hulls removed, or shorts, answer the purpose well. We use almost entirely the former food. Grains, like corn-chop or barley-meal, are not suitable.

The food is mixed to the consistency of ordinary gruel, or until it drips from the end of a stick.

Will it Pay to Buy a Cramming Machine?

For the ordinary person we think not. First-class chickens may be had by feeding in the crate from the trough only; indeed, we have had equally fleshy birds that have been fed for four weeks from the trough as where we have fed them two weeks from the trough and one week from the machine.

Where one has a special trade for high-class poultry we are of the opinion that a more uniform product can be secured by using the machine. Machine-fed birds should realize at least one cent more per pound than trough-fed birds in order to pay for the extra labor, etc.

Birds that are fairly well fleshed when put into the crate will do better, if put at once on the machine, instead of being crate-fed first.

Crate Feeding *vs.* Loose Pen Fattening of Chickens.

The term "fattening of chickens" has been in use for some time, out it does not exactly convey the meaning intended by the feeders of chickens. The object is to make the chickens more fleshy, with just sufficient fat to make the chicken cook well. The chickens are not intended to be abnormally fat, yet at the same time they carry considerable fat well intermixed with lean meat.

We have for a number of years conducted experiments with chickens in crates and in loose pens. We have tried about six different feeders and the results vary. With some feeders we had equally as good results with birds in crates as with them in loose pens. We have had two feeders in particular who could not feed birds to advantage in loose pens as compared with crates. We have had one feeder who could get slightly better returns in some cases, not all, with birds in pens as compared with crates.

In speaking to the buyers of chickens, the majority of them seem to think that the crate-fed birds are much superior to those fed in loose pens. Personally, we would prefer feeding birds in crates, for the reason that it takes less room, and we believe that we can feed them with less expenditure of labor and get a more even product. There are now many people who can get good results from feeding birds in box stalls, etc. No matter which method is followed, cockerels should be fed for two weeks or more before they are killed and sold.

How to Feed.

We receive a number of inquiries as to how we feed the birds that are being fattened. Most inquirers wish to know the exact amount fed each day.

It will be noticed that we fed very lightly at the beginning—a very important point—and that the amount was gradually increased until such times as the birds refused to eat all that was given them. No feed was left in front of them longer than ten minutes after it was placed in the trough. Any food left after such time was removed.

Table showing amounts fed morning and evening to two lots of four birds each. The first lot shows steady increase in amount fed, while the second shows irregular increase.

	LOT No. 1				LOT No. 2			
Dates	Morning		Evening		Morning		Evening	
	Meal	Milk	Meal	Milk	Meal	Milk	Meal	Milk
Oct.10	.... oz.	.... oz.	4.5 oz.	6.25 oz.	.... oz.	.... oz.	5.0 oz.	7.5 oz.
" 11	5.0 "	7.5 "	5.5 "	8.25 "	5.0 "	7.5 "	6.0 "	9.0 "
" 12	6.0 "	9.0 "	6.5 "	9.75 "	6.5 "	9.25 "	6.0 "	9.0 "
" 13	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	5.5 "	8.25 "
" 14	7.0 "	10.5 "	7.0 "	10.5 "	6.0 "	9.0 "	6.5 "	9.25 "
" 15	7.5 "	11.25 "	7.5 "	11.25 "	6.0 "	9.0 "	5.5 "	8.25 "
" 16	7.75 "	11.75 "	7.75 "	11.75 "	6.0 "	9.0 "	6.0 "	9.0 "
" 17	8.0 "	12.00 "	8.25 "	12.00 "	6.5 "	9.25 "	7.0 "	10.5 "
" 18	8.5 "	12.25 "	8.75 "	13.00 "	8.0 "	12.0 "	8.0 "	12.0 "
" 19	9.0 "	13.50 "	9.25 "	14.00 "	8.0 "	12.0 "	9.0 "	13.5 "
" 20	9.5 "	14.25 "	9.75 "	15.75 "	10.0 "	15.0 "	10.0 "	15.0 "
" 21	10.0 "	15.00 "	10.25 "	15.25 "	10.0 "	15.0 "	9.0 "	13.5 "
" 22	10.5 "	15.50 "	10.75 "	16.00 "	9.0 "	13.5 "	9.0 "	13.5 "
" 23	11.0 "	16.50 "	11.25 "	16.75 "	10.0 "	15.0 "	8.0 "	12.0 "
" 24	11.25 "	16.75 "	12.00 "	18.00 "	10.0 "	15.0 "	10.0 "	15.0 "

It is difficult to give a ration suitable for fattening chickens and that meets the requirements of every individual. Many of us have to use whatever foods are available, and for that reason we are giving several rations that have worked fairly well with us in a general way. It may be said that the grains in a ration should be ground as finely as possible, and further, some grit should be fed to the chickens at least once a week, and it is also desirable that the food should be mixed to the consistency of a pancake batter, so it will pour; and moreover, the best results are secured when the food is mixed twelve hours previous to feeding.

The best ration that we have yet used is one composed of two parts of finely ground oats, two parts of finely ground buckwheat, and one of finely ground corn; to this is added sufficient sour milk to make a batter or ordinarily about two to two and one-half pounds of milk to one pound of grain. We have gotten very good results from a ration composed of equal parts of corn meal, middlings, and buckwheat meal. Frequently barley meal can be substituted for the buckwheat, or oat meal for the middlings. It is desirable, if possible, to always use milk, as much better gains are made with it than any other food. Where milk is not available, blood meal and beef scrap can be substituted, but we would not advise more than fifteen per cent. of the grain ration to consist of these foods. We would advise soaking the blood meal or beef scrap in warm water for twelve hours previous to being mixed with the grain. We have gotten better results in some cases and equally as good in all cases by feeding any of the above mixtures cool or cold rather than warm—that is to say there were no better gains made by keeping the food at 70 or 80 degrees than at 35 or 40.

It is of the utmost importance that the birds be kept with keen appetites, as a little over-feeding on the commencement usually means indifferent gains. One should be careful to have the birds free from lice or other insects, and as far as possible to keep them in a cool, comfortable place, rather secluded, so as not to be disturbed by the visiting public or other chickens. The birds should be dusted with a small amount of sulphur or other insect powder in order to keep the lice in check. If the sulphur is used too freely it produces a scaly appearance on the birds when dressed.

We have a surplus of cockerels each year over and above those required for breeding purposes, and a number of these are fattened and killed; a few are sold to farmers or breeders. Cull pullets are also fattened. A year or so ago we kept close record on our crate feeding work with the above-mentioned birds, and they showed very good returns. From September to December we put in the fattening crates six hundred and twenty-six birds. The loss by death among these was two birds. The birds weighed (when brought in from the range, usually with full crops) two thousand two hundred and thirty-three pounds. They were fed from four days to three weeks before killing. We hoped to have fed them all three weeks, but at times the demand for dressed chickens required us to kill the birds shortly after cooping.

Rations.

The main ration consisted of barley meal, low-grade flour, middlings and buttermilk. Some other mixed grains were used and a little shredded wheat. The six hundred and twenty-six birds ate two thousand and fifty-seven pounds of ground grain and four thousand pounds of milk.

Many farmers and others market their birds in a thin condition. We can, for the time it takes to feed, clean out the pens, etc., make at least fifty cents per hour over and above the cost of feed. We usually feed these birds by lamplight at night, so that little valuable time is lost.

Financial Statement of Fattening Chickens.

626 chickens weighing 2,233 lbs. at 8c. per lb., live weight	$178 64
2,057 lbs. of grain at $1.50 per cwt.	30 85
4,000 lbs. buttermilk at 10c. per cwt.	4 00
Total cost	$213 49
624 dressed chickens, bled and plucked, but undrawn, 2,358 lbs. at 12½c. per lb.	294 75
Profit	$81 26

Birds that are starved ready to kill shrink 12 per cent. by bleeding and loss of feathers. We have figured frequently that the average profit per bird in three weeks' feeding was about fifteen cents each; the above table shows nearly thirteen cents. The profit would have been somewhat higher if all the birds had been fed at least two weeks.

During the fall of 1916 crate feeding was done by some students at the College. These men were inexperienced, and their results could hardly be expected to equal those of professional feeders. They fed seventy birds, composed of practically all breeds and varieties, both light and heavy, and both pure and crossed. Their results were as follows:—

70 chickens weighing 287 lbs. 6½ oz., at 14c. per lb., live weight	$40 24
250 lbs. 5 oz. grain at $2.00 per cwt.	5 01
390 lbs. 13 oz. buttermilk at 30c. per cwt.	1 18
Total cost	$46 43
70 chickens, bled and plucked, but undrawn, 317 lbs. 7 oz., at 20c. per lb.	63 50
Profit	$18 07

These birds, when starved ready to kill, showed a shrink of 11.15 per cent. in bleeding and plucking. The birds, while only fed for two weeks, still showed a return of practically thirteen cents per bird per week, as in the former case. They required 3.6 lbs. of grain for one pound of gain in flesh. As in the case of past feeding trials, the light breeds, such as Leghorns, required from one and one-quarter to one and one-half pounds more grain for a pound of gain than did the heavier breeds. In respect to the profits, those from the heavier breeds were practically double what the light breeds were.

Killing and Dressing Poultry.

All birds should be fasted for twenty-four hours before killing, and during the period of fast given some water to drink. If this is not done, the food remaining in the crop and intestines at the time bird is killed decomposes. As a result of this decomposition of food in the digestive tract, strong-smelling gases are liberated which taint the flesh of the bird, not only destroying the flavor, but very much lowering its keeping qualities.

All birds should be killed by bleeding, preferably through the mouth. This is a very simple operation, and a little practice will ordinarily make one fairly handy at this work. Two general positions for the bird during the operation are used. The one is to place the bird on a padded bench or table, and the other is to hang the bird up by the feet with a small rope or cord. For the average person the latter method is to be preferred, as there is less danger of bruising or barking the skin than where the bird is lying upon some object. The one end of rope or cord may be fastened to a small rod or pole and to the other end attach a small block about 2 in. x 2 in., as shown in Fig. 52. Where hanging the bird up, the end of the rope

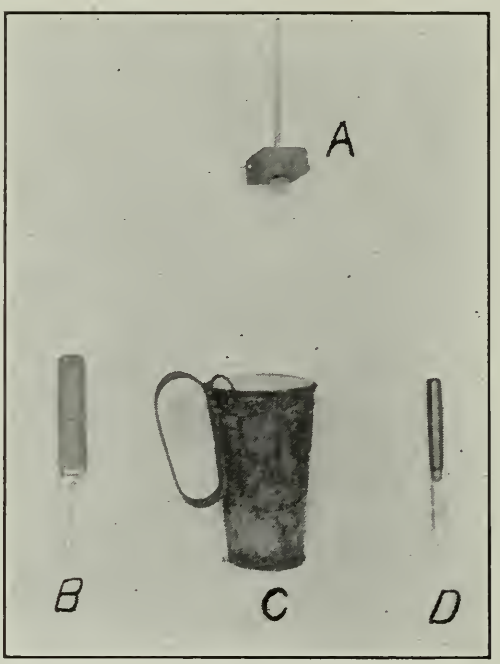


Fig. 52. A. Rope and block for hanging bird up with. B. Killing knife. C. Blood can. D. Pinning knife.

Fig. 53. Killing and plucking chickens.

with block on is placed around the feet and the block dropped in between the bird's feet and rope. This holds bird without tying, and should be so adjusted that bird's feet are about on a level with the picker's shoulders.

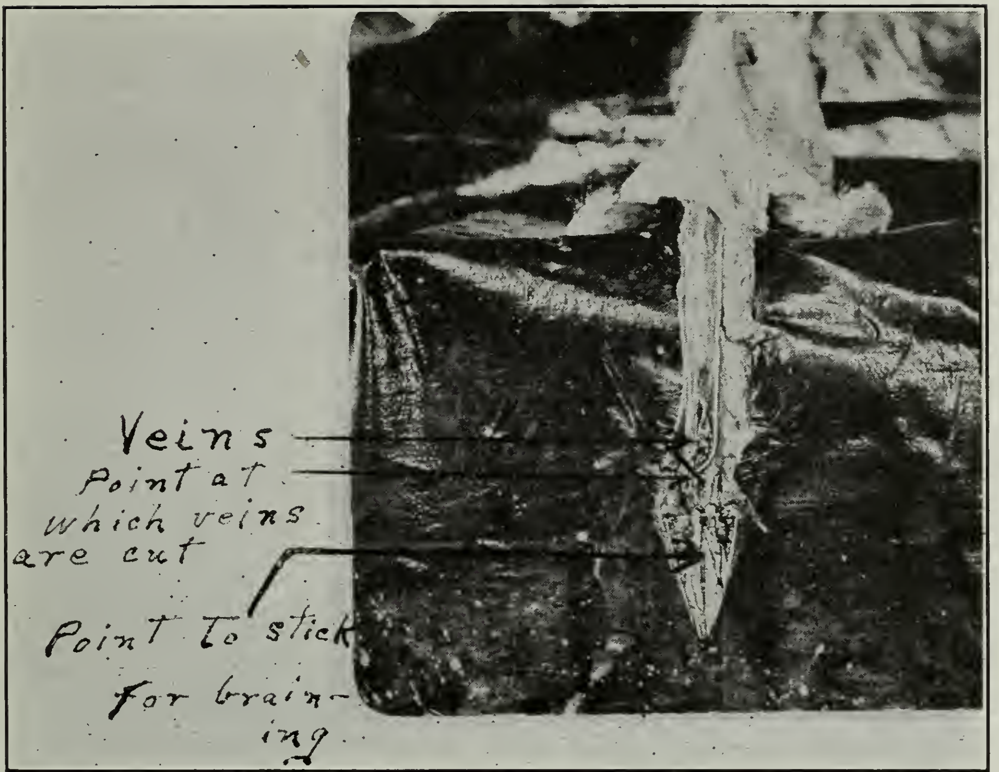


Fig 54. Cut showing location of veins and point for sticking brain.

For bleeding a sharp knife with a blade about three inches in length will answer. A regulation killing knife is shown in Fig. 52. To bleed, catch the bird's head with the thumb and forefinger just at the juncture of the neck and

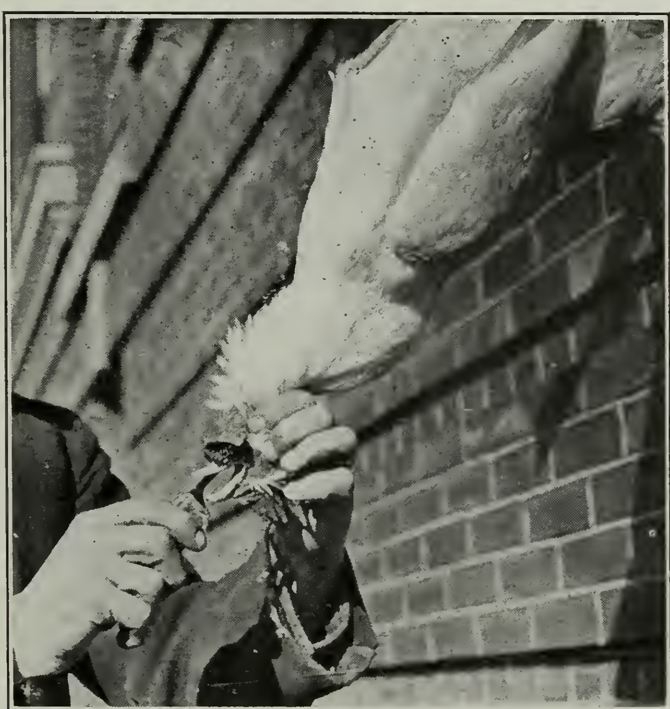


Fig. 55. Bleeding Operation.

head or at the ear-lobes, as shown in Fig. 55, then with the third finger open the chicken's mouth. Next insert the knife and put down the throat practically the length of the blade, then with the edge of blade turned down, cut rather heavily with a drawing stroke of the knife. The object is to sever the jugular veins at the point where they unite back of the head, as shown in Fig. 54.

The bird should bleed freely if the cut is made at the proper point. Next, turn the blade of knife over and insert the point of blade in the slit or groove in roof of mouth, as shown in Fig. 54, and then quickly push backward so as to pierce the brain. If the back of the knife is kept on a line with and touching the point of the bill, the blade will pierce the brain. One can tell when this is done as the chicken will squawk. If the bird does not squawk the brain is not pierced, which means tight feathers and hard picking. As soon as the sticking operations are completed attach a blood-can to the lower bill. This catches the blood, thus preventing it being thrown about, and the can being weighted tends to hold the bird still. For a blood-can, any can which is small and to which a small hook can be attached will answer the purpose. In Fig. 52 is shown a style of blood-can which is used extensively in packing-houses. In this can the hook is solidly

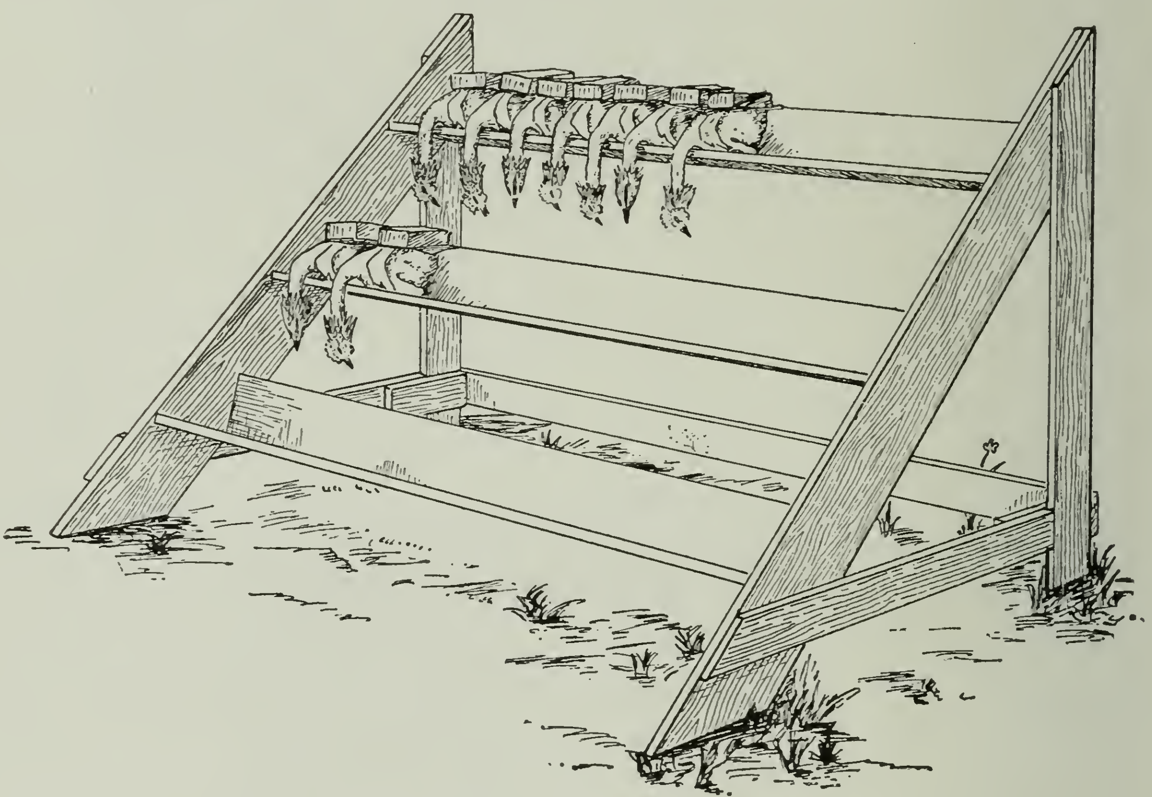


Fig. 56. Showing a Number of Chickens in the Shaping Boards.

attached on the inside of the can near the handle. The weight in can is provided in the form of three-quarter inch of lead in the bottom. Cement or a small stone will answer the purpose equally as well.

The chicken should be plucked immediately, first removing the long wing feathers and tail feathers, then each side of the breast, then the legs, and lastly the back. Do not try to pull the feathers either forward or backward, but more sideways or at an angle. The rough or coarse feathers should be removed in the shortest time possible, as the more quickly the feathers are removed after sticking the easier they will come and the less danger there is of tearing the skin. For instance, in removing wing feathers grasp both wings in the left hand and the feathers of both in the right, removing them all at one stroke of the right hand. Next, raise the right hand to the tail, grasping all the feathers in the tail, and with a slight twist remove with a second stroke of the right hand, and so on over the different sections of the body. To remove the pin feathers use a dull, round-bladed knife, similar to an ordinary paring knife. (See Fig. 52.) Be careful not to rub or bark the skin. This may be done very easily by rough handling, or by placing the chicken in contact with coarse clothing, hence do not put chicken on your lap to pluck it. If you should, unfortunately, tear the skin, hold the skin at the torn part tightly to the body between the thumb and first finger, and then

Fig. 57. Cooling Rack.

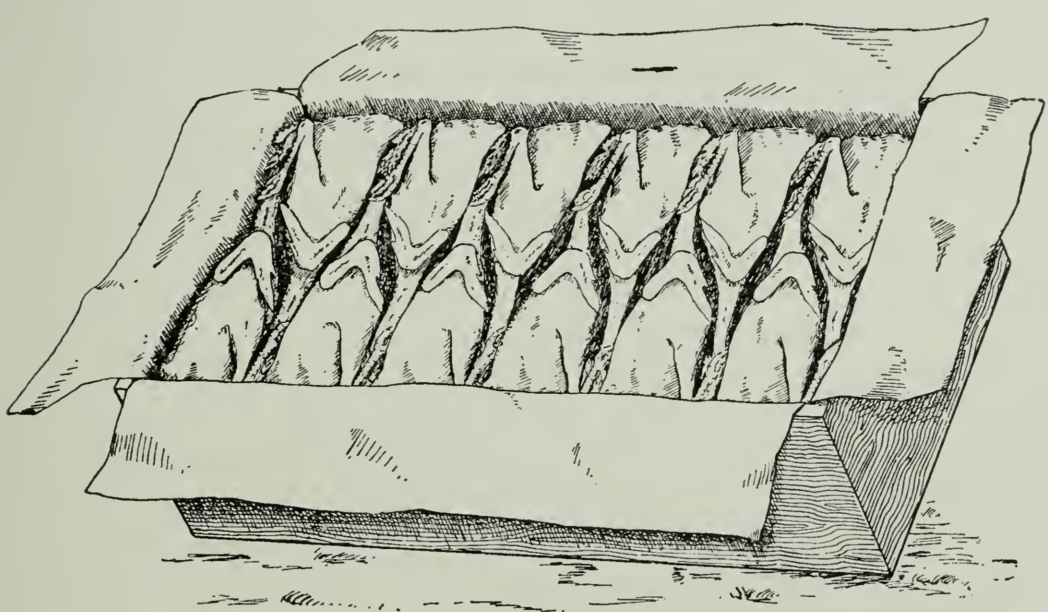


Fig. 58.

remove the rough feathers near torn part. Anyone with a little practice can remove the rough feathers in from three to five minutes. Expert pickers will do it in from three-quarters of a minute to one minute.

The birds should be plucked clean, the blood washed from the head and out of the mouth and the feet washed clean.

After the chicken has been plucked it should be placed on a shaping board, as seen in Fig. 56, or a cooling rack, Fig. 57. In the case of the shaping board, the weight placed on the top of the chicken is used to give it a compact appearance. The weight may be of iron, as seen in the cut, or a brick may be used in its place. The cooling rack allows free circulation of air around the birds, resulting in more rapid cooling, which on large packing plants is very important, and hence we find the cooling rack in common use in such places.

Many good chickens are spoiled by being packed before they are thoroughly cooled. Care should be taken that all the animal heat is out of the body before the birds are packed. We find it advisable to cool the birds at least twelve hours before packing them.

In packing birds for shipping, they should be packed in boxes holding one dozen birds to the box. The size of the boxes varies with the grade or size of chickens packed in them, but should be such that when chickens are packed they are absolutely tight, so that there is no possibility of them shaking about, and becoming bruised. The boxes are best made of basswood or similar wood, free from odor, as otherwise the flesh of the birds will absorb the odor, thereby tainting the flesh. The box is lined with parchment paper, and, if the chickens are to be shipped a long distance, each bird is wrapped in parchment. This prevents the chickens bruising each other, and, at the same time, to a considerable extent, checks decomposition. Do not use ordinary wrapping paper, as it draws dampness and will cause the chickens to become clammy, which makes them more or less unsaleable. Fig. 58 shows one method of packing in common use, and is termed the "side pack," *i.e.,* the birds are so placed in box as to show the entire side.

The dimensions of some of the boxes are: for broilers, weighing about twenty-four pounds per dozen, 16 in. x 15 in. x 3½ in. inside. This is where they are packed in single layer, with the breasts up and the legs extended. For chickens weighing thirty-six to forty-two pounds per dozen, a box 23 in. x 15½ in. x 4 in. inside would do. One dozen roasters, weighing four to four and one-half pounds each, a box 32 in. x 19 in. x 4 in. inside. For heavy roasters, weighing five to five and one-half pounds each and packed single layer, a box 33 in. x 20 in. x 4¼ in. inside measurement. The material used varies in thickness from one-quarter inch for sides, bottom, and top, and one-half inch for ends in the smallest size boxes to one-half inch for sides, top and bottom, and seven-eighths inch ends in the largest boxes.

(The writers wish to acknowledge the use of "Poultry Packers' Guide" in preparation of box dimensions above stated, for which credit is hereby given.)

Poultry and Eggs for Market.

The profit for poultry and eggs depends upon the cost of production and the selling price. Some excel as producers and others in the disposal of the product. The variation in the prices realized by the producers in the many markets of the province, and at times the margin between what the producer receives and the consumer pays makes one consider what is wrong with the marketing system.

Our market conditions change annually, and at times weekly, if not daily. We are now exporting eggs; the demand is great, the prices good, and furthermore, the home consumption is said to have increased. People are eating more eggs each year. These factors go to make a healthy condition. There can be no doubt but eggs and poultry are placed on the market in better condition each year, which means more money to the producer and better satisfaction to the consumer, and in turn the consumption is increased. We are doing better, but could do more. It is our duty as good citizens to produce many more eggs and meat to assist the

Mother Country. Those of us who cannot go to the war should do our best to produce as much produce as possible and get it to the consumer or cold storage quickly.

In the producing sections situated away from the centres of consumption the selling of the produce for its value is a problem. There are two things that would assist in solving this problem. One would be for the buyer, whether dealer or grocer, to buy the produce on the quality payment basis; and the other is selling through co-operative organizations. Which is the better method depends entirely on local circumstances. A co-operative society situated away from large local markets, when well managed, should be the better method; on the other hand, payment on the basis of quality is simple and just. These problems can be best solved by the producer and dealer getting together. Co-operative buying and selling is the ideal method, but everybody must work together and stay with association. It is seldom that a co-operative society or joint stock company does not have poor years and unsatisfactory conditions. Success depends on united effort.

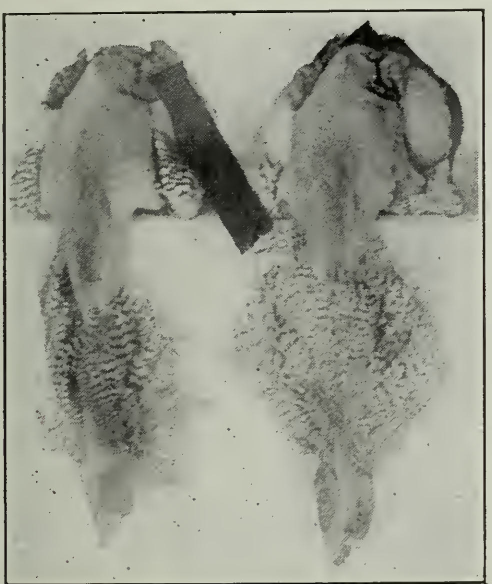


Fig. 59 A. Fig. 59 B.
Showing Good (A) and Poorly-fleshed (B) Birds.

There appears to be a general idea that the shell of an egg protects the contents against all kinds of germs and weather; that the outside of the shell may be filthy, but that the interior is not in the least affected by the filth on the outside.

There is nothing more disgusting than at the breakfast table to break a bad egg. No more eggs are wanted for days, perhaps for weeks, and consequently egg consumption decreases; or eggs are looked upon as a doubtful source of food. Many bad eggs are due to ignorance on the part of the producers and consumers, and many dealers are as careless in their methods.

The shell of an egg is porous, or is full of very small holes. The egg is designed to hatch a chick. The chick under favorable conditions grows inside the shell, and finally bursts it open. The holes in the shell supply the chick with air as it grows, also allows the bad air to escape. Science has proved this, but we have ample illustration in practical work. Eggs that become badly smeared with broken eggs in the nest during incubation usually rot, owing to the breathing holes becoming plugged or blocked by the broken egg content. Greased eggs will not hatch for the same reason; and we might mention several other examples.

Knowing that the shell is porous, we can readily understand how minute animal or plant life, or germs, may enter the eggs. Let us take a common case of mouldy or musty eggs. Frequently the paper fillers of egg boxes will become damp due to the boxes being left in a shower of rain or something of the kind. The fillers are only slightly damp, and we think they will do. If no eggs are put in the boxes, and the boxes with fillers are set aside for, say, a week or so, when they are opened they smell musty, and if the fillers are examined we will see slight developments of moulds here and there. Now in cases where eggs are put in such fillers they soon become musty, and when they are left in for some time they become mouldy, not only on the outside of the shell, but on the inside as well. The writers have taken clean eggs on the day they were laid, and put them in dry paper boxes which were slightly mouldy, and set them aside in a dry cellar for a period of a few weeks, and at the end of this time many of the eggs had well-developed mould on the inside of the shell.

Many eggs are spoiled by being partially incubated. Most people believe that an egg must be set under a hen, or put in an incubator before it will start to hatch. Eggs will start to hatch at less than 90 deg. of heat. Many eggs are submitted to this or higher temperatures for several hours, if not days, before reaching the consuming public. When the germ inside the egg commences to develop, the edible qualities of the egg are lessened, or the egg goes off flavor. Eggs may be kept at an incubating temperature for a day, when the chicks will start growing; next day the temperature may be so low that the chick is killed, and from that point decomposition begins, possibly slowly, but, nevertheless, the egg is gradually going bad.

There are almost innumerable ways in which eggs may start hatching during the summer, such as forgetting to gather the eggs daily, and leaving some under broody hens over night, leaving them exposed to the sun or in warm rooms, stores, cars, etc., or even in the kitchen cupboards.

No one can guarantee eggs to their customers during warm weather unless the males are removed from the flock. Unfertilized eggs are essential. We may at home take every precaution, but who knows where or how the cook may keep those eggs, even after they have passed from the dealer's hands. The allowing of males to run with the hens all summer costs the Ontario growers a large sum of money. The writers have stood by candlers in a large packing house, and saw over twenty of the thirty dozen eggs in a case that were more or less incubated, most of the eggs being about forty-eight hours on in incubation. The dealer is thus foced to make prices to meet this shrinkage; at times the public may get "bargain" eggs.

Filthy eggs, or even washed eggs, may be decomposed or rendered useless from the germs in the filth on the eggs. Washed eggs, if used immediately, are good, but they deteriorate very quickly after washing.

Flavor of Eggs.

Many of us forget that eggs will absorb odors. They will not absorb odors as readily as milk, but, at the same time, care should be taken in keeping the storage room for eggs free of strong odors. For instance, to put eggs alongside of onions, turnips, or similar strong smelling foods would mean that the eggs would absorb more or less of these flavors.

Again, the food that a hen consumes very materially affects the flavor of the eggs. This can be very easily demonstrated by feeding mostly scorched grain, or giving large quantities of pulped onions in a mash food. One demonstration will convince anyone that eggs have been scorched, or taste of onions no matter how cooked.

When hens get but little grain food during the summer and are forced to hunt for their living over manure piles, and catch insects, the yolk will become almost red in color. These eggs make the consumer remark that winter eggs taste better than summer eggs. Frequently feeding as above produces a thin, watery white, and the egg has not only a bad flavor, but has poor keeping qualities, and, moreover, is little better, if as good, as a fair pickled or cold storage egg.

Market Terms Used. A new-laid egg means an egg that is under five days of age, or at least not over one week old. It should be clean, and the boxes should be clean.

Fresh eggs are very very hard to define. With some they mean eggs from one day to three weeks or even more of age, while with others they mean eggs just out of cold storage.

There are several other market terms, such as pickled, held, etc., which are used mostly by the dealers, and need no explanation here.

STANDARDS FOR CANADIAN EGGS ADOPTED BY THIRD ANNUAL CONVENTION CANADIAN PRODUCE ASSOCIATION,

GUELPH, JANUARY 11 AND 12, 1915.

(Revised at the Fifth Annual Convention, Montreal, February 6th and 7th, 1917.)

CLASSES AND GRADES.

Classes—	Fresh Gathered.	Storage.	Cracked and Dirties.
Grades—	Specials		
	Extras	Extras	
	No. 1's	No. 1's	No. 1's
	No. 2's	No. 2's	No. 2's

Allowance for deterioration in transit 10 per cent., but none bad, *i.e.*, eggs should grade at point of delivery 90 per cent. of grade named at point of shipment.

DEFINITION OF GRADES.

Specials—Eggs of uniform size weighing over 25 ozs. to the dozen or over 47 lbs. net to the 30 doz. case; absolutely clean, strong and sound in shell; air cell small, not over 3-16 of an inch in depth; white of egg to be firm and clear and yolk dimly visible; free from blood clots.

Extras—Eggs of good size, weighing at least 24 ozs. to the dozen or 45 lbs. net to the 30 dozen case; clean; sound in shell; air cell less than ⅜ inch in depth; white of egg to be firm and yolk slightly visible.

No. 1's—Eggs weighing at least 23 ozs. to the dozen or 43 lbs. net to the 30 doz. case; clean; sound in shell; air cell less than ½ inch in depth; white of egg to be reasonably firm; yolk may be quite visible but mobile, not stuck to the shell or seriously out of place; cell not necessarily stationary.

No. 2's—Eggs clean; sound in shell; may obtain weak, watery eggs and eggs with heavy yolks, and all other eggs sound in shell and fit for food.

Definitions of grades in class "Cracked and Dirties" to be same as for grades in Fresh Gathered class, except that the terms referring to soundness and cleanness are not to apply.

To measure accurately the depth of the air cell the following method must be adopted. Measure from the points indicated by the arrows.

Pullet Eggs.—Eggs which have the quality of Specials and Extras, but which fall short in weight, shall be known as *Pullet Specials*, or *Pullet Extras*, providing they weigh at least 23 ozs. to the doz., or 43 lbs. net to the 30 doz. case in the instance of the former, and 20 ozs. to the doz., or 37½ lbs. net to the 30 doz. case, in the instance of the latter.

Where and How to Keep Eggs.

The nests in which the hens lay should be clean. These usually need cleaning monthly. The best material we have used for nests is shavings.

Eggs should be gathered twice each day, and placed in clean basket, pails, etc.

The room should be cool, not higher than 60 degrees if possible, and it should be dry. A cool, dry cellar will answer nicely.

The dirties, small, extra large, and found nests of eggs should not be sold. Use them at home. The large ones break in shipping and the smalls and dirties are not wanted on the market. These sell the good eggs at poor prices.

Where one is trying to supply private customers, or a select wholesale trade, it is wise to stamp the eggs with your own initials, or the name of your farm. This is some guarantee to the buyer.

Never Try to Deceive the Dealer.

You may sell bad eggs to the grocers, but the honest people in the district do not get full value for their good eggs.

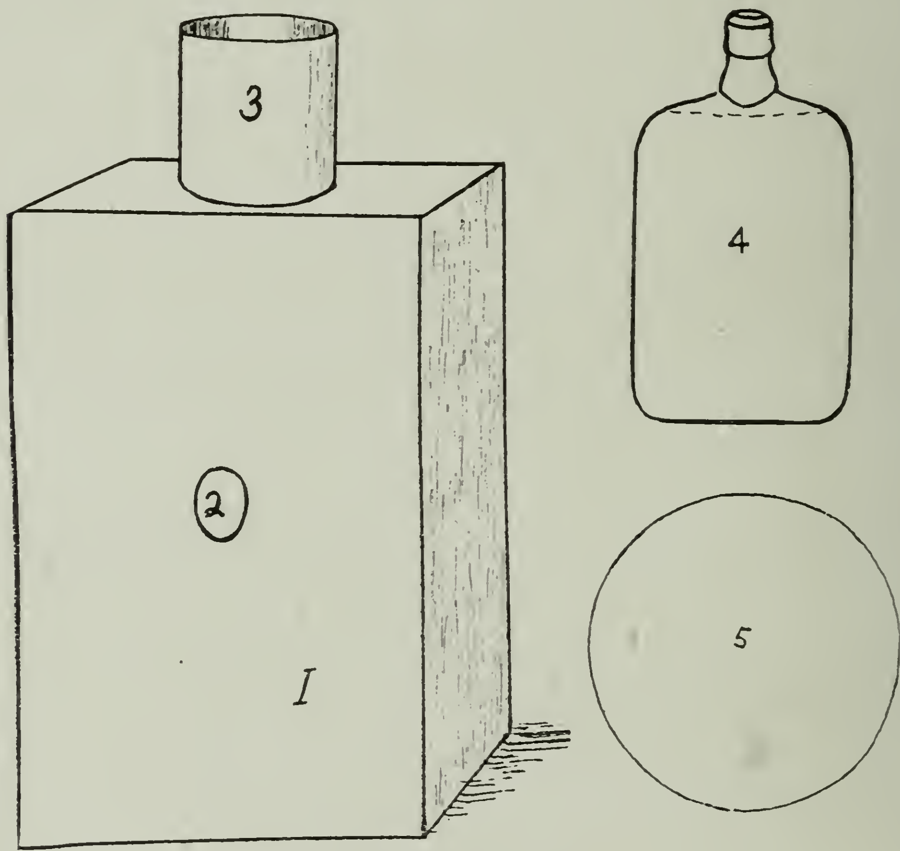
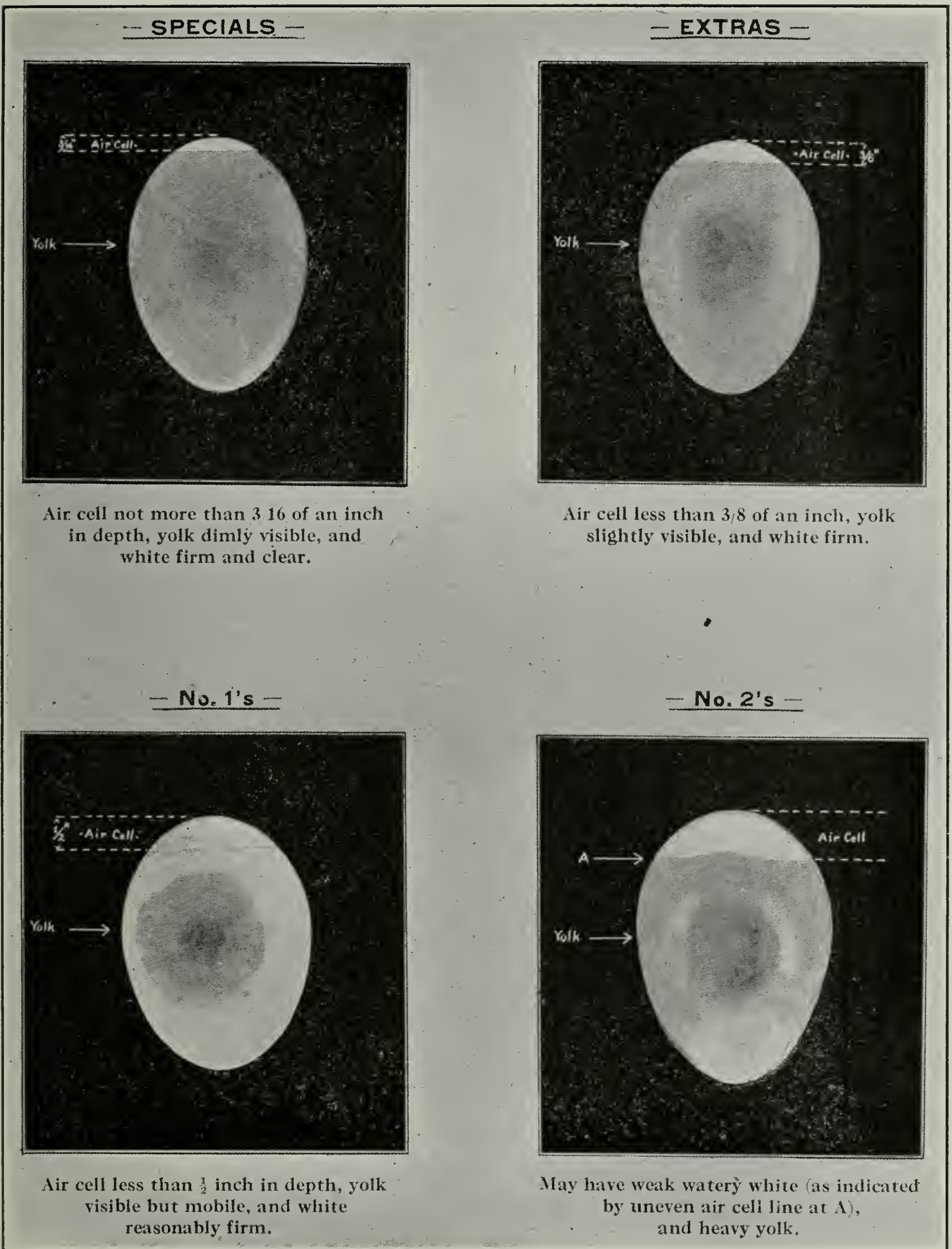


Fig. 61. The Egg Tester.

1. Egg-testing box.
2. Hole through which light shines and before which egg is held to be tested.
3. Chimney.
4. Bottle of water placed between light and No. 2.
5. Reflector to be placed behind light.

An ordinary lamp or electric light is placed in the box so that the light shines through No. 2. The bottle of water condenses the light, which makes the testing of eggs a comparatively simple matter.



Air cell not more than 3 16 of an inch in depth, yolk dimly visible, and white firm and clear.

Air cell less than 3/8 of an inch, yolk slightly visible, and white firm.

Air cell less than ½ inch in depth, yolk visible but mobile, and white reasonably firm.

May have weak watery white (as indicated by uneven air cell line at A), and heavy yolk.

Fig. 60.—Grades of Fresh gathered eggs.

Some people hold their September and Early October eggs, and then ship them later in the year to a dealer as fresh eggs. They, of course, expect the top price for new laids. Please do not believe you can deceive the dealer. By candling the eggs, which he always does, he can tell fairly close what your eggs are like as to age, etc.

Do not sell infertile eggs that are removed from the incubators as being good eggs or good food.

Do not allow the male bird to run with the hens after June 1st.

Do not keep the eggs in damp or musty cellars, boxes, or baskets.

Do not leave the eggs sitting in the sun, and if your grocer keeps eggs in his store window in which the sun shines, please ask him to remove them, unless he wishes to hatch chickens.

Do not sell eggs from found nests.

Practically all dealers have now agreed to pay for eggs according to quality. If your dealer pays as much for all kinds of eggs as he does for your good, clean, large sized, non-fertile eggs we will try to put you in touch with dealers who buy on a quality basis.

Kill the rooster after June 1st.

Candling Eggs.

Eggs are candled very easily. See Fig. 61. A new-laid egg, when held between the eye and the light, has a clear appearance, the yolk is practically invisible, and the air cell is about the size of a five-cent piece.

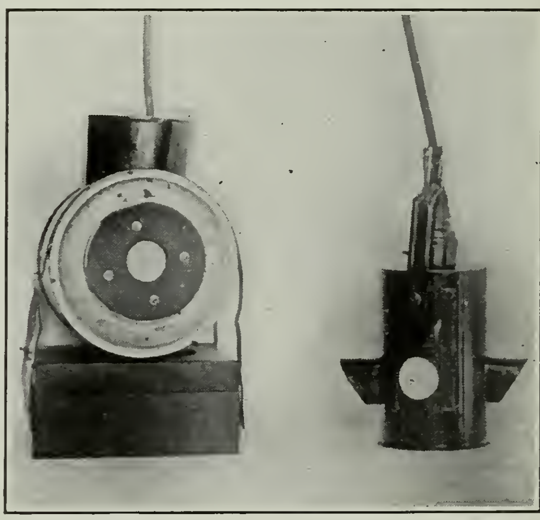


Fig. 68. Two types of commercial egg candles.

Unless the eggs are put in pickle or held in cold storage, the air cell gradually increases in size, and the yolk becomes visible.

Cold storage and pickled eggs may have small air cells, but the yolks are conspicuous.

Fig. 62 is a photograph of a new-laid egg. It will be noticed that all portions of the egg are similar in appearance. There is a very small air cell at the large end of the egg which does not show in the photo; this air space is not larger than a five-cent piece.

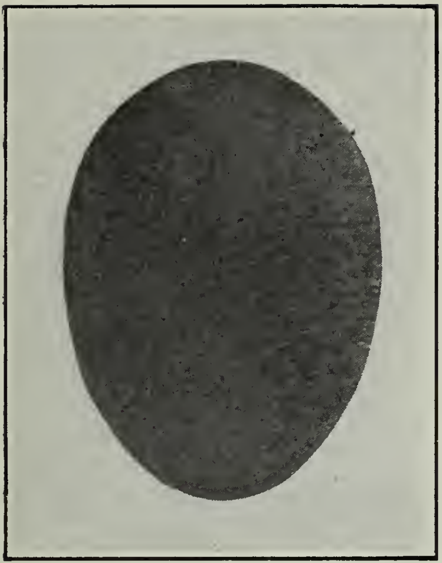


Fig. 62.

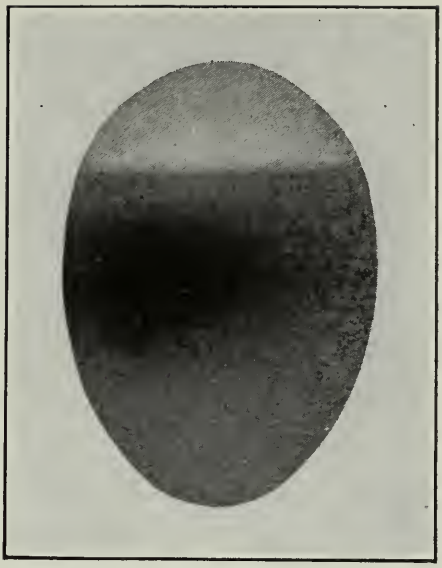


Fig. 63.

Fig. 64.

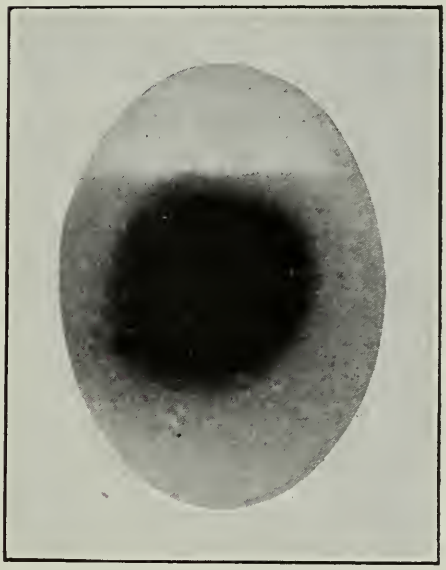


Fig. 65.

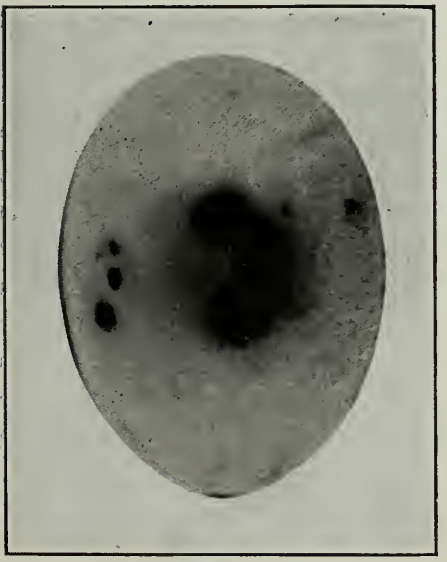


Fig. 66.

Fig. 67.

Fig. 63 is a photograph of a held egg, or one that is suitable for baking purposes, but not for boiling or packing. Notice that the yolk is conspicuous and the air space is very large. Pickled eggs usually show a conspicuous yolk but a small air space. Eggs that are two weeks of age usually show the yolk, and have an air space about the size of a twenty-five cent piece.

Figs. 64, 65, 66 and 67 are photographs of what the dealers term "spots," as they show various growths of moulds in the egg. These eggs are not rotten, but when opened smell musty. The mouldy portions are usually easily seen.

POULTRY HYGIENE AND SANITATION.

There is very great doubt in the minds of the writers of the advisability of "doctoring" sick chickens. The unit of production (the individual bird) is so small that if a man's time is worth anything it will not pay him unless he considers the bird especially valuable. The "cured" bird will always remain a menace to the flock, and with the slightest adverse conditions will show a return of the disease. Disease of any kind usually weakens the constitution of the individual, and hence lowers their breeding value. In such simple diseases as indigestion, colds, etc., where the greater part of the flock is affected and the flock can be treated as a unit, treatment is, no doubt, advisable. Where the birds are kept for the production of eggs and meat only, the hatchet will be found the safest and most effective method of treatment for individuals.

Prevention is better than cure, and every effort on the part of the poultry keeper should be exerted to maintain such environmental and sanitary conditions as to prevent disease gaining a foothold in the flock.

The stock which is used for breeding purposes should be selected first for *constitutional vigor,* as this is the foundation upon which the breeder must build future success. Discard all birds which have at any time been sick, and cull very closely birds which, as chicks, were raised in closely confined quarters.

The housing of the birds is very important in the prevention of disease. Abundance of fresh air and sunlight in the house, without draughts or dampness, will do much in maintaining a healthy flock. Houses must be kept sanitary by frequent removal of droppings and litter, as the latter becomes soiled. At least once during the year, preferably about the month of August, the house should be thoroughly cleaned and disinfected. All movable fittings, as nests, hoppers, and roosts may be removed from pen to facilitate cleaning. Thoroughly scrape dropping-boards, if used; remove all litter from floor, and then brush down ceiling and walls with a broom. The house is now ready to be disinfected. The writers find it advisable to apply a coat of whitewash to all pens once a year to brighten and help cleanse the pens. They have also found it most economical to combine the whitewashing and disinfecting processes by adding the disinfectant to the whitewash. The whitewash is made by slacking fresh stone lime and adding sufficient water to dilute to a creamy mixture. To this is added ten to fifteen per cent. of crude carbolic acid or some of the tarry compounds used for disinfecting purposes, and the whole applied with a hand spray pump. A pump capable of developing a fair amount of pressure is desirable, as it forces the solution into all cracks and crevices about the building. Applying with a whitewash brush is not to be recommended, as there is not sufficient penetration. Such materials as salt and cement, which are used by some to give sticking power to the wash, are not here used. Nests, roosts and other movable fittings are best treated by dipping in solution of the wash or may be sprayed, but the dipping is to be preferred. Be sure to strain all whitewash before using in spray pump.

The land upon which birds are running must receive close attention in order to keep it clean and sanitary. Constant ranging over a piece of land by birds tends to foul the land, making it "chicken-sick." The heavier the soil the more serious is the trouble. Aim to cultivate the run or yard at least once in the year and grow a crop of grain or rape on it. This tends to cleanse the soil of droppings and at the same time produces succulent green feed for the birds.

The food must be closely attended to and no food given the birds which is musty or mouldy or where putrefaction has started. Only the purest and most wholesome foods should be used, as there is not only the ill-effect on the health of the birds, but seriously affects the produce from the flock.

Exercise is very essential to health, and this applies to chickens just as much as to other classes of stock. This is very important in the winter months, especially if one wishes to secure good hatches of strong, vigorous chicks.

In case of sickness, isolate all sick birds from the flock and either treat or destroy. All dead birds should be disposed of by burying deeply (two to three feet) or burned; the latter is the safer method of disposal.

Birds which are badly infested with vermin, such as lice or mites, will not thrive. If the vermin are not kept under control they will in time become so bad as to seriously lower the vitality of the birds, thus rendering them more susceptible to disease attack.

POULTRY DISEASES.

It is seldom that the external symptoms are so strongly marked as to present conclusive proof of the type of disease affecting the bird or flock. It is, therefore, necessary to conduct a post-mortem examination of diseased specimens. This is easily done. Place the dead bird on its back on a table or bench, and spread the legs apart, pressing them down flat on the table. Open the body of the bird just back of the point of the keel bone, after which cut the ribs along both sides of the body up to the front of the keel. Next, take hold of the back point of keel, raise it, and bend it forward with sufficient force to break the remaining attachment at the fore part of the body, being careful not to disturb the internal organs. It will now be possible to view the liver, heart, gizzard, and a portion of the intestines before moving any of the organs. Next, raise the liver and gizzard, placing them to one side. The gall bladder and spleen will be noticed on the under side of the liver, while the lungs will be found forward and closely attached to the back along the ribs. The moving of the gizzard will disclose the intestinal tract, which, if removed, will reveal in females the ovaries and oviduct. Examination of each organ should be made and the condition noted, the external symptoms being also considered in determining the nature of the disease present. While this examination may indicate the presence of a certain disease, one cannot be absolutely certain without a bacteriological examination.

Tuberculosis. This disease is very widely distributed throughout the Dominion of Canada. In some sections flock infections are much more serious than in others. Practically all classes of birds, with the exception of ducks, have been known to contract the disease. It is found, however, chiefly confined to adult birds. Very rarely, if ever, is it found in young chicks.

For a complete description of this disease, its dissemination and control, the reader is referred to Bulletin 193, "Tuberculosis of Fowl," by S. F. Edwards, M.S., formerly Professor of Bacteriology at the Ontario Agricultural College. This bulletin may be secured from the Ontario Department of Agriculture, Parliament Buildings, Toronto.

Blackhead.—This is a contagious disease affecting turkeys and fowl. It is quicker acting and more often fatal in the former than in the latter. It affects the liver and intestines, especially the blind pouches or ceca of the latter. In many sections of the country, where once turkeys were grown extensively, they are now seldom ever seen, due to the presence of this disease.

Young turkeys from two weeks to three or four months old are most frequently affected by the disease. The affected birds become mopy and show loss of appetite. In the more advanced stages the wings droop, and the head assumes a darkened or black appearance. Post-mortem examination will reveal enlarged and congested condition of the ceca with cheesy matter, while the liver will show the development of yellowish spots, which are slightly depressed in the centre.

Treatment of diseased birds has never proven successful. Preventive measures to control the outbreak and spread of the disease should be adopted. If purchasing birds or eggs for hatching be sure they come from healthy stock. Wipe hatching eggs with cloth wet in 80 to 90 per cent. alcohol and hatch in incubator if possible. Rearing on fresh ground, keeping old or wild birds away, disinfecting houses, etc., frequently, and killing and burning all diseased birds will do much to control attack of the flock. Some maintain that the use of an acid-drinking solution, such as sour milk or buttermilk, will assist in preventing the spread of the disease. If the milks are not available the addition of one dessertspoonful of muriatic or hydrochloric acid to one gallon of drinking water will accomplish the same purpose. It is now believed by some that the disease can be largely controlled by close regulation of the ration to prevent over-feeding during the first ten weeks of the young poult's life.

White Diarrhœa of Chicks. When chicks are about twenty-four to ninety-six hours old they resemble each other very much in appearance, with the exception that we have noticed that hen-hatched chickens and chickens hatched in moist incubators were longer in the down, or looked larger and fluffier. The trouble generally begins about the fifth day. Some of the chicks will have a thin, white discharge from the vent; the chick is not active, and has a sleepy look; also the head appears to settle back towards the body. One thinks the chick is cold or in great pain. Some of the chicks get in the warmest spot under the hover; others have intense thirst. The white discharge from the vent is not always present. The chicks may die in large numbers between the fifth and tenth days, or there may be a gradual dropping off each day until they are six weeks of age. The disease kills some quickly; others linger for a week or more. A few chicks appear to recover, but seldom, if ever, make good birds. They are small, unthrifty, and are good subjects for roup or any other epidemic.

To the ordinary observer a post-mortem examination may reveal any or all of the following conditions: The lungs will usually show small white spots in them. These are generally quite hard and cheesy. These spots are not always present, but from our examination I would judge they are in fifty per cent. of the cases. Some lungs have no white spots, but are red, sometimes fleshy. These, in our experience, are not very common, unless the chickens are chilled. The yolk is often hard and cheesy. It varies greatly—some yolks are of a gelatinous nature or almost like the white of the eggs; others are hard and cheesy and very yellow in color, sometimes these are greatly inflamed; other yolks appear like a custard that has curdled, and they usually have a very offensive odor. The ceca, or blind intestine, is frequently filled with a cheesy substance.

The white spots in the chicks' lungs are generally considered to be due to the growth of a common mould. This may be in the eggs, or more frequently comes from mouldy feed or litter. It is much more troublesome in damp, dull weather, when the chicks are most inclined to stay under or near the hover.

Chicken-pox. A contagious disease of poultry which usually affects those parts of the head and face which are bare of feathering. The disease seldom affects birds which are not fully mature. It usually appears as warty nodules scattered over the face and about the eyes and mouth and over the comb, as shown in Fig. 70. In advanced stages of the disease other parts of the body may show development of the nodules.

The disease spreads rapidly from contact. Wild birds and parasites may serve as carrying agents, and thereby assist in spreading it among the flock.

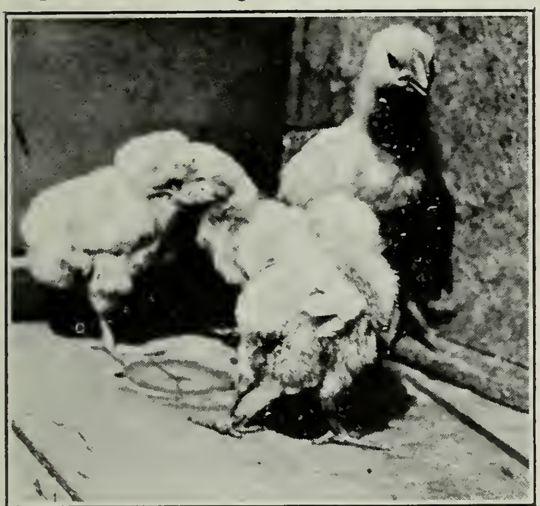


Fig. 69. Showing young chicks affected with White Diarrhœa.

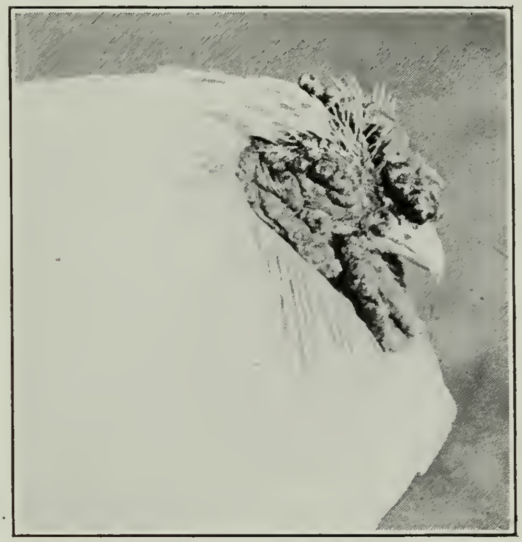


Fig. 70. A typical case of Chicken-pox.

Buying in birds coming from diseased flocks, or it is sometimes carried by birds from the showroom.

In attempting treatment observe precautionary measures to prevent spread or incubation by carriers. Isolate diseased birds; remove crust of nodules; and treat with creolin (2 per cent. solution) or corrosive sublimate $\frac{1}{1000}$ and dusted with iodoform. It may also be treated by swabbing the affected parts twice per day with the following simple remedy:

Common table salt	1 teaspoonful.
Vinegar	1 teaspoonful.
Carbolic acid	1 teaspoonful.
Boiled water	1 pint.

Fowl Cholera. It is a virulent, usually fatal, and highly infectious disease. While rather common in Europe, it is not so prevalent in this country, although investigations show it to be on the increase here. It is a bacterial disease affecting all kinds of birds. The disease may be acute, in which case birds die in a few hours, or it may be sub-acute, the birds lingering for several days.

The earliest indication of the disease is the yellow coloration of the urates, which, normally, are white. This may be tinted with yellow as a result of other disorders than cholera. The urates is the chalky discharge on the droppings, and is excreted by the kidneys. While this yellowish coloration is not absolutely certain proof of the presence of cholera, it should be taken as a warning and the birds showing the condition isolated. The excretion of the yellow urates, which later changes to a bright emerald green, is accompanied with more or less diarrhœa, which consists largely of colorless mucus. The bird isolates itself from the balance of the flock, the plumage becomes roughened, the wings droop and the head is drawn down to the body. They become very weak, the crop is distended and the birds show intense thirst.

Post-mortem examination reveals an inflamed condition of the digestive organs, kidneys, and mesenteries.

The disease is transmitted by contact with infected birds and drinking water used by an infected flock. Occasionally apparently healthy birds may serve as carriers, yet never show any outward ill-effects from its presence.

The only satisfactory method of treatment is to kill and burn diseased birds. In killing, do not draw blood, as this is heavily charged with bacteria, and might serve to infect the whole flock. Clean up and thoroughly disinfect all buildings and equipment, and cultivate the runs or yards thoroughly and frequently. Those birds which appear to recover from the disease should be killed and marketed to prevent them acting as chronic carriers of the disease, causing infection, and later on outbreaks.

Roup. This is a contagious catarrh attacking the membrane lining the eye, the sacs below the eye (*infra-orbital sinuses*), the nostrils, the larynx and the trachea.

The disease, which is aggravated by cold, wet fall weather, is first indicated by a watery discharge from the nostrils. In a few days this becomes thick, obstructing the breathing. The birds become listless and mopy, the wings droop and the head is drawn in to the body, while the birds show a decided loss of appetite. The inflammation, which begins in the nasal passages, soon extends to the eyes. The lids become swollen and glued together by the accumulated secretion. The viscosity of the discharge from the nostrils and eyes increases until they become completely closed, and the secretions become thick and cheese-like, producing swellings which continue to increase in size as the disease becomes more firmly established.

The course of the disease is usually of long duration. Where swellings occur about the head the case usually becomes chronic. Birds may become affected with the disease, but not at any time severely enough to be serious, yet may act as a carrier and source of infection to the flock at all times. Once introduced, it may remain in the flock for years.

While the specific organism or organisms which cause the disease are not certainly known, its infectious nature is well established. It is probably carried from one individual to another in the flock by the particles of dried secretion in the air or possibly by the food and drink contaminated by diseased birds. It may also be carried on the clothing or utensils.

Treatment.—Prevention is better than attempted cure. Be careful in introducing birds from other flocks. Isolate all sick birds, and aim to keep the flock as healthy as possible, thus rendering them disease resistant.

In case of infection, individual treatment is necessary, and as the possibility of obtaining a complete cure is very slight, it is, therefore, not advisable to attempt treatment unless the bird is a particularly valuable one. Potassium permanganate may be used in the drinking water to help prevent the spread of the disease. Treat infected birds by immersing the head in a solution of potassium permanganate for twenty to thirty seconds. This should be preceded by a massage of the head, applying pressure with the thumb and forefinger on the nostrils in the direction of the beak two or three times. If tumors are present, however, a cure is practically impossible.

Internal Parasites. They are present in the intestines and ceca in small numbers in almost all birds. Normally they do not cause trouble, but under certain conditions, however, they become so numerous as to be serious. In such cases they affect the digestion and cause diarrhœa. In such cases they may become rolled into balls in the intestines, causing complete stoppage of the same.

In treating for worms a simple remedy to use is oil of turpentine. This may be given at the rate of one-quarter to one-half teaspoonful, to which is added about an equal amount of sweet oil. Follow this in two or three hours with a teaspoonful of epsom salts. In a week or ten days repeat the treatment if necessary.

External Parasites—Lice. There are several varieties of these, which are more or less common on hens. They seldom leave the body of the bird, so that

Fig. 71. Showing swelling about the eye, a common condition in cases of roup. There is almost an entire absence of discharge from the nostrils in this case.

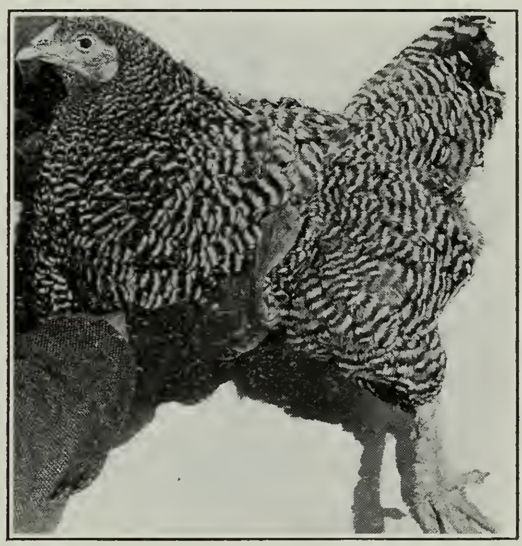


Fig. 72. Bird showing a bad attack of Scaly Leg Mite.

treating it is necessary to treat for the parasite on the bird. The common method of treatment is to dust the bird's plumage with insect powder, although in some cases applying Blue Ointment to the fluff and under the wings, or even dipping the birds in some of the prepared dips. The first two are the most satisfactory as the dipping is liable to cause colds unless the birds are thoroughly dried in a warm room.

Possibly the most satisfactory lice powder to use is one invented by Mr. R. C. Lowry, formerly of Cornell University. It is made as follows:

Take 3 parts of gasoline and 1 part of carbolic acid, 90 to 95 per cent. strength. Mix these together and then add gradually, by stirring, enough plaster of paris to take up all the moisture. It will take about four quarts of the plaster of paris to one quart of the liquid. After stirring sufficient to insure thorough mixing spread out and allow to become perfectly dry. If the proper strength carbolic acid cannot be secured the same quantity of cresol may be used.

Next to the above, pure pyrethrum or Persian insect powder will be found as cheap and effective as any.

In using any powder or treatment for lice one application is not sufficient to free the birds of the parasites, as there are the unhatched eggs which are not affected by the application. The treatment should be repeated in about ten days and a third application given if necessary.

With young chicks, lice, if present, are usually found on the top of the head. The only safe and satisfactory treatment is to apply grease, such as lard or vaseline, to the top and back of the head with the finger. The addition of sulphur to the grease is sometimes recommended, but should not be used on young chicks.

Mites. The most common variety is the fowl mite or red mite. They visit the birds only to feed, usually at night, and spend the rest of the time on the under sides of the perches, in cracks or crevices, or in collected droppings, or other filth that may be allowed to accumulate about the house. They breed in such places as mentioned above and reproduce very rapidly, especially in the hot spring and summer.

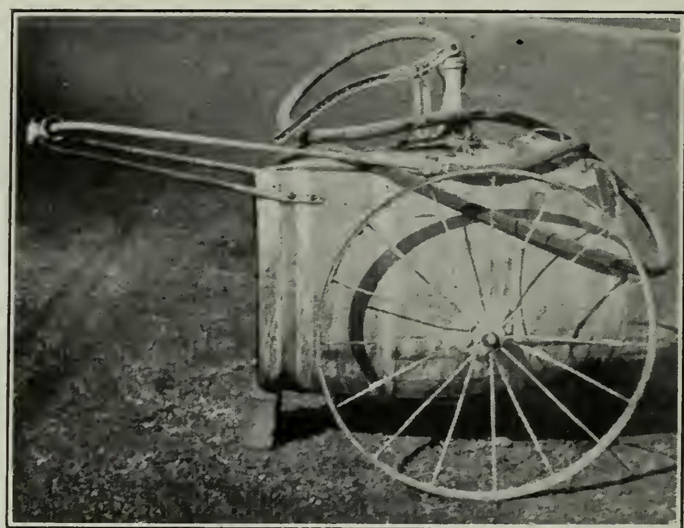


Fig. 73. A good type of spray outfit for a poultry plant.

Treating for mites consists in first thoroughly cleaning the house, removing all droppings, litter and nesting material. Then thoroughly spray with a five per cent. solution of cresol, using sufficient force to get good penetration into the cracks and crevices. Repeat this if necessary. Treating the roosts with kerosene at intervals of two weeks during warm weather will assist in preventing spread of the parasites.

Scaly Leg. The mites producing this condition excavate places under the skin where they live and breed. The irritation produced by the presence of the mites under the skin induces a discharge from the surrounding tissue which solidifies. Increased secretions raise the skin of the legs, producing the rough, scaly condition. The raising of the skin enables the mite to burrow further into the tissue, thereby aggravating the scaly condition.

Individual treatment is necessary. It consists of the application of some penetrating oil to the infected parts. Immersing the shanks in kerosene or a five per cent. solution of cresol, anointing the parts after each immersion with lard or vaseline, will usually effect a cure.

(NOTE.—In the preparation of the foregoing work on diseases the publication "Diseases of Poultry" by Pearl, Surface and Curtis, has been used extensively, for which credit is hereby given).

BULLETIN 248] [APRIL, 1917

Ontario Department of Agriculture

FRUIT BRANCH

PRUNING

F. M. Clement, B.S.A., and F. S. Reeves, B.S.A.

PRUNING FRUIT TREES, VINES AND BUSHES*

In submitting the following pages it is requested that it be borne in mind that an attempt is made to present general facts only. At no time are variations of varieties dealt with specifically. It is felt that the basis of intelligent pruning is a thorough knowledge of the fruiting habit of the tree. The point of view that is kept in mind always is perhaps somewhat distant from the popular opinion. Pruning as generally discussed by practical men throughout the Province is primarily a special operation performed on the tree regularly or irregularly to make it produce fruit abundantly. The point of view accepted by the writers is that the natural habit of the tree is to produce fruit abundantly, and that pruning is a special treatment intended to aid the tree in its natural habits. The fruit for market purposes must possess a certain degree of (1) color, (2) quality, (3) freedom from blemishes, (4) size, (5) uniformity. Pruning is to assist in the development of these qualities to the greatest possible degree. It is desired to emphasize this fact. Fruiting is natural for the tree. The object of pruning is to assist in making the fruit merchantable. Pruning may not accomplish the desired objects. It alone may be carried to excess in which case the results are as disastrous as no pruning at all.

Pruning should be carefully distinguished from training. During the first few years of its life a tree is largely trained. It is desired to construct a framework that will carry the maximum amount of fruit with merchantable qualities. At the same time in the construction of this framework the main purpose of the tree—that of fruit production—must not be lost sight of. Training also includes putting and keeping the tree within manageable bounds. It must be kept under the absolute control of the operator. Such terms as "heading in," "cutting back" and "dehorning" are not fully understood. These operations are largely for purposes of "training" and only partly for purposes of fruit bearing control. Such operations are sometimes recommended for certain "ills" or "bad habits" to which the tree is subject, for instance—biennial bearing. Pruning is not a specific for the various ills but rather a treatment along with other treatments, cultivation, spraying, fertilizing and thinning, to keep the tree in its natural habits.

No definite rules can be laid down. Pruning, though one of the oldest of orchard practices, has been studied very little scientifically. Only a few generalities can be given, such as (1) heavy winter pruning tends to the production of wood growth, (2) heavy summer pruning tends to the reduction of excessive wood growth. And even these statements are made only generally especially for the latter case. Pruning studies are still in their infancy.

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*The material for this Bulletin was prepared by the joint authors while F. M. Clement was the Director of the Horticultural Experimental Station at Vineland.

Of the various operations practiced by the fruit grower, pruning is placed first and is considered of most importance. Color in a variety is the best evidence possible denoting that the fruit is mature and has matured in the sunlight. Of late years, spraying has been emphasized most emphatically and pruning though not neglected has for its importance been overshadowed. Spraying is a special practice for the control of fungus and insects, and to stimulate the general health and vigor of the tree. Fungus, the greatest enemy of tree fruit, thrives in shadows, darkness and moisture. Spraying is only an artificial means that must be practiced to make more complete the results. Spraying is to augment sunlight not to take the place of it. For insects, poisons, food and contact, must be applied in order that it may reach the insects or the insects may be able to reach it. Judicious pruning is one of the foundation stones of success in spraying.

Fruit bearing should be uniform and regular. In practice, however, especially with pears and apples, the ideal is not always obtainable. But, keeping in mind the objects of the various operations of production, can it be said from experience that the operations are as uniform and regular as they should be? The main point to emphasize is this. Regularity of pruning, regularity of cultivation, regularity of spraying, fertilizing and thinning tend to retain the regular natural habits of the tree. The extreme of any one operation is advisable only when it is desired to throw the tree out of balance, or if it is already out of balance to throw it in some direction with the hope that it may be the right and proper thing to do.

But little is known about the whole subject and the field of study is very large. As a basis of general study, however, the following pages are offered. It is hoped that the various fruits may be dealt with more specifically and in detail at a later date.

FRUITING HABITS IN RELATION TO PRUNING

The nature study idea has in recent years been much talked of in educational circles. Probably nature study in its truest sense was designed for children, but any of us might profit had our faculties for observation been quickened by such study. Much of our education is gained through observation, and many of us are such poor observers that two or three good educations might be overlooked in a lifetime. It is observation that will teach us to answer such questions as these: How many flowers will a single fruit bud of the peach, plum or cherry produce? Do these fruit buds produce leaves as well as flowers? Are the fruit buds axillary or terminal? Yet the formation is important in order to understand the aim and objects of pruning in relation to fruit bearing. The moral is, we should be better observers and if this bulletin does no more than encourage a better observation of our fruit trees and plants the time and effort will have been well spent.

Anyone who has had any great experience in pruning the common fruit trees and plants realizes that they bear their fruit in certain positions, each kind of fruit tree or bush having a fruit bearing habit more or less its own. Great variation in detail may be noticed between varieties of the same fruit, but in general their fruiting habits are similar. This bulletin deals with general fruiting habits only.

The pruning operation is one of the most important in the fruit plantation, and the ideas here advanced are based on observations and a study of the buds from the dormant stage until buds are produced again and the fruit is ripe. Though the details of pruning every kind of fruit are not fully discussed. it is hoped that the fundamental principles to be observed in pruning in relation to the fruiting habits of these plants have been clearly set forth.

TYPES OF FRUIT BEARING.—Among our common deciduous fruit trees we have two types of fruit bearing: from axillary buds, and from true terminal buds. The axillary buds are borne in the axils of the leaves along the side of the spur or branch and the terminal buds, at the end or tip of the branch. When applied to buds the last term is confusing for not every bud terminating the growth of the season is a true terminal bud. Each axillary bud is developed in the axil of a single leaf, while the true terminal bud is usually subtended by two leaves, and in the latter case a continuance of the spur growth will be produced from a lateral

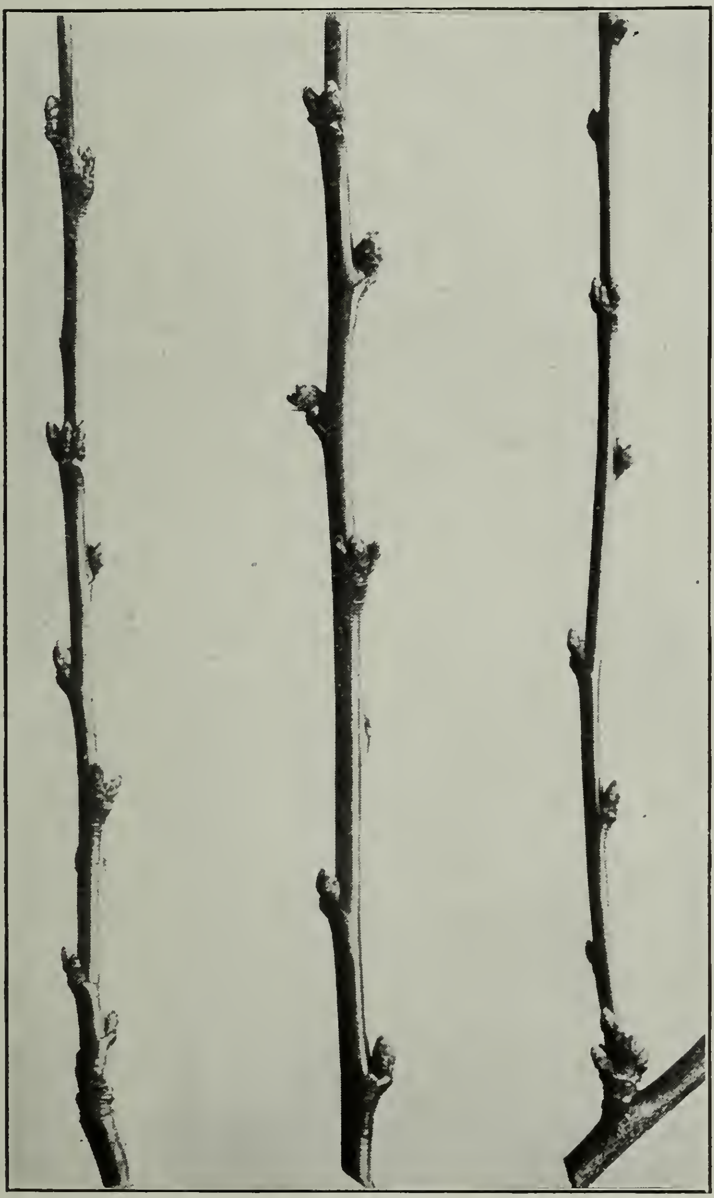


Fig. 1. Greensboro.

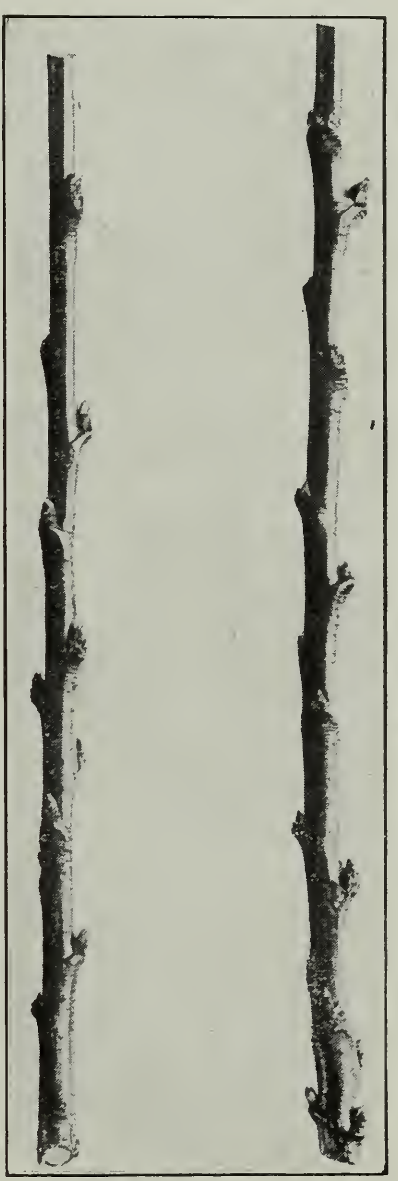


Fig. 2. St. John.

bud. The plant which bears its fruit from axillary buds is naturally more productive than the one that bears only from terminal buds. The stone fruits as a class bear from axillary fruit buds, and they are recognized as more fruitful than apples and pears, which bear mostly from terminal buds. For this reason the stone fruits require more vigorous pruning. But a fruit bearing habit may mean more than bearing from axillary or terminal fruit buds. Fruit buds may also be said to appear on certain ages of wood or certain types of branches. But each kind of fruit has a fruit bearing habit more or less peculiar to itself, and must be considered separately.

PEACHES

The fruit buds of the peach are normally axillary, and only very rarely is one found terminating a twig. They are borne always on one-year-old branches and short twigs the latter sometimes very much resembling tree fruit spurs. These buds open and produce a single flower but no leaves. They are borne single in the axils of single leaves or in pairs, one on either side of a leaf bud, the three buds being borne in the axils of as many leaves.

The first type of flowering is found in trees very lightly pruned or on weak shoots in well pruned trees with certain variations depending upon variety. Some of our best varieties bear a large percentage of their buds singly. Fig. 1 shows the two types of buds, the single buds on the smallest and weakest grown shoot and a

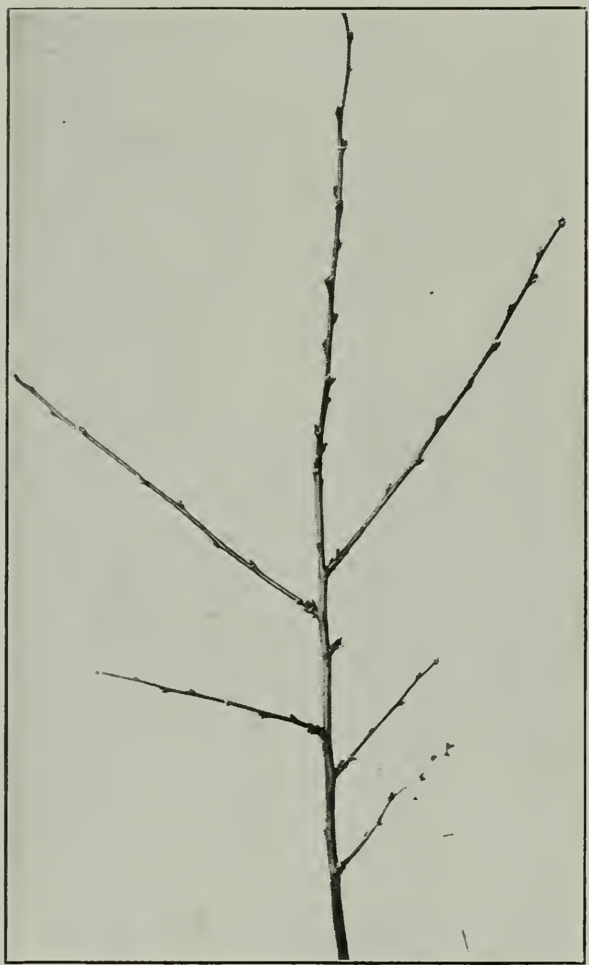


Fig. 3. Greensboro.

Fig. 4. Crawford.

majority in the three bud formation on the strongest shoots. The stronger type with the triple buds is most desirable. However, some of the best varieties bear their fruit buds mostly singly even on strong twigs, as a reference to Fig 2 shows.

In Fig. 2 most of the buds are leaf buds and the fruit buds may be noted as being more rounded at the apex and a little stouter throughout. In most varieties shoots that do not make a growth of over ten or twelve inches bear their fruit buds singly. The triple buds are found on the stronger one-year-old wood.

In reference to Fig. 3 it will be seen that the centre shoot which is the strongest grown, bears far more of its buds in the triple formation than the laterals which are shorter and weaker and have most of their buds borne singly. Fig. 4 shows a branch in which all buds are single and but few of which are fruit buds.

Fig. 5. Greensboro.

Fig. 6. St. John.

Fig. 7. Greensboro.

Fig. 8. Crawford.

Figs. 5 and 6 show the buds of the two types at the opening stage. Fig. 5 is triple bud formation in which the centre is a leaf bud supported by the fruit buds on either side. This is the large flowering type of peach while Fig. 6 is of the small flowering type. The latter shows the single buds opening and the uneven distribution of leaf surface while there is a good percentage of fruit buds. This

Fig. 9. Greensboro.

Fig. 10. Crawford.

point is well to remember as it has considerable significance in "heading in" fruiting wood for the purpose of thinning the fruit.

Fig. 7 shows the triple bud flowering type—two blossoms, one leaf bud—where there is an abundance of bloom and an even distribution of foliage, also even bloom on short laterals or spurs on two-year-old wood. In this illustration the branch at the right was cut from the branch at the left and all parts are one-year-old wood except the heavy portion of the branch on the left. Fig. 8 shows the type with the single bud formation and consequently a scarcity of leaves along that portion of the branch where most of the fruit is borne. The petals of the flowers have fallen. In this latter case it is impossible to thin the fruit by heading in the fruiting wood because a large percentage of leaf surface is lost with the consequent poor nourishment of the fruit. Where the tree has made poor growth and where the fruit buds are borne singly, pruning can be employed as a means of thinning the fruit only in so far as whole branches can be spared. With the triple bud formation, heading in may be resorted to, for fruit thinning purposes without fear of loss of leaf surface. The fruiting wood with its fruit buds in pairs with a branch bud between—that is the triple bud formation—may be cut back to even its last pair of fruit buds. The branch bud will continue the growth of the twig. Such a type of fruiting wood can only be developed by severe pruning. Some of these strong twigs will grow in the tops of poorly pruned trees, but to grow them in the centre of the tree the top must be pruned back severely. It is almost impossible to maintain a fruiting depth of more than four to six feet. Little is gained by growing a peach tree fifteen feet in height when the bottom seven feet is barren. It is better to keep the trees down to a height of ten feet with fruiting wood within three feet of the ground. A well pruned tree will grow thirty inches or more of new top each year, but if the tree is to continue productive, a very large portion of this must be removed each year. It is safe to say that in a well pruned peach tree from one-third to three-quarters of the one-year-old growth is removed each pruning season.

Figs. 9 and 10 show the two types of bud bearing wood in fruit. Fig. 9 is that of the triple bud formation, and shows that while it bears an abundance of blossoms very close together the fruit that sets has ample room and will develop normally, although some of them are very close and may require thinning. Fig. 10 shows the fruit well scattered from the single bud formation. The leaves of this branch had wilted before it was possible to photograph it.

PLUMS

The different species of plums vary considerably in their fruiting habits. Only the Triflora and the Domestica groups are dealt with here. The fruit buds are borne mostly in groups on short spurs on two and three-year-old wood and singly on one-year-old wood. Most of the plums bear no true terminal buds and weak spurs are objectionable as frequently they bear no leaves and after producing their fruit die and become thorns. The Japanese or Triflora group bears its blossoms and fruit somewhat like the peach, a large percentage of their buds being borne singly on one-year-old wood. Occasionally the triple bud formation of the peach is found. Most of the fruit is, however, borne on short spurs on two and three-year-old wood. On older wood short spurs are found which bear buds in clusters. The Domestica group bear the fruit mostly on short spurs on two or three-year-old wood and very few fruit buds may be found on one-year-old wood. The latter seldom set fruit. In pruning these two groups of plums the point to bear in mind is that most of the fruit is borne on wood ranging from one to four years old. Each fruit bud may produce four or five flowers. They bear no leaves or at best only rudimentary leaves. The larger number of buds indicates more vigorous growth. Generally speaking, the best types of fruiting wood are the spurs that are also vigorous enough to bear some branch buds. This type of fruiting wood is supplied with means of continuing its growth, and will develop fruit buds for another year.

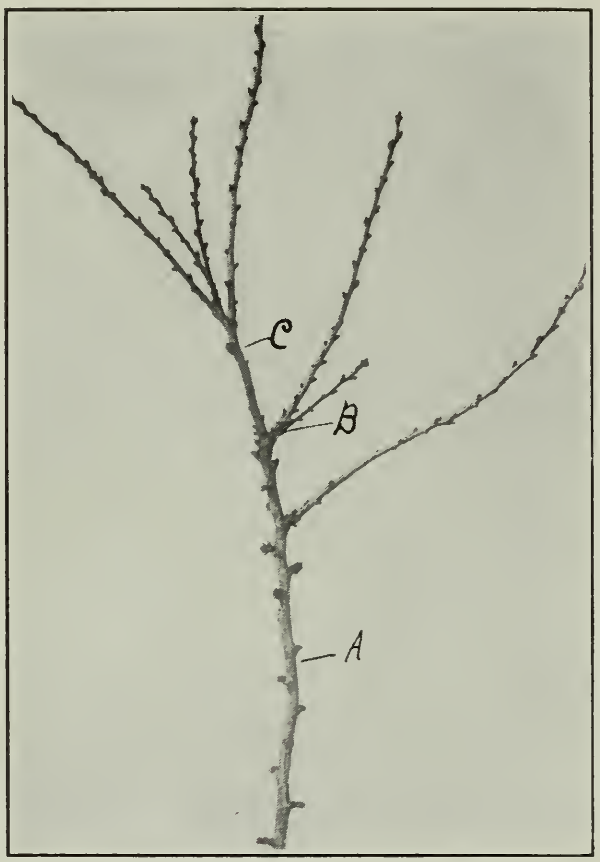


Fig. 11. Burbank.

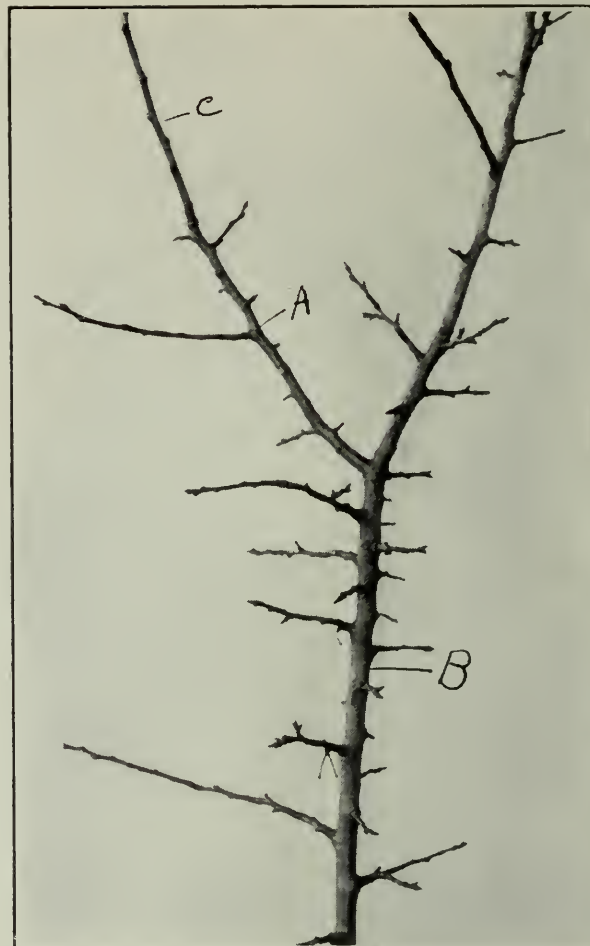


Fig. 12. Reine Claude.

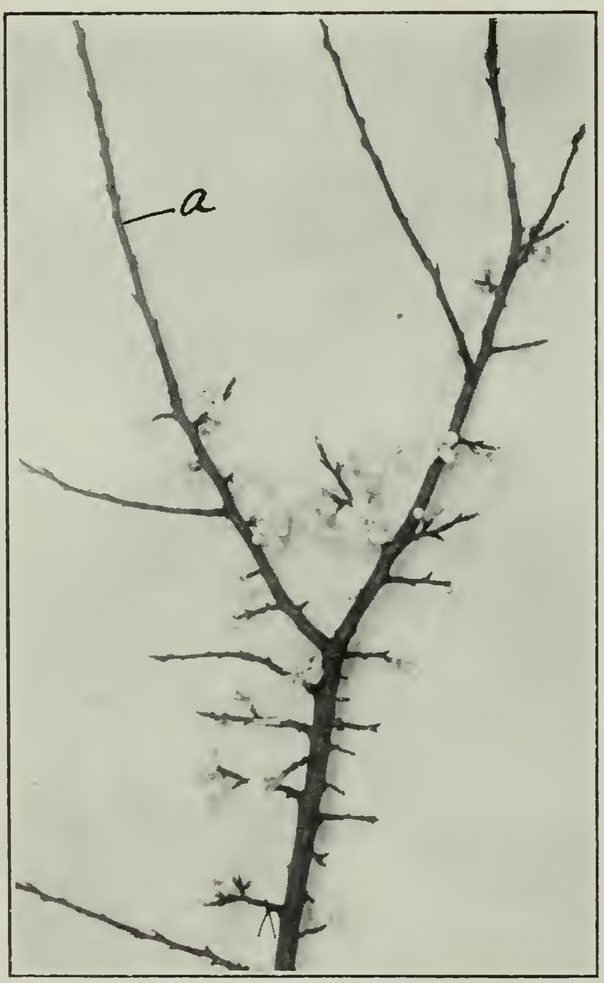


Fig. 13. Reine Claude.

Fig. 14. Burbank.

The spurs, however, cannot be depended upon for very long service. The best of these are one year old. To keep an annual supply of these one-year-old spurs a good supply of new twigs must be grown each year from twelve to eighteen inches in length. In most varieties these twigs will bear some fruit the following year and will also develop from axillary branch buds strong spurs that may be depended upon for the next year's crop. Nearly every cluster of buds will have one branch bud which may be depended upon to continue the growth of the twig.

Fig. 11 shows a branch of one, two and three-year-old wood of one of the Japanese varieties. It will be noted that the best buds are on the spurs on the three-year-old wood (A) and around the base of the one-year-old twigs (B). The two-year-old wood (C) in this case is very short and bears very few buds. The stout round buds are fruit buds whereas small and pointed buds are leaf buds.

Fig. 15. Burbank.

Fig. 16. Burbank.

The manner of pruning this type of tree will differ from the Domestica on account of the different habit of growth. The principle of maintaining a supply of comparatively young wood for the production of fruit buds is, however, the same.

Fig. 12 shows a branch of two (A) and three-year-old wood (B) of the Domestica group with an abundance of fruit spurs along the length of the stem. The smaller twig (C) is one year old. In this case there is not so much difference in appearance between fruit and leaf buds, but a reference to Fig. 13 will show the abundance of bloom on these spurs. Position laterally rather than terminally is a fair indication of the denomination of the bud. Notice also the absence of bloom on the one-year wood (a). Fig. 13.

Figs. 14 and 15 show fruit spurs up to three and four years old which are found growing on the main branch of a plum of the Japanese group and in the case of open headed trees will bear a fair crop with the minimum of wood growth. Notice the very heavy grouping of the buds on old spurs in Fig. 15. The two central cuttings of Fig. 15 illustrate an attempt to continue growth even in a partially shaded position on the main limbs.

Fig. 16 shows the same type of spurs in bloom.

Fig. 17 shows a branch of the Japanese plum in bloom. This branch consists of one, two and three-year-old wood. The main stem is three years old, while the two-year wood is a short growth at the fork of the branches. The topmost shoot

Fig. 17. Burbank.

Fig. 18. Keiffer.

is one-year-old wood. If shaded, the spurs on the two and three-year-old wood will gradually die, and others on the younger and newer wood will take their places. It is essential some new wood be produced each year.

PEARS

Pears, unlike the stone fruits, bear their fruit from terminal buds on short spurs. These spurs are found on two-year-old and older wood, and sometimes, but very seldom, fruit buds may be found terminating the growth of one-year-old wood. Such buds, however, as the latter, seldom set fruit, and are of little importance to the fruiting habit of the tree. In a young and fast-growing tree the spurs may become well developed on two-year-old wood, and as the tree increases in age continue to develop. They do not die out after one, two and three seasons of fruiting as in the case of plums.

Pruning, therefore, develops itself into a method of keeping these spurs in a healthy and vigorous state with an ample supply of sunlight and air, to prevention of overbearing and the encouragement of growth. On young trees, the long, one-year-old growth may be shortened back and thinned out and so give the spurs

Fig. 19. Keiffer.

Fig. 20. Keiffer.

full opportunity to develop. Too severe cutting, however, tends to produce wood growth at the expense of spur development. On an older and more mature tree, the annual growth becomes less rapid. The branches which are from twelve to fourteen years of age will bear a mass of fruit spurs. Each fruit bud will bear from four to five flowers and as many leaves and the spur as long as it is maintained healthy and vigorous will continue to produce fruit and leaves annually or biennially.

Fig. 18 shows a two-year-old branch of a young, fast growing tree with short fruit spurs up the stem. The twigs at the top are one year old. The illustration shows where the two-year-old branch had been shortened the previous year to encourage spur development. The branch, however, indicates extreme wood growth and indifferent spur growth caused by too severe cutting back.

Fig. 19 shows the same type of branch in blossom. Notice that each spur has an ample supply of leaves to develop its fruit. This branch was much more "mature" for its age than Fig. 18. Notice also some terminal bloom on the new wood. This latter bloom by chance may develop fruit. Notice also that no blossoms are found on the new or one-year wood.

Fig. 20 shows the same type with its crop of fruit. Here it will be noticed that the development of each fruit seems to be in proportion to the amount of leaf surface growing on the spur.

Fig. 21 is an old and well-branched fruit spur found on the older branch of a tree. The exact history can be read owing to its habit of producing fruit from

Fig. 21. Bartlett.

Fig. 22. Bartlett.

terminal buds. The bud that continues the growth of the spur arises from below the fruit during the year the fruit is being borne and so causes the spur to have a zigzag appearance. Growth never continues from the scar where the fruit was attached. A, B, C and similar scars show where fruit has been borne. Each bud will ordinarily produce four or five blossoms and as many leaves, and at the time of opening will grow out an inch or more. These buds are not always fruit buds, as reference to Fig. 22 will show. This is a similar spur and shows only two of these buds as being fruit buds. This condition on the individual spurs is largely controlled by the condition of the tree at the time these buds are formed the previous year. Where there is an extra crop of fruit to call largely on the resources of the tree, nature has made provision that only a few fruit buds will be developed, and the remainder will be leaf buds. This creates a tendency towards the biennial habit of bearing.

Fig. 23. Bartlett.

Fig. 24. Bartlett.

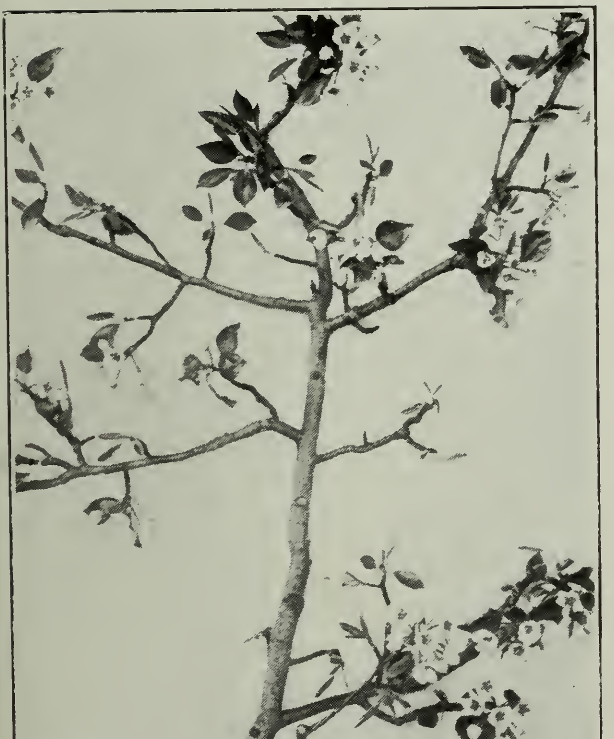


Fig. 25. Bartlett.

Fig. 26. Bartlett.

Fig. 23 shows a spur similar to Figs. 21 and 22 in fruit. In this case most of the leaves have been cut away and the buds may distinctly be seen. Notice the continuation of the spur in the long new wood at the right.

Figs. 24, 25 and 26 each shows a branch of a mature tree. It is obvious that such branches will need no pruning excepting for purposes of thinning the fruit. Here again every spur does not produce a cluster of blossoms. In some cases they may be seen to produce a small branch one or two inches long in the season; such a one for instance may be seen in Fig 23 above the fruit at the right. The fruitfulness of each spur is controlled by conditions of the previous season for if it could not then produce a fruit bud, none but leaves can arise the following season; in this season, however, it will make a very short growth of an inch or two and set good strong fruit buds.

Study Figs. 24 and 25 together. They are excellent illustrations of the general fruiting habit of the average mature but thrifty pear tree. Though the two illustrations are not from the same branch, Fig. 25 will illustrate where blossoms would have formed on Fig. 24.

CHERRIES

The cherries develop most of their fruit buds in the axils of leaves on short spurs on two and three-year-old wood. Some fruit buds are borne singly on one-year-old wood in the sour cherries, but very few buds are borne on wood over three years of age on either sweet or sour varieties. The spurs after bearing two or three crops usually succumb to adverse conditions of intense shade and poor air circulation. Only on well-pruned trees do they continue to bear good crops for several years, and even on such trees the great quantity of the fruit is borne on newer spurs on the two- and three-year-old wood.

Such a branch of the sweet cherry is shown in Fig. 27. The branch at the left was cut from the other for photographic purposes. This shows one, two and three-year-old wood. (A) shows the point of union between the one and two-year-old wood and (B) shows the point of union between the two and three-year-old wood. It will be noticed that the most of the fruit spurs are near the top of the two and three-year-old wood. This is not quite so pronounced as is seen in the case of one of the Duke variety shown in Fig. 28. In this case the second year's growth is shown in the cluster of spurs at D.

Figs. 29 and 30 are taken from a sour variety.

In Fig 29 the two centre branches have fruit spurs right to the top. This quite often happens. The whole strength of the branch has gone to the production of fruit buds at the tip instead of continuing the growth. This type of wood cannot be considered desirable, as no new wood has been made for the continuation of fruiting wood. Notice also some fruit spurs at the base of the one-year wood. Fig 30 is also a sour cherry branch showing the desirable type of wood. Wood of this type bears heavy annual crops and continues to produce fruiting wood regularly. The branch at the right was cut from the stub on the larger branch. Branches of this type are generally found only in the tops and over the surfaces of poorly pruned trees. They can only be developed throughout the entire tree by vigorous pruning or thinning out to allow growth to develop from the main branches. The sour varieties bear more fruit on the one-year-old wood than either the Duke or Sweet varieties. Consequently "heading-in" is very apt to remove a large number of fruit buds.

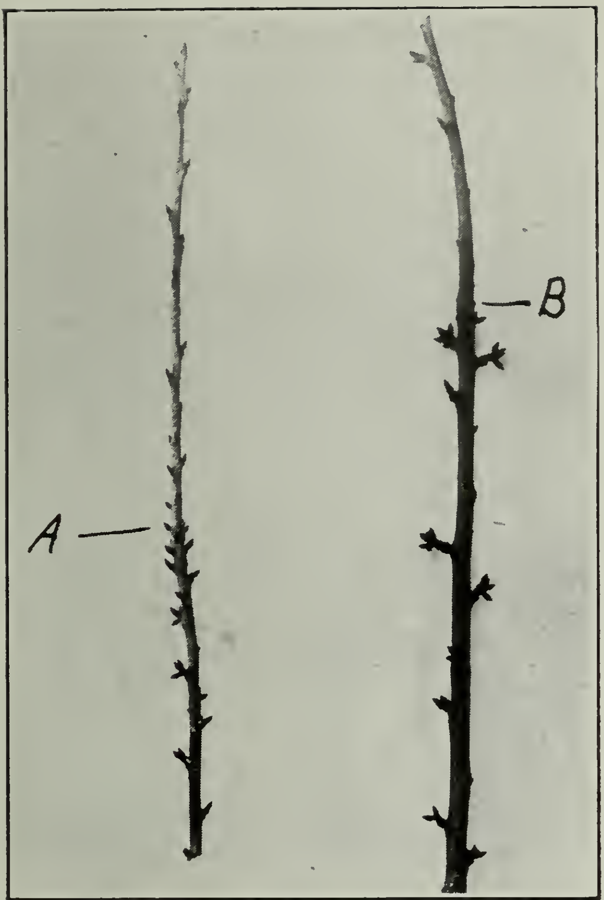


Fig. 27. Sweet Cherry.

Fig. 28. Duke Cherry.

Fig. 29. Sour Cherry.

Fig. 30. Sour Cherry.

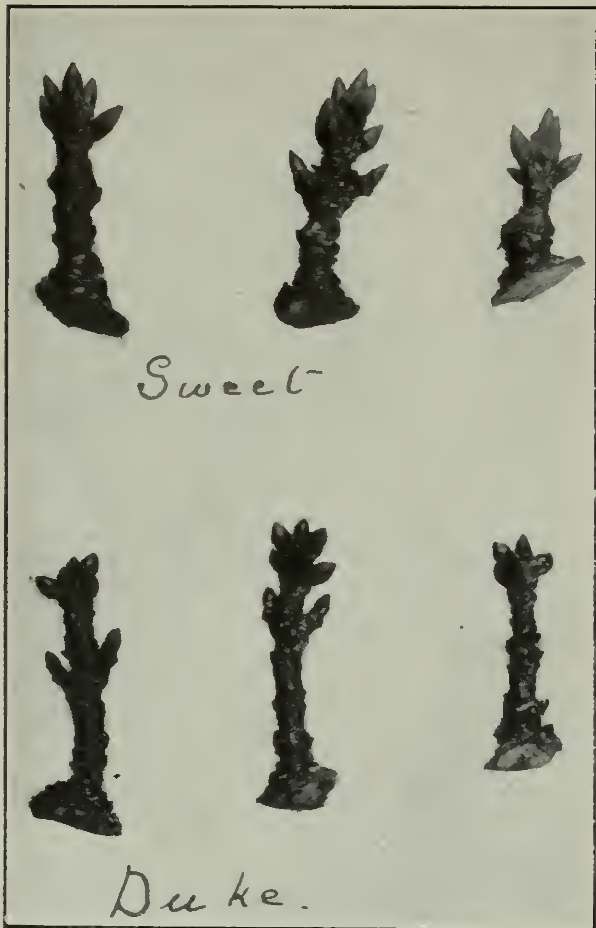


Fig. 31. Cherries.

Fig. 32. Cherries.

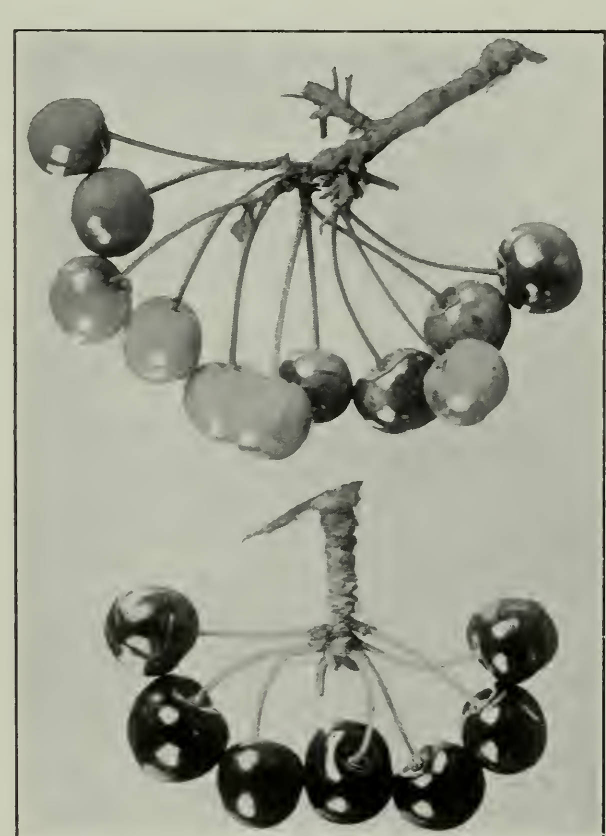


Fig. 33. Duke and Sweet Cherries.

Fig. 34. Sweet Cherry.

Each bud may produce from one to five or more flowers but no leaves. The spurs are provided with leaf buds and a terminal branch or leaf bud which continues the growth of the spur in a straight line.

Figs. 31 and 32 show spurs in the dormant stage and in bloom. Notice which are the leaf buds and which are the flower buds. In both cases the upper spurs are of a Sweet variety and the lower a Duke. Both have the same fruiting habits. Notice the difference in shape of buds between the Sweets and the Dukes.

Fig. 33 shows the same type of fruit spurs with their load of fruit. The leaves have been cut away. The buds which will continue the growth of the spur and

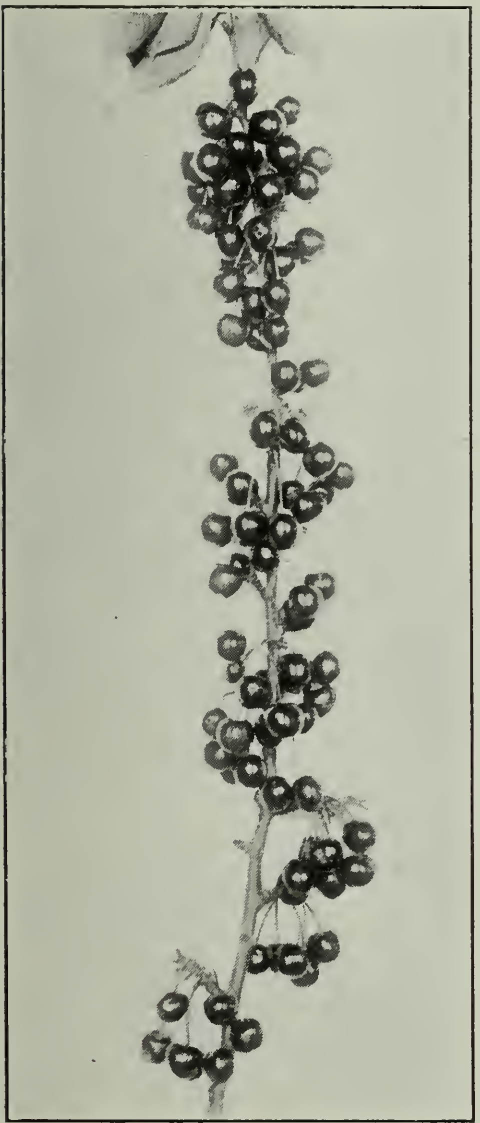


Fig. 35. Sweet Cherry.

Fig. 36. Duke Cherry.

produce the next season's crop are borne in the axils of the leaves, but at the fruiting stage are not far enough developed to show in the illustration. After the crop is off they develop quite rapidly, and extend the length of the spur a half inch more or less. This amount of growth varies according to the general vigor of the tree. Spurs on poorly pruned trees may not grow over a quarter of an inch, and under such conditions of growth are inclined to bear only on alternate years. Spurs that grow three-quarters of an inch are the most desirable type and will produce annual crops of vigorous blossoms and large fruit. But it is a question if it is wise to depend upon old spurs. It is better to prune the tree enough

Fig. 37. Duke Cherry.

Fig. 38. Sour Cherry.

Fig. 39. Sour Cherry.

Fig. 40. Sour Cherry.

to secure each year some new growths of from four to twelve inches long. These new twigs will bear a few lateral fruit-buds near the base and those nearer the tip will be leaf buds. The following year these leaf-buds will develop vigorous and productive young fruit spurs. If the new growths are long and produce many lateral buds it is best to reduce the number of leaf-buds to five or six by heading-in during the dormant season. If many buds are left the resulting spurs will be weak and the best ones will be too far removed from the main branches of the tree.

The cherries then produce their fruit on short spurs and at the base of some one-year-old twigs. Fig. 34 shows the sweet cherry in bloom and Fig. 35 the same is one, two and three-year-old wood. In this particular case the two-year-old wood. Bloom similarly is borne along the older branches but not in so great profusion. The shoots with leaves only at the top are one year old. In Fig. 35 the leaves have been cut away to show the fruit. Here is shown the quantity of fruit borne along five different season's growth. The branch was taken from a mature, well-grown tree where the annual wood growth was short. The tree had been well pruned. The new wood at the top has no fruit. The one-year wood just below it has the greatest quantity, gradually decreasing until the fifth year is reached at the base. A few spurs must be developed each year to take the place of the older ones.

A Duke variety is shown in bloom in Fig. 36. The branch which is in bloom is one, two and three-year-old wood. In this particular case the two-year-old wood is very short, being only an inch or two in length at the densest part of the bloom. In Fig. 37 the leaves have been cut away to show the fruit, which is near the terminus of the two-year-old part of the branch.

Fig. 38 shows branches very similar to Fig. 29, except that the buds have burst into bloom. Compare the two figures.

Fig. 39 shows a sour cherry in bloom with blooms on spurs of two and three-year-old wood, and from lateral buds on one-year-old wood.

Sour cherries in fruit are shown in Fig. 40. The leaves are removed to show the position of the fruit. The portion of the limb on which the greater quantity of fruit hangs is two years old. That above the union of the three twigs at A and B on the larger branch is only one year old, and shows consequently only a few fruits. The sour cherries then produce the most of their fruit on spurs found on two and three-year-old wood, with a small percentage from axillary buds on one-year-old wood. The more the trees are opened to the sunlight the longer will the old spurs survive, and the more numerous will they be on main limbs and stronger branches.

APPLES

The apples, like the pears, generally speaking, bear their fruit from true terminal buds on short spurs. Sometimes fruit is produced from the terminal bud on new wood. Each bud may produce from one to five or more flowers and as many leaves. This condition is shown in Fig. 41. The position of each fruit borne in former years is also shown at A, B, and C. The reasons the spurs grow crooked are the same as in the case of the pear; the fruit bud is always terminal and the bud that continues the growth of the spur arises from below the fruit. Note also the central blossom from each spur. It has opened a little in advance of the other blossoms in the cluster.

Fig. 41. Baldwin.

Fig. 42. Apple Spurs.

Fig. 43. Spy.

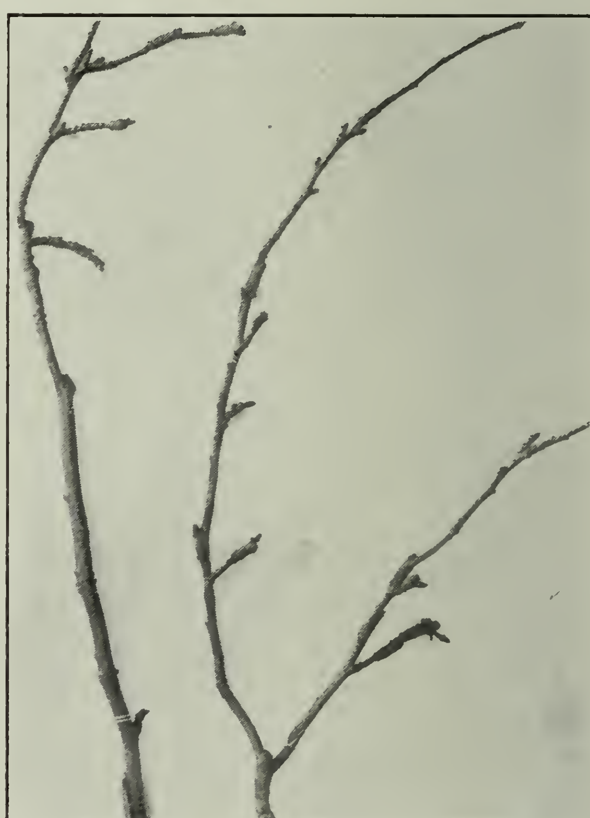


Fig. 44. Spy.

In Fig. 42 is shown the bud (a) for the continuation of the spur which may be found situated below the stem of the two apples. The rate of growth of each fruit-bearing spur depends largely upon its situation on the tree, and the health and vigor of the tree. Pruning, to admit sun and air, is not the least factor in the development of spurs. Very often, owing to lack of vigor in the tree, or possibly sunlight, the terminal bud remains a leaf-bud. When pruned too heavily this continues growth in the form of a twig. If allowed to remain shadowed, it cannot possibly grow into either fruit spur or twig.

Fig. 43 illustrates the effect of too heavy pruning. These two twigs bore one or two fruits each near the junction at the main stem, then for several years produced no fruit. One fruit was produced on each branch, but owing to the vigorous growth of the tree instead of only the spur and bud or a short twig a branch has been produced. Notice the long, slender, new growth starting from below the fruit and continuing upward. This can scarcely be expected to bear fruit the next year, though it may after the plan illustrated in Fig. 44. Apples have at various times been produced along this branch, but the growth being rapid gave the limb the appearance of a small branch rather than a fruit spur. These small branches are very often found growing along the main limbs of the tree. On insufficiently pruned trees they succumb to darkness, leaving the fruit to be produced on short spurs on younger wood over the outer surface of the tree. When the top is sufficiently open to admit sunshine, they produce fruit regularly.

Fig. 45 shows the spurs on two, three and four and five-year-old wood. The one-year-old wood is seen at the top of branch A. The branch A is cut from branch B. In young trees very seldom are fruit buds found terminating the season's growth, and the lateral buds are always leaf-buds. No exception is known to this. A few varieties set fruit terminally on new wood on young trees. The fruit spurs with their terminal fruit buds are found on two-year wood and older. On mature trees many of the small branches bear flowers along their whole length from short spurs, and also carry terminal flower buds. In this case the small branches may be looked upon as overgrown fruit spurs. Figs. 46 and 47 in bloom illustrate this. The blossoms appear to be coming from lateral buds on new wood, when really they are very short spurs on two-year and older wood. The marks between the various season's growth do not show in the illustration.

Two years at least are required to produce a fruit spur. Observation shows that a part of the lateral buds on one year wood, under proper conditions of growth, light and air, grow out into short spurs the second year. These may or may not set fruit buds the second year. Under average conditions, they do not. The following year, the spur grows a little longer and sets a fruit bud. The following year the fruit may be produced, i.e., first year, lateral bud; second year, short spur; third year, fruit bud; fourth year, fruit. With normal growing conditions in well pruned trees, the growth given above as second and third year may be produced in one year.

Why are many apple trees biennial bearers? From a "fruiting habit" point of view, the question might be answered this way. The fruit bud is the terminal bud on the spur. While the fruit is maturing on the spur, a bud, or a short growth and a bud, is being produced below it. This is to continue the wood growth of the spur. The best effort of the tree seems to be put forth to mature the apple and ripen the seeds it contains. The bud on the new growth is the reserve bud that may be called on if needed. When once the fruit is ripened the food supply may be used to develop more fruit buds. And that is what really happens, but it cannot be

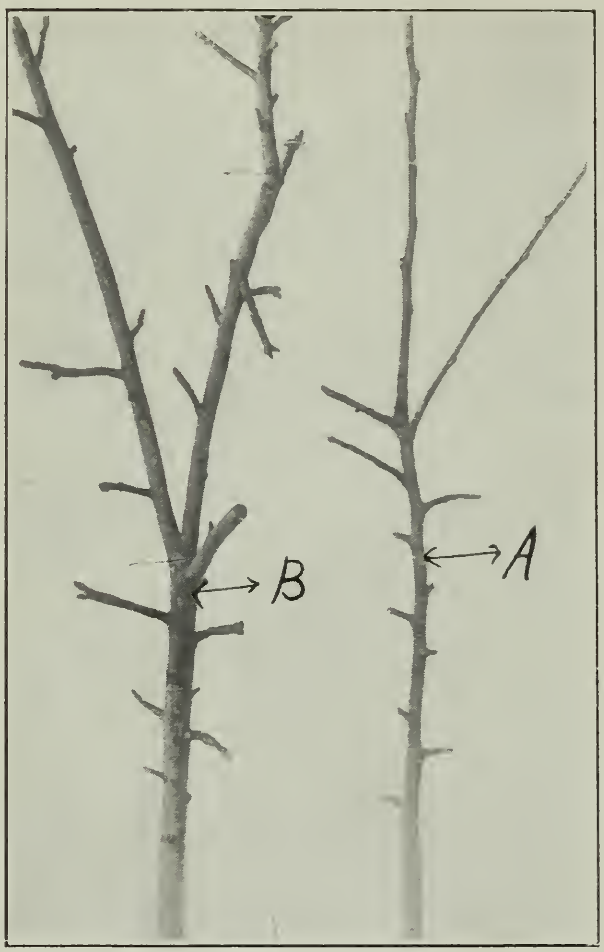


Fig. 45. Baldwin.

Fig. 46. Baldwin.

Fig. 47. Transcendent Crab.

Fig. 48. Transcendent Crab.

done before the following year, as the apple did not ripen till fall. The year is required to once more fill the tree with fruit buds, which in turn produce a crop the following year.

Fig. 48 shows fruit on short spurs on two and three-year-old wood the way it is produced on comparatively young trees. Notice the new rapid growth beyond the fruit.

Fig. 49 shows the fruit on a small limb, which contains many fruits spurs and small branches found throughout the head of well pruned trees.

Fig. 49. Baldwin.

GRAPES

Grape vines bear their fruit entirely on wood of the current season's growth. The varieties may vary in extent of growth, but the fruit is usually borne in about the same position no matter what the variety.

An examination of the old fruit canes in the dormant season will illustrate what has taken place at each node of the cane. In Fig. 50, the four branches are all one, cut for purposes of photography, (a) the first node produced a leaf and bud in its axil, the next four nodes (b) produced a bunch of fruit each with a leaf opposite and buds in their axils, the next produced a tendril and leaf (c) and the next node a leaf and bud only (d), the next two nodes produced tendrils and leaves opposite and buds in their axils (e), the next one a side shoot and leaf (f) and the remaining nodes produced leaves and tendrils at each node alternating the position of each on the side of the cane with buds in the axils of leaves to the end (g). The cane was sixteen feet long, and is not all included here. One side shoot is usually

Fig. 50. Lindley.

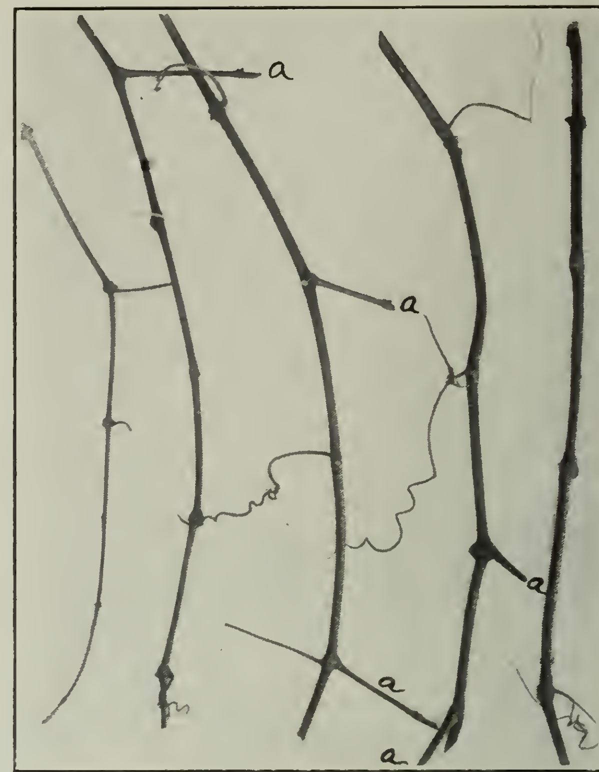


Fig. 51. Concord.

Fig. 52. Concord.

Fig. 53. Lindley.

produced on a strong cane and sometimes two or even three. These produce fruit, leaves and tendrils on the same system as the main cane, but the fruit is usually small and the bunches loose. Usually they are late in ripening.

Fig. 51 is a similar cane of a different variety. It shows a cane bearing five side shoots (a) which should be pruned in any summer pruning that may be attempted. In their effort to produce bunches of fruit these absorb energies of the vine that should go to develop the first set of fruit on the main cane. Almost every bud produced in the axil of a leaf will, if the vine is allowed to grow, produce fruiting canes the following year on the same system as this fruit was produced. Hence, the reason the vine must be pruned annually back to a certain number of buds. It concentrates the fruit on a certain number of canes.

Fig. 54. Concord.

Fig. 55. Lindley.

Fig. 52 shows the growing shoot as it comes from the bud on the old cane early in the season. Three bunches of fruit are forming, and the illustration shows clearly the sub-laterals (a) which spring from the axils of the leaves subtending the next season's bud. This is the right stage to remove these sublaterals. They are of no value. Any fruit that may be produced on them will be small of bunch, and will not likely mature.

Fig. 53 shows the same formation, but on a different variety. Sub-laterals are attempting to grow at nearly every node. The usual formation of a bunch of fruit with a leaf opposite at the first three or four nodes will be noted, the leaves and fruit alternating on the side of the cane. Leaves and tendrils alternate in a similar manner.

Figs. 54 and 55 shew ripened fruits of the same varieties. Notice the extent to which the sub-laterals have grown.

Fig. 56. Raspberry.

Fig. 57. Red Raspberry.

Fig. 58. Black Raspberry.

Fig. 59. Black Raspberry.

RED RASPBERRIES

Red raspberries bear their fruit in loose clusters and singly from the axils of the leaves on the short laterals of the current season's growth. This growth is borne on one-year-old canes. Raspberry canes usually grow straight, although sometimes they throw off one, two or a number of branches. Some growers advocate pinching back at the top when it has reached the height of three or four feet to induce branching. It is questionable if this operation is advisable, as the laterals produced cannot possibly be the most vigorous, and may easily succumb to the rigors of winter. Canes allowed to grow straight, and cut back in the spring, will bear all the fruit they can mature.

Fig. 56 shows a branched cane in the dormant stage. The buds shown here are those which produce the laterals on which the fruit is borne.

Fig. 57 is an upright unbranched cane with its crop of fruit. All the laterals here are of the current season's growth, and the fruit is borne at their terminals in clusters and singly, and also to a lesser extent, in the axils of the leaves. Fruiting wood of this nature has served its purpose after one crop has been picked, and must be removed. Another cane will grow up from the roots the same season to replace it.

BLACK RASPBERRIES

The black raspberries have the same fruiting habits as the reds, but are much stronger growers.

Fig. 58 shows the cane in the dormant season. The pruning practice has been to cut off the cane when it has reached the desired height. This has caused it to throw out laterals. When this is done early enough in the season, the laterals will make a strong growth and develop vigorous buds. These in turn produce laterals the following spring on which is produced the season's crop. The fruit is borne in clusters at the extremities. and singly in the axils of the leaves on short sub-laterals. Each lateral comes from single buds as seen in this illustration.

In Fig. 59 the manner of fruit production is distinctly shown. All the buds on the lateral branches have produced fruiting wood right back to the main cane as well as the buds along the stem of the cane. In the dormant season, or very early in the spring, the laterals of the last season's growth may be pruned back leaving only a sufficient number to produce fruit in quantity. The whole cane after once fruiting, is of no more value. The new growths which have come up during the season and been pinched back in midsummer, will fill the place and produce a crop the next season.

BLACKBERRIES

The blackberries bear their fruit in clusters at the ends of short sub-laterals of the current year's growth, and also to a small extent in the axils of the leaves. In Fig. 60 is shown the method of pinching back the single cane during the growing season, in order to cause it to branch. When the cane has reached the desired height, it is pinched back, and then two, and sometimes as many as four or five lateral branches spring out from the buds below. In this case, two laterals only develop, but one of these was pinched back a second time, causing it to branch. The buds which are borne in the axils of the leaves will give rise to short sub-laterals the following season. and on these the crop is produced.

Fig. 60. Blackberry.

Fig. 61. Blackberry.

Fig. 62. Blackberry.

Fig. 61 is a view of the blackberry in bloom. In this case, three lateral branches arose after the main cane was pinched back. Near the ends of these are seen the sub-laterals in bloom. It will be noted here that the first three or four buds on each lateral have produced no bloom. The varieties of blackberry differ somewhat in this respect, and a knowledge of this controls the subsequent method of pruning during the dormant season.

The same variety in fruit is shown in Fig. 62. Here it will be noticed six fruiting laterals were produced after the cane was pinched back. It will also be noticed that each lateral is comparatively weaker than those in Fig. 61. The whole cane, after having once fruited, is of no more value as in the raspberries, and must be replaced with a new cane, which has come up from sucker growth during the growing season.

CURRANTS

The black and red currants do not bear fruit in quantity similarly, hence the pruning of the one is a little different from the other. The black currant bears most of its fruit on new growth, on two-year-old, and on wood of the previous

Fig. 63. Red Currant.

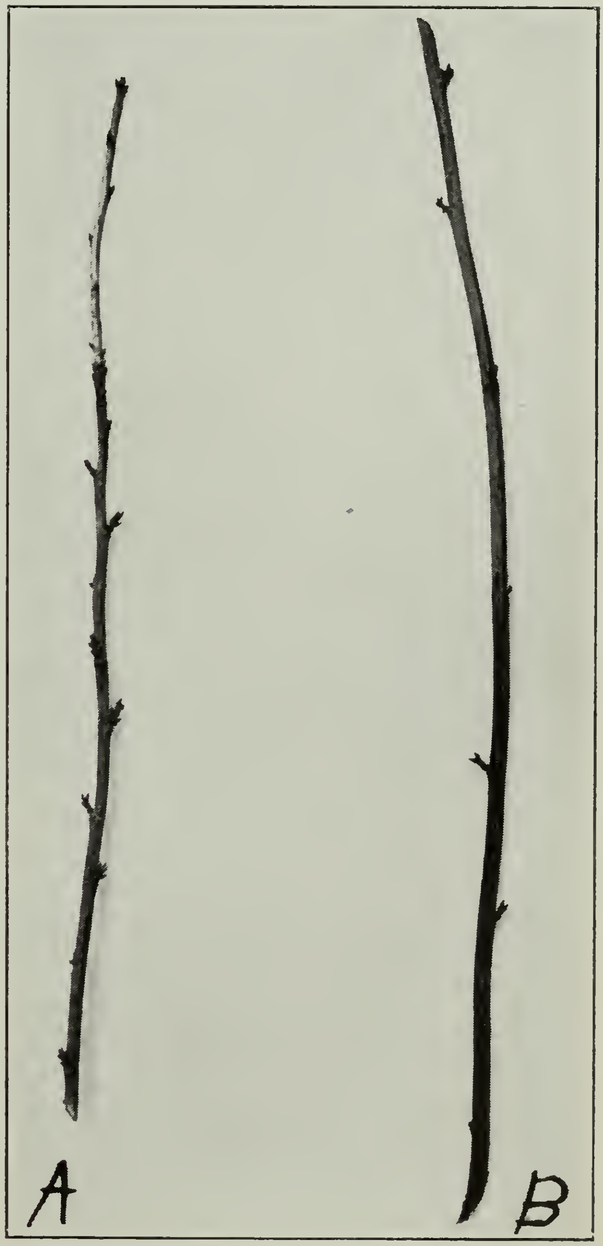


Fig. 64. Red Currant.

Fig. 65. Red Currant.

Fig. 66. Red Currant.

Fig. 67. Red Currant.

season's growth. The red currant produces most of its fruit on spurs, which develop from wood of two or more years old; but as the fruit on older wood gradually becomes inferior, it is best to depend upon wood of not more than three years old for the crop. For this reason, a supply of young wood must be maintained to replace the old. which is removed after having borne a second crop. The black currant, on the other hand, produces it most and best fruit on one and two-year-old wood. It is best to remove the branch after it is two years old, or at most three years old, and to permit a supply of young wood to grow to take its place.

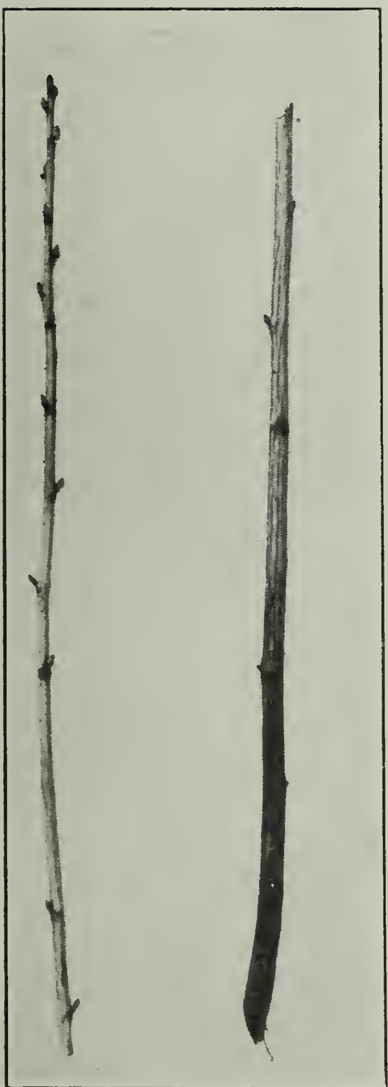


Fig. 68. Black Currant.

Fig. 69. Black Currant.

Each bud produces from one to three or four bunches of fruit and as many leaves. The fruit spurs with their buds in groups are usually terminated with a leaf bud, which continues the growth of the spurs.

Fig. 63 shows a branch of the red currant of one, two and three-year-old wood. The fruit buds are in groups on short spurs on the two and three-year-old wood. Such a branch as this after producing its crop might profitably be removed. Although it may continue to produce fruit, it does so in diminishing quantities, and will not be as productive as younger wood. Cutting back tends to produce side shoots and spur growth. Fig. 64 shows a long shoot which will take the former's place. A and B are one growth. This shoot is two years old, and will develop lateral branches during the season, as well as produce considerable fruit, as is shown in Fig. 65. This is a one-year-old branch, which has been shortened in pruning, and has developed a little fruit on the one-year-old wood. It is also developing several laterals, which will make strong fruiting branches for the two seasons following.

The red currant in bloom is shown in Fig. 66, and another type of branch with its crop of fruit in Fig. 67. In Fig. 66 all the lateral branches are two years

Fig. 70. Black Currant.

Fig. 71. Black Currant.

old, while the main stem to about half its length is three years old. There is a good show of blossoms here throughout the entire length of the laterals, but they are mostly on two-year-old wood. The one year old growth is very short at the terminals. Such a branch as this will produce a good crop again the next year, as most of the spurs, where the fruit is borne, will continue to develop and set a plentiful supply of fruit buds for the following season. Following this season if it can be replaced with such a branch as is shown in Fig. 65, it will be profitable to replace it.

Fig. 67 shows a main branch, the lower part of which is three years old, and the top part two years old. The lateral branches are one year old, and will be seen to be bearing a fair crop of fruit. They are really fruiting laterals on three-year-old wood.

The black currants produce a greater proportion of their fruit on the one-year-old wood than do the reds.

The type of long one-year-old shoot such as comes from the centre of the bush, is the shoot to replace the old fruiting wood. This is shown in Fig. 68. The portion at the left was cut from the portion at the right. In Fig. 69, the same type of wood is seen in blooming time. Notice the large percentage of bloom near

Fig. 72. Black Currant.

Fig. 73. Black Currant.

its top. The portion at the right was cut from the portion at the left. It will be noticed also that this cane is commencing to form lateral branches. Fig. 70 shows a similar type of cane which had been shortened back during the dormant season and has branched. It is bearing no fruit. This is a good type of branch to replace the older fruiting branch, and will bear a heavy crop the following season.

The branch shown in Fig. 71, is an ideal type of fruiting branch. The main portion of the branch is two years old, and produced a crop of fruit during its first year, as can be seen by the old fruiting stems still adhering. It also developed short fruiting spurs on the two-year-old wood. It will also produce a fair quantity on the one-year-old portion at the top. Fig. 72 shows a similar type of fruiting wood in bloom. Here it will be noticed that the main stem of the branch, which is three-year-old wood, is practically barren, while an abundance of fruit is produced higher on the one and two-year-old wood. The portion at the left was cut from the other. Fig. 73 shows the same type of fruiting wood carrying its crop of fruit. The three-year-old portion of the branch is not shown in this case. It was practically barren of fruit.

GOOSEBERRIES

The fruiting habit of the gooseberry is practically the same as the red currant. It produces the most and best of its fruit on short spurs on two and three-year-old wood, and a similar proportion from lateral buds on one-year-old wood. It

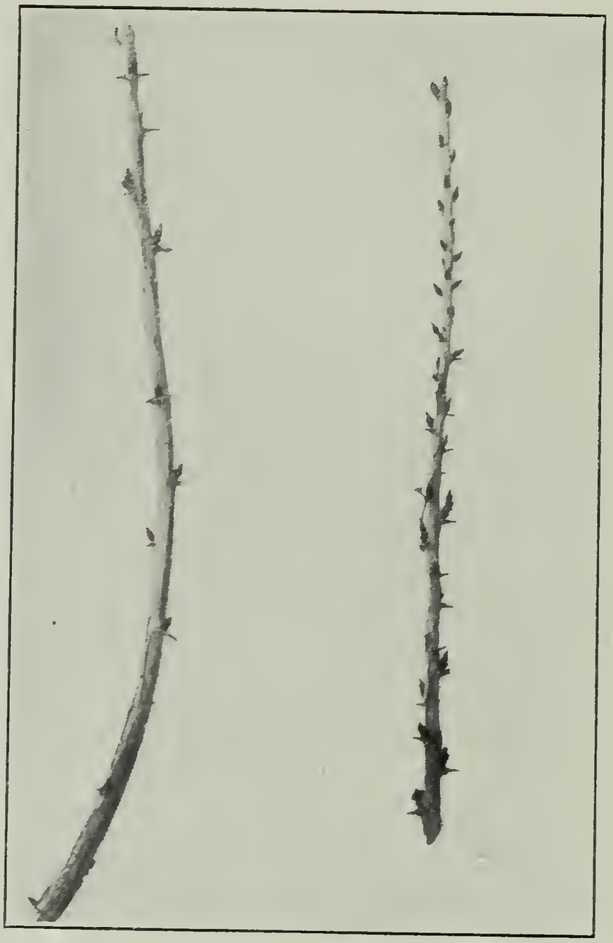


Fig. 74. American Gooseberry.

bears fruit on all wood execpt the very old. After the wood becomes three years old, its productive power is diminishing. Long one-year-old shoots, which grow from the centre of the bush, should be left to replace the older branches when they are removed. Each fruit spur bears a cluster of three or four buds, and on the one-year and two-year-old wood the fruit buds are usually borne singly in the axils of the thorns. Each bud produces from one to three or four fruits with as many leaves. The fruit buds in the dormant stage can usually be distinguished, as they are larger and plumper than the leaf-buds.

Fig. 74 shows the long shoot which grows from the centre of the bush, and which will, during its second season, throw out lateral branches to replace the older branches, which have been removed after their period of greatest productiveness.

Fig. 75. American Gooseberry.

Fig. 76. American Gooseberry.

Fig. 77. American Gooseberry.

Fig. 78. American Gooseberry.

The portion at the right was cut from the other. Fig. 75 shows the type of branch in the dormant stage, which bears the heaviest crops of fruit. The lower portion of the main stem is three years old. The lower portions of the laterals are two years old, and the remainder is one-year-old wood. Fruit will be borne all along these laterals and down the main stem to near its end. A reference to Fig. 76 will show this. This is a similar type of branch in the blooming stage. It will be noticed that bloom extends throughout the branch, and that almost every bud has produced two or three flowers.

Fig. 77 shows on the right the long cane which will replace the old fruiting wood. There are only a few blossoms near its apex. This shoot should be shortened to induce it to produce laterals. It will, however, produce medium, strong laterals similar to the branch on the left without being headed back.

Fig. 78 illustrates the fruiting type of one, two and three-year-old wood, showing the crop of berries. Particular attention is drawn to the fact that the largest and best fruits are on the one and two-year-old wood, with perhaps the very largest on the one-year-old laterals.

BULLETIN 249] [MAY, 1917.

Ontario Department of Agriculture

FRUIT BRANCH

THE PEAR IN ONTARIO

F. M. Clement* and O. J. Robb.

The pear has always been a more or less favorite fruit with both grower and consumer. The demand for many years has been scarcely equal to and at no time greater than the supply; consequently, but for the ravages of Pear Blight, it is reasonable to expect that plantings would have increased rapidly. The many large trees found growing to-day in various parts of Ontario, on which have been grafted three, four and five varieties, and in many cases twenty varieties and more, bear silent testimony to the esteem in which this fruit was held in past years and by the pioneer.

The object in writing these few pages is to make a summary of the industry from a study of the general situation with the hope of stimulating to some extent a somewhat neglected industry and to rouse those interested to fight still more faithfully the Blight, the dread disease that is holding the possibility of rapid development of the industry in check.

THE INDUSTRY.

The 1901 Census of Canada credits the Dominion with 617,293 bearing trees and 344,808 non-bearing trees. The 1911 Census of Canada credits the Dominion with 581,704 trees bearing and 385,538 trees non-bearing, a decrease of 35,589 bearing trees and an increase of 40,730 non-bearing trees; making an increase of 5,141 trees, bearing and non-bearing, in the Dominion.

The 1901 Census credits Ontario with 564,798 bearing trees. The 1911 Census credits Ontario with 505,368 bearing trees, a decrease of 59,430 trees in ten years.

The 1901 Census credits Ontario with 280,175 non-bearing trees and the 1911 Census credits Ontario with 237,769 non-bearing trees, a decrease of 42,406 trees in ten years.

In other words, the total decrease for Ontario in ten years is 101,836.

*At the time this Bulletin was written Mr. Clement was the Director of the Horticultural Experiment Station, Vineland.

Production figures for these years are not available for this fruit; nor are import figures for pears alone. Under the particular head of fresh fruit entered for consumption in Canada are also listed, quinces, apricots and nectarines. Pears however, make up by far the greater bulk of the total imports under this head.

Fig. 1. Dwarf Duchess tree in bloom. Age, 10 yrs.

The imports into Ontario of these fruits during the last three years were as follows:

	Lbs.	Value.
1913	3,475,974	$86,497
1914	1,789,707	76,649
1915	2,338,282	74,987

The imports of these fruits into Canada for a part of the same period and the last fiscal year were as follows:

	Lbs.	Value.
1914	11,040,871	$446,932
1915	11,780,751	384,160
1916	11,625,576	271,991

Certainly some part of these fruits is imported at a time when home grown fruits are not on the market, but nevertheless a large part of them comes into direct competition with the home grown product.

A careful study of the industry seems to indicate that pear growing is now and is likely to be for some time a profitable industry. Why production has scarcely equalled the increased demand is very likely to be found largely, if not entirely, due to the ravages of Fire Blight (Bacillus amylovorus). Young, thrifty trees suffer more than older, slower growing trees, and it is undoubtedly for this reason that the total number of trees in the Province does not show an increase.

PEAR CLASSES.

Two distinct classes of pears are grown in Ontario. In the one, we have the common European varieties so generally popular: Bartlett, Flemish Beauty, Bosc, Anjou and many others. In the other class we have the less popular but still quite heavily planted varieties such as the Kieffer, Garber and Le Conte. The

Fig. 2. Three pear types. Bartlett, Hybrid-Kieffer and Chinese Sand. The Kieffer is a cross between the other two types.

former of these three varieties is, in some sections of the east, very heavily planted. These latter varieties are hybrids between the European pear (Pyrus communis) and Chinese Sand Pear (Pyrus serotina) (formerly, and as it now appears erroneously identified as Pyrus sinensis). Generally speaking, they lack the quality of the European varieties but may possibly be a little less subject to Blight. This statement, however, does not hold true in every instance.

The pear is also one of the favorite fruits and is grown as a garden tree wherever climate and soil will permit. Fond remembrances are retained of fine old trees in the dooryards of the older homesteads, many of which are still bearing good crops in spite of neglect. Naturally the tree is very hardy and exceedingly long-lived. Historically, it is one of the oldest fruits, having been grown in Europe for over three centuries. It is believed that the original trees came from Southern Persia, but it is due to the improvement work of the last two centuries in Europe that we have so many excellent varieties at the present time.

Several good varieties have been originated in the United States and a few have been originated in Canada. It may be interesting also to know that of the many hundreds of named and described varieties known to-day, by far the greater number belong to England, France, Belgium and Germany. Possibly more work has been done on improvement and propagation in Belgium than in any other country.

In the experimental orchard at Vineland upwards of one hundred and fifty varieties including all the common ones and many French and other European varieties are under test.

Fig. 3. Dwarf Duchess orchard. This orchard is clean cultivated.

The pear has nearly as wide a range of culture in the Province as the apple. It is grown to some extent at Ottawa and all along the upper St. Lawrence River, and it succeeds as far north as Manitoulin Island, but is not found inland or on the higher lands which are not nearly as far north as Manitoulin Island. In these northern sections it is limited to one or two of the hardiest varieties. Possibly the range of commercial culture might be said to follow the line of commercial apple culture with a slightly shorter range extending along the upper St. Lawrence and Lake Ontario and west to Georgian Bay, including a small section south of Lake Simcoe, also in many sections within these limits only the most favorable sites should be chosen.

Of the dozen or more common varieties grown in the Province the following are recommended for the respective districts:

VARIETIES RECOMMENDED.*

General list, approved by the Board of Control.

Giffard, Clapp, Bartlett, Boussock, Flemish (hardy, subject to spot), Howell, Louise, Duchess, Bosc, Clairgeau, Anjou, Kieffer.

District Lists.

Niagara District.

(Including the Niagara Peninsula from the Niagara River to Hamilton and north of the escarpment.)

The late Robert Thompson, St. Catharines: Giffard, Clapp, Bartlett, Bosc, Duchess (dwarf), Anjou, Kieffer.

Egbert M. Smith: Giffard, Bartlett, Howell, Louise, Flemish, Duchess (dwarf), Anjou, Kieffer.

Burlington-Oakville District.

(Including the southern part of the counties bordering on Lake Ontario between Hamilton and Toronto.)

A. W. Peart, Burlington: Wilder, Clapp, Bartlett, Boussock, Louise, Duchess (dwarf), Anjou, Kieffer, Lawrence, Nelis.

W. F. W. Fisher, Burlington: Lawson, Clapp, Bartlett, Duchess, Anjou, Nelis.

Essex Peninsula.

(Including Essex, Kent and Pelee Island.)

J. L. Hilborn, Leamington: Bartlett, Anjou, Duchess.

J. Atkins & Son, Leamington: Bartlett, Kieffer, Duchess.

Lake Huron District.

(Including Counties of Huron and Bruce.)

D. F. Hamlink, Goderich: Clapp, Bartlett, Louise, Clairgeau, Anjou.

Georgian Bay District.

(Including northern portions of the Counties of Grey and Simcoe bordering on the Georgian Bay.)

J. G. Mitchell, Clarksburg: Clapp, Bartlett, Flemish, Duchess, Anjou, Clairgeau.

Lake Simcoe District.

(Including the northern and eastern section of Simcoe and northern sections of York and Ontario, bordering on Lake Simcoe.)

G. C. Caston, Craighurst: Clapp and Bartlett.

* Fruits of Ontario.

Guelph District.

(Including the high inland counties of south-western Ontario, i.e., Wellington, Waterloo, north-western section of Perth, south part of Grey, Dufferin, and north-west section of Peel and Halton.)

Prof. J. W. Crow, O.A.C., Guelph: Clapp, Flemish, Seckel, Sheldon, Anjou.

Lake Ontario District.

(Including the southern portions of the counties bordering on the Lake Ontario shore from Toronto to Trenton.)

W. H. Dempsey, Trenton: Giffard, Clapp, Boussock, Hardy, Bosc, Clairgeau, Lawrence.

St. Lawrence Valley District.

(Including the Valley of the St. Lawrence from Kingston to the eastern boundary of the Province.)

Harold Jones, Maitland: Flemish (if grown in sod), Ritson (not so hardy in fruit bud as Flemish).

Ottawa District.

(Including the Ottawa Valley and the eastern portion of the Province, not elsewhere enumerated, south of latitude 46 degrees.)

W. T. Macoun, Horticulturist, Central Experimental Farm, Ottawa: Flemish in most favored parts.

VARIETIES.

A number of the more important leading and promising varieties are described in the following pages. This list is intended as a guide to the grower in selecting varieties to suit his conditions. An ideal commercial orchard will contain not more than six of these varieties and possibly as few as two. The varieties are arranged alphabetically.

Anjou (Beurre d'Anjou) is one of the more widely grown varieties, although it is claimed by some to be a shy bearer. Under proper conditions this variety bears large crops every year. It succeeds well on dwarf stock. The fruit is medium to large in size, greenish-yellow color with a brownish-red blush on the side; ripens in December and is a valuable pear for shipping to distant markets. The variety is losing somewhat in favor although the tree is very hardy and not as subject to blight as most varieties. It is in good demand.

Bartlett (Williams) is too well known to require any description. Take away the Bartlett, and the pear crop will be reduced nearly two-thirds. There is no one variety of fruit so well known and so universally grown as this variety. It is unexcelled in size and quality, and has won a well merited reputation all its own. It is in great demand. The fruit is ready to pick late in August or early in Septem-

Fig. 4. Dwarf Bartlctt tree showing fruit. Age, 6 yrs.

Fig. 5. Dwarf Flemish Beauty. Age, 6 yrs.

ber in Southern Ontario. When well grown the fruit is large, greenish-yellow, with a reddish tinge on one side. The tree does well on either standard or dwarf stock, being much longer lived on the standard. It requires to be cross pollinated to secure a full set of fruit. At times the tree is badly attacked by blight, but on the whole with reasonable attention it will survive. This variety should be grown more extensively as there is a ready and unlimited market for Bartletts of quality.

Boussock (Doyenne Boussock) is a hardy and fairly productive tree, but slow in bearing and of only second rate quality when compared to the Bartlett. The fruit which is apt to drop before fully mature ripens by the end of September.

Bosc (Bosc's Beurre) : This is an excellent pear for the late fall market, and is grown more extensively as it becomes better known. It is a slow bearer, but the fruit when once produced is of the finest quality. The fruit is large, greenish-yellow, covered with russet and will stand shipment very well. The tree thrives over Southern Ontario and does best on standard stock. It requires to be double worked if grown on dwarf stock. The tree is very subject to blight, and consequently can be grown only with the most intelligent care.

Clapp's Favorite is widely grown and much favored both as an early home market and distant shipment variety. It matures just ahead of the Bartlett. The fruit is of first-class quality if picked well before it shows signs of softening on the tree. It soon passes out of season, as it will not stand storage long, quickly showing signs of decay at the core. The fruit when well grown is large and brightly colored on one cheek. The tree is a vigorous grower and a heavy bearer, but is very subject to blight; in fact, many orchards have been lost, and the present supply of this excellent variety is limited. Where the blight does not trouble the tree it is one of the most profitable varieties commercially grown. This pear is of American origin, succeeds best on standard stocks and is quite hardy in all the fruit districts.

Clairgeau is a desirable pear for shipping to local and distant markets owing to its size and fine appearance. It ripens late in October giving large yields of excellent fruit. The tree bears early on either standard or dwarf stock succeeding best on the standard. This makes a valuable variety to follow the Bartlett on the market. It is very hardy and should be planted more extensively as it has a wide range of adaptability.

Duchess (Angouleme) is a well known variety that has been largely planted on dwarf stock. The one serious failing of this fruit is that the tree is a shy bearer, very often failing to set full loads of fruit even when the tree is covered with bloom. It should be planted only in the sections where it has already proven a success. The fruit is inclined to be large and rough but is very high in quality and will ship anywhere with good success. The pear would be a general favorite among the growers if a good yield could be depended on each year. Even with many off years it holds a very high place in the esteem of those who know it best.

Easter Beurre: This is another good winter variety, being vigorous and very productive where grown on good, rich, favorable soil. It does best on the dwarf stock in Ontario. The fruit is large and inclined to be rough, and is green in color at picking time (late October). It is an excellent variety for export purposes and is recommended for further planting.

Flemish Beauty: This is one of the oldest and most widely distributed and best known varieties. It is without doubt the hardiest of the well-known varieties, being successfully grown in the more northern fruit districts. The variety is a general favorite owing to its productiveness and early bearing character, but in the more southern sections it is much affected by scab; in fact, it is very difficult to

Fig. 6. Dwarf Duchess tree showing fruit. Age, 6 yrs.

Fig. 7. Standard Kieffer tree. Age, 6 yrs.

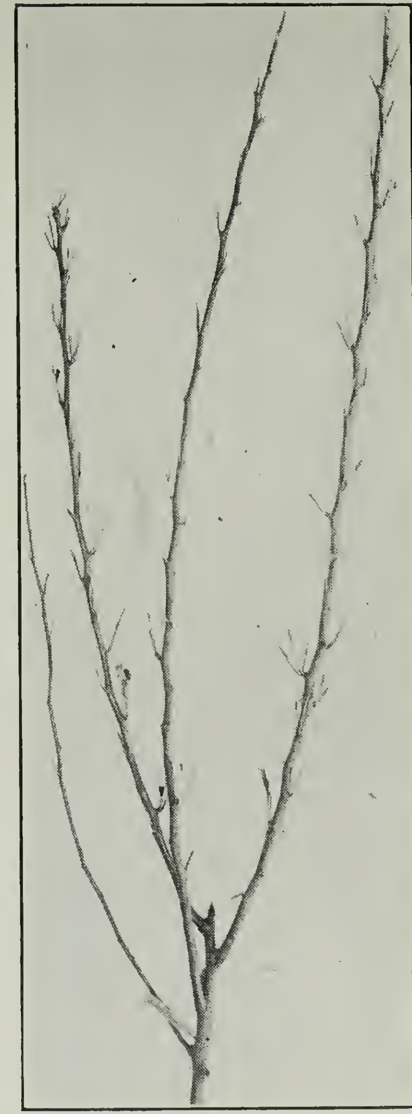


Fig. 8. Young pear tree stripped of leaves before planting in fall.

produce a crop of clean fruit. The fruit is of the highest quality, ripening in late September. Although grown extensively in many sections it is not now considered a profitable variety in most of the commercial fruit districts, because of its susceptibility to scab.

Giffard: This variety is to be recommended as an early market pear. With good cultivation on rich soil it attains a good average size and usually commands the highest price, because of its quality as a dessert and cooking pear at that particular season. The fruit ripens by the end of July and is medium in size, light green in color with a faint blush. The tree succeeds best on standard stock, making a straggling growth, but is hardy and a very productive annual bearer. The blossoms are self-fertile and the tree is not subject to bad attacks of blight. This variety could be planted more heavily.

Howell: This is another valuable variety originating in America at New Haven, Conn. It is a very desirable commercial variety being productive and vigorous, bearing full crops of large sized, good quality fruit.

This variety is recommended for the southern parts of Ontario and is worthy of further planting. It succeeds best on standard stock.

Kieffer: This has been one of the most profitable varieties owing to its great productiveness. Good crops are produced almost every season and the fruit will stand shipping any distance. This variety succeeds over a wide area but does best in the more favored sections when grown on good, rich soil. It often suffers from attacks of blight. In recent years it has lost much in popularity due to its poor quality.

The Kieffer is a hybrid, being a seedling from a natural cross of the Bartlett and the Chinese Sand Pear (Pyrus serotina). The latter is a native of Asia, being hardy, productive and almost wholly blight resistant, but the quality of the fruit is very poor.

The poor flavor and coarse texture of the Kieffer are characters of its Asiatic parent. This variety should only be planted for shipping to distant markets, or for canning purposes when in demand.

Lawrence is a very desirable pear for early winter. It has many characters to recommend it. The tree is hardy and produces good crops of medium sized fruit of high quality. The fruit ripening in December comes at a time when other varieties are scarce. It should not be overplanted as the market is limited.

Lawson: This is an early pear of rather poor quality, ripening in August. The fruit is handsome in appearance, but is of little value except for the home markets, and is, generally speaking, not a profitable variety to grow. The tree is fairly vigorous and succeeds best on quince stock. It is grown only in the southern parts of the Province.

Ritson is a very valuable variety which originated in Ontario near Oshawa. The tree is a regular bearer of good crops of medium sized fruit, which is of first-class quality. It is valuable for both canning and home markets. This variety succeeds over a wide area and is very profitable where properly handled.

Seckel is without doubt the highest quality pear grown in the Province. It succeeds best on quince stock and is very hardy and productive. This is a very profitable variety where it is known on the market, but its small size is against it where its fine quality has not already been recognized. It is not recommended for commercial planting unless it is intended to supply a special market.

Sheldon: This high quality, dessert pear is not grown very extensively owing to its shy bearing habit and to the tenderness of the fruit. It is valuable only for the home market in October and is not a profitable variety to grow. It falls very easily.

Tyson: This is a medium sized variety, of good quality, but is valuable only for the home market as it comes in too near the Bartlett season to be profitable. It is a valuable addition to any garden collection, and is of American origin. It is not widely grown in this Province.

Wilder: This variety ripens in August, and though early is not widely grown. It is excelled in productiveness by the Tyson which comes at the same season. The fruit is medium to large with a deep red cheek and of first-class quality. It is valuable for the home market. The tree is a very productive and early bearer on dwarf stock. This variety might be planted more extensively.

Winter Nelis (Beurre Thouin): This is an old favorite as a late winter variety. The fruit is rather small but has proven to be a somewhat profitable variety. The tree is hardy and very productive, succeeding best where top-worked on some other variety, such as Duchess or Bartlett.

Bartlett Seckel (Barseck): This is a new variety of high quality. It is larger than the Seckel and of better quality than the Bartlett. It is a cross between the Bartlett and Seckel originated by Mr. Moore, at Rochester, N.Y. The variety is to be recommended for special markets only.

SOILS.

Because the pear is very often found growing in dooryards, along fences, roadsides and various other out of the way places, is no indication that it has no soil preference. The fact that it grows everywhere indicates rather that it is fairly well adapted to a wide range of soils and can more or less adapt itself to varied conditions.

Though the tree is not as quickly or immediately weakened and destroyed by excess water as the peach and the cherry, the destruction due to excess is none the less sure. The tree cannot long survive an excess of moisture.

The soil may range from a sand to a clay, with a decided preference for loams and clay loams. The deep, strong, heavier lands seem to fill the requirements best especially if well underdrained. On the lighter soils, the trees possibly respond to cultivation and manure a little quicker than on the heavier soils, but the stimulated growth is also more subject to the dreaded blight. The heavier soils maintain the steadier growth and because of this are to be preferred.

The subsoil must be deep and open. No tree can possibly be a profitable bearer and long-lived that is forced to feed on the surface only. Many good pear orchards are on stoney and gravelly soils. These soils, though difficult to cultivate, are often deep, rich and open and are consequently ideal for growth and production. Though adapted to heavier and rougher soils than the peach and the cherry, it must not be inferred that the tree will thrive on any soil that is not adapted to these fruits. Choose the site as carefully as for a tender fruit.

If possible, choose sloping ground preferably to the north or east. This insures good drainage and circulation of air. Rolling land with no deep hollows or pockets is the ideal site for a pear orchard. Our best orchards are on sloping lands which drain early and never are wet and sour. While many of the largest orchards are in close proximity to the large lakes the pear succeeds equally well far inland in the southern part of the Province and is very hardy and long-lived. Many trees in these situations in the different parts of the Province are known to be upwards of one hundred years old.

DWARF PEARS.

As stated elsewhere standard pears are grown on seedling, largely imported, pear roots. A few for purposes of dwarfing are grown on quince roots.

It is claimed for the dwarf trees that they come into bearing more quickly, that more trees can be grown to the acre, that the trees are more blight resistant than standard trees and that the quality of the fruit is higher. Undoubtedly the trees are smaller, and more trees can be grown to the acre, but the first cost of the trees (not individually) per acre is higher, the number of baskets produced per acre is no greater than for standard trees, and cultivation is possibly a little more difficult on account of the close planting. It is admitted, however, that the trees are more resistant to blight. The most common variety grown on dwarf stock is Duchess of Angouleme. Other varieties: Bartlett, Anjou, Flemish Beauty are also grown on quince stock, but it is not proven that anything is gained except possibly greater blight resistance and earlier bearing. No experimental data is available on which to base definite conclusions regarding yield and quality. Dwarf trees planted too deeply will send out roots from the trunk underground but above the quince root. Such trees will quickly establish themselves on their own roots and grow much larger than the dwarfs around them.

PLANTING.

The time to plant depends largely on the condition of the soil, but also on availability of the proper grade of *well ripened stock*. Experiments seem to indicate that fall planting will result in as large a percentage of "takes" as spring planting, or possibly a little larger if well ripened trees are obtainable in early October and planted at once. Well ripened trees are not always obtainable at this time, though they are more likely to be obtainable than the Baldwin or especially the Northern Spy apple. If the stock is well grown, and the leaves have dropped early, because of early ripening of the wood, good results can be expected from fall planting.

The distance apart to plant may vary a great deal depending on the desires of the grower and methods of cultivation and pruning practised. The average distance is 20 ft. x 20 ft. Many orchards are set 18 ft. x 20 ft., some 18 ft. x 18 ft. and various other distances. The recommended distance for standard trees is 16 ft. x 20 ft.

Trees from the nursery usually have well branched tops. Prune these as little as possible; cut back little or not at all. If enough good branches—two to four—are available, use these for the framework of the tree. If these are cut back or removed equally good ones do not always replace them. Severe cutting back induces rapid growth with the consequent susceptibility to blight.

CULTIVATION AND FERTILIZATION.

The extent to which a pear tree may be cultivated and manured is determined largely by the prevalence of blight or the degree to which the variety is subject to blight.

The pear, like the peach and the cherry, quickly responds to clean, thorough cultivation, and where such a practice may be followed the fruit is invariably the cleanest, of the largest size, and of high quality. For the greatest quantity of good fruit, clean cultivation, judiciously practised, is undoubtedly the best method to follow, but because of the more succulent growth of the tree under such conditions and consequent susceptibility and rapid spread of blight in the tree, less *complete* if not less *thorough* methods are necessary.

Various practices are followed in the bearing orchard.

(1) A sod mulch system. This consists of little or no cultivation, but instead the grass is allowed to grow. This is mowed and either raked and spread close in around the tree to act as a mulch to the tree and cause the sod to decay or is cut and allowed to lay where it falls to act somewhat as a mulch and retain some moisture. The mowing may be done two or three times a year. Any application of straw or strawy manure tends also to retain moisture and prevent the development of too stiff a sod. A fall application of straw or strawy manure around the tree trunks in addition to the mowing of the grass and weeds adds materially to growth and

Fig. 9. Sweet clover growing as a cover crop in orchard at Vineland in June, 1916.

vigor without producing growth in excess. In this case means must be taken to prevent girdling by mice or rabbits.

(2) Clean cultivation with a cover crop or clean cultivation in early spring leaving the weeds to grow from mid-July till fall is the practice most generally followed. This is undoubtedly the most ideal practice and is the one recommended if the ravages of blight are not serious.

(3) Leaving a strip of sod along the rows of trees and cultivating the centres. This system, where followed judiciously, seems to be giving good results. The sod close in around the trees seems to hold the growth in check, while the cultivated strip between the rows seems to be ample to supply enough plant food to keep the tree healthy and vigorous. From two-fifths to one-half of the total area is kept in sod.

The idea of the cultivated strip is apparently to produce a medium growth, healthy and vigorous, but not so rank that the susceptibility to blight is increased.

The objection to the sod mulch is the shelter it provides for insects and fungous diseases. Young trees present a different problem: the trees must be grown, and consequently it is advisable to produce as much growth as is consistent with blight resistance. Prune as little as possible. Some limbs or branches may be removed in order to balance the framework of the tree, but limbs should not be cut back unless absolutely necessary in order to form a suitable head. Grow intercrops; oats, if provision can be made for convenient cutting; potatoes, corn or any other hoed crop. A practice that is sometimes followed is to cultivate one year, seed to clover and timothy in July and cut for hay for one or two years; cultivation being practised only once in two or possibly three years.

The idea is to grow the trees as steadily and uniformly as possible. It is a very difficult task, and only with the most constant care can the best results be obtained.

A few young orchards have by choice of the owner been left in sod and the grass cut for hay. The practice is apparently to secure as little blight development

Fig. 10. An old orchard showing a strip of sod close by trees.

as possible, but growth is very slow, and what fruit is produced is small and knotty.

It would appear that with our present varieties there is no permanent relief from the ravages of Fire Blight, and that since blight resistant varieties are not available, the proper cultivation and treatment of the soil is the most important factor, if not the only practical means of saving many orchards, and developing new ones. It is claimed by many that constant cutting will control the blight, but in view of the fact that it cannot be all cleaned up in a neighborhood at once, being always present somewhere, if not in the orchard in the near vicinity, the cutting process must go on continually at the expense of the tree.

It is necessary for the grower to study his soil and to work out the proper balance between cultivation and sod, between manuring and intercropping, to suit his conditions, and even then he may often make mistakes in abnormal seasons. As the situation stands at the present time, and with our present knowledge of the disease and methods of control, no definite advice can be given that will hold for most cases.

Cutting out is necessary to check the spread of the disease where it occurs, but it should be the constant aim of the grower to produce conditions unfavorable for the development and spread of this disease. Cutting out alone will not keep it under control.

PRUNING.

It is a safe rule to follow when it is stated that as little pruning as possible should be given. It is the natural habit of the tree to bear fruit, and this it will do even under adverse conditions. It is not the purpose of pruning to make a tree produce fruit, but to produce better, cleaner and larger fruit, and possibly also in greater quantity.

Pruning is very often, and especially with the amateur, practised in order to make the tree more attractive in appearance and more symmetrical and pleasing to the eye in general. In many cases, this practice is carried too far, and fruit-bearing is sacrified to symmetry. Another reason why with the pear as little pruning as possible should be practised is because pruning (especially in winter) ordinarily induces more rapid succulent growth, which is likely to prove susceptible to blight.

Prune young trees as little as possible. Thin out any limbs that cross or interfere with the proper spacing of the branches that will at a later date form the framework of the tree. Cutting back or heading in is not considered advisable. This may be necessary in exceptional cases in order to properly form or balance a tree, but it should be done out of extreme necessity only. Taken in conjunction with cultivation and manuring, the aim should be to maintain a very steady uniform growth, at no time forcing to the extreme.

A bearing tree is less susceptible to blight, but even here it is considered advisable to reduce pruning to a minimum. A little pruning regularly, March and August, might be considered a reasonable rule. The habit of growth varies a great deal, and must to some extent be taken into consideration. The long, loose, open growth of such varieties as Bosc and Kieffer may be counteracted and brought within manageable bounds by a severe summer pruning about mid to late August, after the trees have reached an age of five or six years.

FRUITING HABITS.

Pears, unlike the stone fruits, bear their fruit from terminal buds on short spurs. These spurs are found on two-year-old and older wood, and sometimes, but very seldom, fruit buds may be found terminating the growth of one-year-old wood. Such buds, however, as the latter seldom set fruit, and are of little importance to the fruiting habit of the tree. In a young and fast-growing tree, the spurs may become well developed on two-year-old wood, and as the tree increases in age continue to develop. They do not die out after one, two and three seasons of fruiting as in the case of plums.

Pruning, therefore, develops itself into a method of keeping these spurs in a healthy and vigorous state, with an ample supply of sunlight and air, to prevention of overbearing and the encouragement of some new growth. On the young trees the long one-year-old growth may be shortened back and thinned out, and so give the spurs full opportunity to develop. Too severe cutting, however, tends to produce wood growth at the expense of spur development. On an older and more mature tree, the annual growth becomes less rapid. The branches, which are from twelve to fourteen years of age, will bear a mass of fruit spurs. Each fruit bud will bear from four to five flowers and as many leaves, and the spur as long as it is maintained healthy and vigorous, will continue to produce fruit and leaves annually or biennially.

Fig. 11. Kieffer.

Fig. 12. Kieffer.

Fig. 11 shows a two-year-old branch of a young, fast-growing tree, with short fruit spurs up the stem. The twigs at the top are one year old. The illustration shows where the two-year-old branch has been shortened the previous year to encourage spur development. The branch, however, indicates extreme wood growth and indifferent spur growth, caused by too severe cutting back.

Fig. 13. Bartlett.

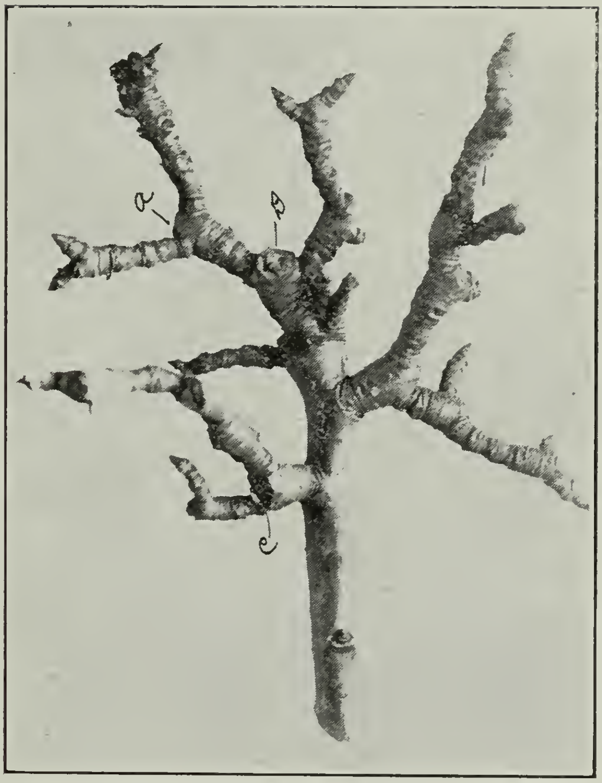


Fig. 14. Bartlett.

Fig. 15. Bartlett.

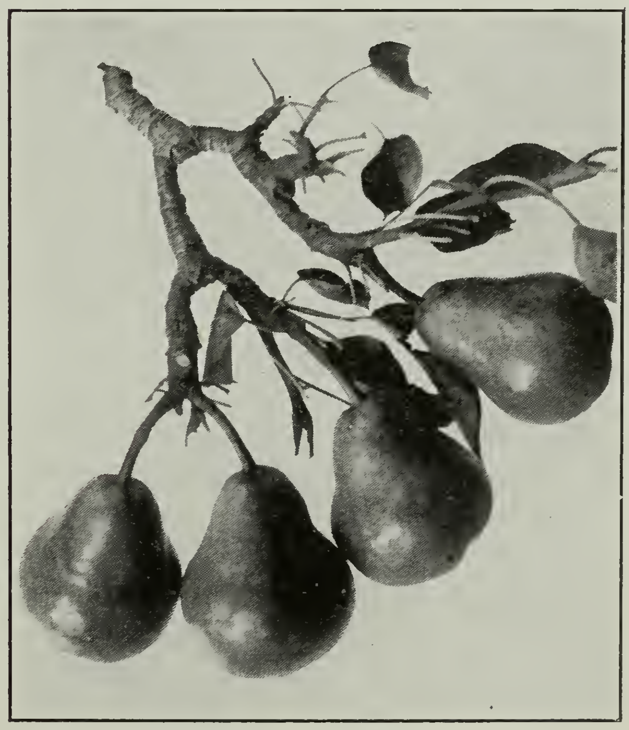


Fig. 16. Bartlett.

Fig. 12 shows the same type of branch in blossom. Notice that each spur has an ample supply of leaves to develop its fruit. This branch was much more "mature" for its age than Fig. 11. Notice also some terminal bloom on the new wood. This latter bloom by chance may develop fruit. Notice also that no blossoms are found on the new or one-year wood.

Fig. 13 shows the same type with its crop of fruit. Here it will be noticed that the development of each fruit seems to be in proportion to the amount of leaf surface growing on the spur.

Fig. 14 is an old and well-branched fruit spur found on the older branch of a tree. The exact history can be read owing to its habit of producing fruit from terminal buds. The bud that continues the growth of the spur arises from below the fruit during the year the fruit is being borne, and so causes the spur to have a zigzag appearance. A, B, C, and similar scars, show where the fruit has been borne. Each bud will ordinarily produce four or five blossoms and as many leaves, and at the time of opening will grow out an inch or more. These buds are not always fruit buds, as reference to Fig. 15 will show.

This is a similar spur and shows only two of these buds as being fruit buds. This condition on the individual spurs is largely controlled by the condition of the tree at the time these buds are being formed the previous year. Where there is an extra crop of fruit to call largely on the resources of the tree, nature has made provision that only a few fruit buds shall develop, and the remainder will be leaf buds. This creates a tendency towards the biennial habit of bearing.

Fig. 16 shows a spur similar to Figs. 14 and 15 in fruit. In this case, most of the leaves have been cut away and the buds may distinctly be seen. Notice the continuation of the spur in the long new wood at the left.

Figs. 17, 18 and 19 each shows a branch of a mature tree. It is obvious that such branches will need no pruning except for purposes of thinning the fruit. Here again each spur does not produce a cluster of blossoms. In some cases they may be seen to produce a small branch one or two inches long in the season; such a one, for instance, may be seen in Fig. 16, below the fruit at the left. The fruitfulness of each spur is controlled by conditions of the previous season, for if it could not then produce a fruit bud, none but leaves can arise the following season; in this season, however, it will make a very short growth of an inch or two and set good strong fruit buds.

Study figures 17 and 18 together. They are excellent illustrations of the general fruiting habit of the average mature but thrifty pear tree. Though the two illustrations are not from the same branch, Fig. 18 will illustrate where blossoms would have formed on Fig. 17.

SPRAYING.

Ordinarily pears should be given three sprayings the same as the apple, at about the same time, with the same materials and with the same degree of completeness and efficiency.

The first spray must be applied to the dormant wood. It is generally considered advisable to delay this as long as possible, or until the buds have begun to burst, if aphids have been present until the eggs have begun to hatch. Use the winter strength lime sulphur 1.03 specific gravity to each forty gallons of which have been added one-third pint of Black Leaf 40 or nicotine sulphate.

Fig 19.

Fig. 18. Bartlett.

Fig. 17. Bartlett.

For the second spray use lime sulphur, summer strength, about 1.009 specific gravity, or slightly weaker, after the winter buds have burst and sent forth the blossom *unopened,* but before the petals have expanded. (The winter pear bud contains several blossoms which grow out to some length, each on a single petiole before the blossom opens). Add to this spray 2½ lbs. of lead arsenate paste for each forty gallons of mixture. This spray is for both scab and worm control.

The third spray must be applied as soon as the petals of the blossoms have fallen, and before the calyces have closed. Use the same mixture, with the same addition of arsenate of lead as for the second spray. The lime-sulphur may, however, be made a little weaker, as low as 1.007 to 1.008 specific gravity.

A fourth spray, a duplicate of the third spray, may be used from ten to fourteen days later if considered advisable for the more complete control of worms and scab.

For special sprays for special outbreaks of any pest, see under the head of Insects and Diseases.

POLLINATION.

Each pear bud produces from five to eight blossoms. When bloom is heavy, or medium heavy, it is not necessary for more than one or two blossoms, usually, only one, to set fruit on each spur in order to produce a heavy crop of medium to large size fruit of good quality.

A few varieties of pears, including the Duchess of Angouleme and Bosc, two of the leading varieties, are believed to be as nearly as can be judged from the small amount of work done on them, largely self-fertile. At the same time, more fruit is apparently set when intercrossed, or crossed with some other variety. It is a fairly safe rule to say that crosses are more likely to set and remain on the tree than fruit produced by self-fertilization, or pollen from another tree of the same variety.

Experiments also indicate that of the remaining best known varieties, including Anjou, Bartlett, Boussock, Clairgeau, Clapp, Lawrence and Winter Nelis, that self-sterility is the rule. Seckel and Kieffer are apparently partly self-fertile. Also in the face of experimental evidence that seems to point to the contrary, many large blocks of varieties, principally of Bartletts, set heavy crops of fruit fairly regularly. How much better they would do if interplanted with Anjou or Duchess can only be supposed or guessed, but it is reasonable to expect that the quantity would be materially increased.

Another factor that apparently must not be lost sight of in securing a heavy set of fruit is the general health and vigor of the tree. Experimental testing and observation both point to the fact that a vigorously growing tree sets a larger percentage of blossoms than the tree lacking in vitality.

Other points such as weather conditions and dates of blooming are also important factors in determining the set of fruit. These, however, need not be discussed here as the statements are general, and have been used very often in connection with other fruits.

One other point that might be emphasized is the value of the insects and the bees. Experiments again point to the fact that very often blossoms are pollinated by the wind, and that the major portion that are not automatically self-pollinated are pollinated by insects. The insects also distribute the blight infection, and as such are more or less distrustful, but they are nevertheless essential to a full set of fruit in most varieties. The old places of infection, diseased limbs and branches, should be removed and destroyed before growth starts. The cankers on the trunks at the same time may be cut out, disinfected and painted over.

PROPAGATION.

The pear, like the apple, is propagated commercially by means of budding. Seedlings do not come true and are only grown for experimental purposes or for cross-breeding work. Nurserymen may obtain quantities of seeds from

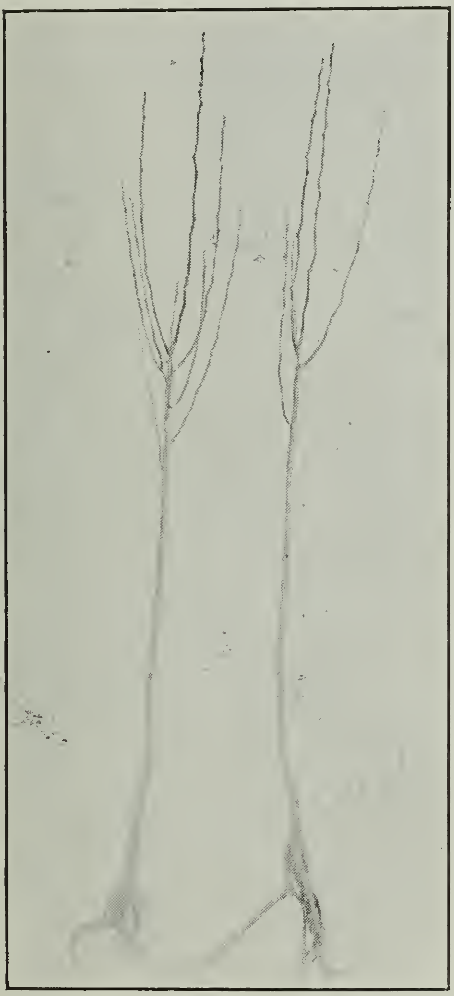


Fig. 20.

Fig. 21.

France. Usually this seed is saved from the refuse of perry (pear cider) presses, but only the best of these are used. Some nurserymen secure the young seedlings of one year's growth, and plant them directly into the nursery row. These usually come from France, preference being given them because the seeds from which they grew were started in beds and the small seedlings transplanted. This tends to the development of a branching root system, much more complete than ordinarily found in untransplanted stocks.

Some pear seed is gathered in Delaware, New Jersey, and Maryland, but what is considered by nurserymen to be seed of the best quality comes from

Japan. The American product is largely from Kieffer trees. Too much care can not be exercised in the selection of uniform vigorous seedlings for roots. In any case, the young seedlings are taken up in fall, stored over winter and are set in the nursery row early in the spring about six or eight inches apart. These are ready to bud by July and August, which process is accomplished in the same manner as with apples. After these trees have grown one year from the bud,

Fig. 22.

Fig. 23.

they are ready to set in the orchard if the grower prefers the one-year stock; if not, they are headed and allowed to grow for another season in the nursery row.

European stock is preferred rather than American stock owing to its greater vigor, uniformity and hardiness. It can also be obtained cheaply. Some varieties are budded on the Angers Quince stock for the purpose of dwarfing. The Duchess is the only variety grown extensively on this stock. The Bartlett, Anjou and Flemish Beauty also do well on quince, but are not long-lived as on the standard pear stock. Advantages claimed for the dwarf stock are earlier bearing, greater blight resistance, and a higher quality of fruit. This latter seems to be true of the Duchess.

The objection of the dwarf being short-lived may be overcome by planting the stock deeply and slitting the bark of the trunk. This will induce roots to start from above the bud and the tree will tend to return to the standard type, as it gradually develops its own roots. Usually well grown, two-year trees are received from the nursery unless the one-year-old stock has been specified. These have been headed and the grower must accept the foundation work of the tree as delivered to him.

Fig. 20 shows the ordinary type of trees from the nursery. These require to be planted slightly deeper than in the nursery row, and also to have the head well shortened back and shaped as in Fig. 21.

TOP-WORKING.

Top-working is not practised to any extent except for changing some undesirable varieties into more profitable ones, and also to aid in the control of blight.

Kieffer is usually used as stock in this case, and varieties that do well on Kieffer are Bartlett, Bosc, Clairgeau and Seckel. Fig. 22 shows Kieffer trees grafted to Bartlett in 1914, and Fig. 23 shows same trees bearing a fair crop of good Bartletts in 1916. The Kieffer may be used on dwarf stock as the medium for double working as in the case of Bosc and other varieties which do not unite readily with the Quince. Top-grafting should be done as early in the season as possible, before there is any movement of the sap, and is accomplished in the same manner as with apples.

HARVESTING.

The pear crop is usually picked and marketed immediately. Baskets, mostly eleven quarts, are used for the local markets, and boxes for the higher quality pears, which are sent to distant markets. Fig. 24 shows two boxes packed with Bartletts ready for shipment. Barrels are sometimes used for large quantities of winter pears, such as Kieffers.

Though most Ontario pears are shipped in baskets, and a few in barrels, too strong a plea cannot be made for a standard box. The lug box described below is undoubtedly a suitable package for a certain quantity of fruit, but the standard pear box of our competitors is much to be preferred. Properly packed, with the fruit properly graded and wrapped, both the consumer and producer stand in a fair way to being satisfied. The box contains a reasonable quantity, and unless very carelessly packed and handled reaches the market in good condition. The box most favored is 11½ in. wide, 8½ in. deep and 18 in. long, inside measurements. This is the same length and width as the standard peach and apple boxes recommended for the Pacific North-West. The variation is in depth only.

The lug box of the Pacific North-West is 14 in. x 16¾ in. x 5½ in., having a hand gouge on each end with a cleat 14 in. x 1½ in. x ½ in. under the cover, which permits a free circulation of air. It is used largely for shipping cherries also.

It cannot be said, however, that this box has a prominent place in Ontario.

The highest quality in pears is secured by picking just before ripe, and storing in a cool room until the color begins to change. If put on the market at this time they ordinarily command a much higher price than if handled green. Winter pears are improved by leaving on the trees as long as possible, and holding in storage for a certain length of time according to the variety.

MARKETS.

The demand for pears is very good at present, and if the supply is not greatly increased, it is reasonable to expect that prices will continue at a high level. The mere fact that large quantities of fresh pears are imported during the

Fig. 24

pear season in spite of a high tariff is fairly indicative that prices to Ontario growers will be remunerative for years to come. This is more truly realized when it is considered the decrease in the number of bearing pear trees in the Province, and also that very few are being planted.

A ready outlet for pears is also found through the canning factories.

Many of our pears found a profitable market in England previous to the war, and this market will again be available as soon as shipping facilities are improved.

At present the local markets take practically all the pears grown in the Province.

A few figures on the cost of production and profit are always of interest, and will not be out of place here. These figures were compiled by a reliable grower, and are pretty close to the average, being taken from a mature orchard, and include cost of caring for one acre for one year only. No figures are available on the cost of planting and rearing an orchard to bearing age, owing to the various methods of handling a young orchard.

The yields given below are averages over a number of years, and so are very near the actual conditions.

The price estimated at sixty cents per eleven quart basket to the grower is a fair average for the last three seasons, and includes the basket. This price is for the early pears (Clapps and Bartletts), and does not include the later varieties, nor the quantities sent to canning factories, which net a much lower price to the grower, usually less than two cents a pound.

No. of Trees	No. 11 qt. Baskets.	11 qt. Baskets per Tree.
225 Clapps	920	4.1
100 Boussock	520	5.2
700 Bartlett	1,874	3.1

Planted 20 ft. x 20 ft. give 109 trees per acre.
Average yield per tree 4.1 baskets, at .60....$2.46.
2.46 x 109 trees....$268.14. Returns per acre for one year.

COST OF CARING FOR ONE ACRE FOR ONE YEAR:

Interest on investment at $400.00 per acre	$24 00
Pruning	10 00
Spraying	11 00
Fertilizer	10 00
Plowing	5 00
Cultivating	4 00
Cover Crop	1 00
Picking and Selling	5 00
	$70 00

$268.14—$70.00....$198.14 profit per acre for one year.

These figures are given for what they are worth as figures, and are intended merely as a guide to the prospective grower. With careful attention, the grower should easily get more than this for his net returns.

INSECTS.

The pear is attacked by most of the insects which attack the apple, and as there are many species, only the most important will be mentioned here. For a full account of these and also of the others, the reader should consult the bulletin on "Insects Attacking Fruit Trees," which is being prepared by Lawson Caesar, Provincial Entomologist, and will soon be ready for distribution.

San José Scale.

This is a very small but very destructive insect, and wherever it occurs must not be neglected, because otherwise in a few years it will destroy the whole orchard. It can easily be distinguished from the Oyster-Shell Scale,—a much less important insect,—by its shape, the San José Scale being circular and the Oyster-Shell Scale, as the name suggests, elongated and shaped somewhat like an oyster shell.

The best method of control is to spray the trees very thoroughly with lime-sulphur, strength 1.035 sp. gr., that is, 1 gal. of the commercial diluted with 7 gals. of water. Apply the spray just after the leaf buds have burst, but before the blossoms have begun to open. One thorough application at this date will completely control the Scale no matter how bad it may be. The spraying could be done at other times of the year; for example, much earlier in the spring, or even late in the fall after the leaves are off, but by postponing the spraying until the time mentioned, it will control in most seasons the Pear Psylla.

The Codling Moth.

The Codling Moth is the insect that causes wormy apples and pears. A large percentage of the fruit is often destroyed by it.

The best means of control is to spray the trees very soon after the blossoms have fallen, with lime-sulphur, strength 1.008 or 1.007 sp. gr., that is, 1 gal. of the commercial diluted with 35 or 40 gals. of water, and add to each 40 gals. of this 2 lbs. of arsenate of lead. Usually one thorough spraying so that the poison is driven into the calyx end of each young fruit will prove sufficient. On varieties not subject to Scab, the lime-sulphur may be omitted, and the arsenate of lead used with water alone.

The Pear Psylla.

This is a very tiny sucking insect, not more than one-tenth of an inch long, brownish or blackish in color, though the young insects are white or yellowish-white, and are usually found embedded in honey-dew. Both the adults and the young suck the juice out of the leaves, leaf stems and fruit stems, and cause a great weakening of the tree and stunting of the fruits. They also exude large quantities of honey dew, which gets everywhere over the tree, and as a black fungus grows in this, it discolors the fruit and leaves, giving them a sooty appearance.

The methods of control are first, as mentioned above under San José Scale, to postpone the first application of spray until the leaf buds have just burst. This destroys large numbers of eggs that are nearly ready to hatch, and also young nymphs that have already emerged. Second, orchards that are commonly much infested with this pest should receive additional treatment in the form of Black Leaf 40 or Nicotine sulphate 40 per cent., added to the regular Codling Moth spray mentioned above. The proportion of this tobacco extract to use is stated on the cans in which it is procured. Great care should be taken to see that all parts of the leaves and fruit are thoroughly covered. If this is done properly, all the young insects will be destroyed, and the trees will remain clean for the rest of the season or until the fruit is harvested.

Pear or Cherry Slug.

This is the little greenish-black, slimy larva, about half an inch long when full grown, which is often found feeding on the upper surface of the leaves of pears and cherries. It removes all the green of the upper surface, leaving the network of veins intact. The leaves, of course, become brown in consequence of the attack. Sometimes a large proportion of the foliage may be destroyed by this pest, of which there are two broods in the year.

It can easily be controlled. The proper way is to examine the orchard from time to time to see if the larvae are present in numbers sufficient to justify treatment, and if so, spray at once with 2 lbs. of arsenate of lead (paste) to 40 gals. of water, covering the leaves well with the spray. A second application later may occasionally be necessary. If only a few small trees are infested, dusting air-slaked lime in a fine dust over them will destroy most of the larvae.

DISEASES.

The diseases attacking pear trees will be found treated at considerable length in a bulletin entitled "Diseases Attacking Fruit Trees," which is being prepared by Professors J. E. Howitt and L. Caesar, and will be available soon after the publication of the present bulletin.

The chief diseases are as follows:

Pear Blight.

This is a bacterial disease and constitutes the greatest menace to pear growing. It is the disease which throughout the growing season causes the death of the leaves, also of the twigs and branches and often of the whole tree. It is carried from tree to tree by insects. The chief time for distribution is during the blossom season when bees and other insects that visit infected trees or portions of them, get their legs or beaks contaminated with the organism and fly from blossom to blossom, leaving the organism on everything they touch. A week or two after the blossoms fall, the leaves will be seen to turn brown on the infected twigs and die. This is evidence of the presence of the disease. Throughout the summer, sucking insects are the principal means of spreading this trouble. These by chance or otherwise puncture diseased twigs, fruits or leaves, or get contaminated with the organism by walking over places on the branches where the disease is causing an exudate of gum which contains many organisms; then they move to healthy twigs, especially water suckers, and by feeding on these cause them to become infected.

Control is not easy, in fact, it requires the utmost care and promptness. It has been demonstrated, however, that the disease can be controlled. The method is to go through all the orchards during the months of February and March, or any time before the sap has begun to move freely. Prune out all diseased branches, cutting about six inches below where the bark is seen to be dead. If there is a diseased area at the crotch, or if it extends only a short distance around the base of a water sucker or other twig, the diseased bark may often be removed with a draw-knife, or even with a stout jack-knife. Special pains must be taken to see that it is removed to a sufficient extent, so that there are no signs of discoloration in what is left. The reddish-brown stains in the bark are indications of the presence of the disease. The object of cutting it out early like this is that the disease may not be carried by the saw or other tools, as it would be if the sap were moving at the time of treatment.

Just before the blossoms open, it is important to go around again and visit all the trees to see whether any diseased parts have been left, and to remove all suspicious cases, or treat further all cases that give evidence of not having been properly treated before. All prunings should, of course, be promptly removed and burned so that insects will not have access to them.

The great importance of this early pruning is to remove as much as possible of the organism from the orchard so that bees, ants, wasps and other insects may not have much chance of becoming infested with the organism, and of spreading it at blossoming time.

The next stage when the disease must be carefully watched is after the blossoms have fallen. Too much care cannot be taken at this time in detecting the first signs of the blossom twigs beginning to wilt, for if these are noticed early and removed at once, the disease can be prevented from running down the branches and doing much damage, as it certainly would if not thus treated.

The proper course to follow is to remove at once all these diseased twigs as quickly as they show up. Often this can best be done by breaking them off with the hand. In some cases, the saw or the hand pruner must be used. Where this is done, the cut and also the saw or other implement must be disinfected at once with corrosive sublimate, one part to 1,000 parts of water, that is, one tablet to one pint of water. The corrosive sublimate may be carried in a bottle in the top of which a piece of sponge is placed. By inverting the bottle, the sponge becomes wet, and the wound can be moistened and also the cutting implement. Failure to disinfect will mean that in many cases the new cuts will become infected from the saw or the pruning tool. Usually, if prompt work is done, and these twigs are at once moved and burned, it will not be difficult to keep the orchard free from this disease for the rest of the season, so that this time during these two or three weeks after the blooming period is by all means the most critical time of the entire season, and is the time that requires most attention and most energetic action on the part of the owner. However, the orchard should be examined at least once every two weeks throughout the season, and any dead or dying branches removed. They should be cut, in all cases, about a foot below where the bark is dead, because the disease often runs inside the bark for a considerable distance without any evidence on the outside. All cuts, of course, must be disinfected.

Caution.—Corrosive sublimate if taken internally is deadly poison.

Some one person on each fruit farm should make a special study of the appearance of this disease, so that his eye will be trained to detect it readily, and that he will feel himself responsible for its prevention.

Pear growers who are specially interested in this matter; should get in touch with the Provincial Entomologist or with Prof. J. E. Howitt, O.A.C., Guelph, who will, so far as time permits, give them individual instruction along this line.

Pear Scab.

This is the disease that causes the black spots, and sometimes the cracking on the fruit. Some varieties are specially subject to this disease, Flemish Beauty being the worst. Many varieties are never affected.

The disease is not easy to control on Flemish Beauty, but it can be controlled with four sprayings of lime sulphur; the first being the regular spray mentioned above for San José Scale; the second, the regular spray just before the blossoms burst, which would come very soon after the first one; the third, the regular Codling Moth spray just after the blossoms fall; and the fourth, about ten days after the third. In all but the first application, use 2 lbs. arsenate of lead (paste) to either 40 gallons of Bordeaux mixture or of lime-sulphur, strength 1.008 or 1.007 sp. gr., that is, 1 gal. commercial lime-sulphur diluted with 35 to 40 gallons of water. The last spray should not be stronger than 1 to 40, because the leaves at this date are more likely to be injured. Good results, of course, should only be looked for if the work is well done. A fine mist spray is better for this purpose than a coarse one.

BULLETIN 250] [JULY, 1917

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Insects Attacking Fruit Trees

Lawson Caesar.

INTRODUCTORY SECTION.

In the following pages we have not attempted to discuss or even refer to all the insects that attack fruit trees in Ontario, but have limited ourselves to those that are commonly found and that, except in perhaps one or two years out of twenty, do almost all the damage. These we have discussed somewhat fully in order that we might meet the needs, not only of the fruit-growers themselves, but also of public and high school teachers and district representatives.

A Spray Calendar for orchard trees has been included and should be consulted by every fruit-grower, as it applies not only to insects, but also to diseases.

Changes or Transformations Undergone by Insects.

Many insects, such as moths, beetles, flies and bees pass through four main stages in their life history, namely, adult, egg, larva (plural larvæ) and pupa (plural pupæ). The adults are usually, though not always, winged. The female adults lay the eggs. These hatch into what are called the larvæ. Larvæ of moths are often called caterpillars, those of beetles grubs, and those of flies maggots. The larvæ cast their skin from time to time to allow of growth. When full grown they change into what are known as pupæ. These usually are either brown or white, and do not eat but remain stationary until they are ready to transform into adults. Many, but not all, larvæ before pupating spin about themselves a protecting case of silk, often mixed with hair. This is called a cocoon. Insects with the above four stages are said to have complete metamorphosis.

Another great class of insects, such as grasshoppers, tree-hoppers, leaf-hoppers and plant bugs, have only three main stages, namely, adult, egg and larva. As a rule the larvæ of these insects are called nymphs. There is no pupal stage. The nymphs usually resemble closely the adults but never have fully developed wings, though the older ones have wing pads, which in the adults have developed into wings. Nymphs, like ordinary larvæ, moult from time to time, and at the last moulting become adults. Such insects are said to have incomplete metamorphosis.

A considerable number of insects, as for example the San José Scale, never lay eggs, but give birth to living young, while some other insects, such as Aphids, give birth to living young throughout the most of the season, but in late fall lay eggs. Quite a number of female insects are capable of producing young without mating with a male. This is known as parthenogenesis, or virgin birth.

One great division of insects has biting mouth parts and feeds by biting off little particles of the leaf or fruit, bark or wood, and chewing these. We call such insects *biting insects*. Caterpillars and beetles are examples.

How Insects Feed.

A second large division has not got biting mouth parts, but instead has four bristles fitting together and forming a sucking tube, enclosed in a soft protecting beak, or lip. With these bristles, which are sharper than a needle, they pierce the skin or epidermis of the part of the plant fed on and suck up the juice from within. We call these *sucking insects*. Leaf-hoppers, aphids and scale insects are examples.

A third class of insects have a sucking tube with a broad expanded lip at the tip. With this lip they lap up liquids, and, as it is furnished with a rasping device, also rasp solids and absorb small particles of them. Such insects may be called *lapping or rasping insects*. Examples are the House-fly, the Apple Maggot and the two Cherry Fruit-flies.

General Principles for the Control of Insects.

What has been said about the different kinds of mouth parts of insects is very important when we come to consider their control. It is clear that insects that bite out little particles of plant tissue and swallow them give us an opportunity to kill them by placing poison on the part of the plant attacked. *Hence for biting insects we spray the plant with arsenate of lead,* this being at the present time our most satisfactory poison because it sticks well to the plant and does not injure the foliage or fruit. Arsenate of lead is known as a *stomach poison* because it is taken into the stomach of the insect.

Sucking insects do not remove the tissues, but only extract the juice from beneath the skin or epidermis; *hence spraying for them with a stomach poison would be useless. They must be killed by some substance that comes in contact with their body, such as strong lime-sulphur for scale insects, or tobacco extract or soap solutions or kerosene emulsion for aphids.* We usually call such insecticides *contact poisons* because they kill by contact.

Rasping or lapping insects since they move around over the surface of the plant absorbing both liquids and solids *may be killed by spraying with arsenate of lead.*

There are other ways besides spraying by which we may help to control some of our worst orchard insects. One is by removing all sorts of rubbish in and around the orchard. The reason for this is that some insects winter under the protection of this rubbish and would perish if it were removed. Another helpful means is good cultivation. This aids by destroying pupæ that are in the soil and also by destroying weeds and grass on which some insects, as for example the Buffalo Tree-hopper nymphs, feed. A third way is to burn all prunings and brush early in the spring each year and thus destroy the insects within, such as Fruit-tree Bark-beetles or Shot-hole Borers, before they can emerge.

Natural Forces That Help to Control Insects.

Man is greatly assisted by nature in the control of insect pests; in fact the control of insects by natural forces is wonderful and affords a most interesting field of study. The following are some of the ways in which this is accomplished: Climate checks the progress of some insects, for instance the San José Scale seems unable to make any headway in the colder fruit-growing portions of the Province, and the Codling Moth, owing to a smaller percentage of a second brood in such districts, is also much less abundant. Late spring frosts sometimes kill great numbers of delicate recently hatched larvæ; alternate freezing and thawing destroy some insects; heavy downpours of rain wash many small insects from trees and many of these never get back; a very cold, wet spring, as in 1916, destroys countless insects in their early stages; a cold backward spring may almost annihilate the Pear Psylla; and very hot spells in spring or summer often cause the disappearance of innumerable aphids.

Diseases of various kinds are very important factors in holding some of our worst insects in control. Wet seasons usually favour disease.

Predaceous insects such as Ladybird Beetles and their larvæ, Syrphus Fly and Lace-wing larvæ, Assassin Bugs and many kind of beetles prey upon insects and aid greatly in control, especially of aphids.

Parasitic insects such as Tachina Flies and Ichneumons lay their eggs upon or in caterpillars or other pests and the larvæ from these feed upon and destroy their victims.

Birds and several other vertebrates do their share to help and are sometimes of great assistance.

Spray Outfits.

Those who purpose buying a spray outfit and spray materials can find the addresses of the various manufacturers by looking over the advertisements in the *Canadian Horticulturist* and the various agricultural journals.

If there are only a few trees to spray, such as one finds in a back yard in a town or village, a small hand-pump, holding about five gallons of liquid, will suffice. This should be equipped with about twenty-five feet of good hose, a leakless stop-cock, an eight-foot rod and a good disc angle-nozzle. Some companies manufacture a special rod and nozzle, so that by adjusting the latter the spray may be shot to the top of even a very high tree. A machine of this character with all the necessary accessories costs about $20.

For more than about a dozen large trees this small outfit is much too slow. If the orchard consists of not more than about six acres of large apple trees or of about ten acres of trees the size of a moderately large plum, cherry or pear tree, a barrel-sprayer will suffice. This, fully equipped, will cost from $20 to $40.

A double action or duplex type of pump gives considerably more power than a single action or barrel pump, and so will enable a person to cover more trees each day, especially if the pump is installed in a 120 or 160-gallon tank. This type of outfit without tank will cost from $40 to $60.

For all apple orchards larger than those mentioned above, a gasoline outfit is almost essential for good work. A power outfit of this type along with tank and trucks costs between $200 and $350.

Good care with any of these outfits will more than double their period of usefulness. Any kind of machine should be washed out each evening after spraying, and when the season's work is over should be well cleaned, oiled and put away in a dry place.

Some Suggestions on Spraying.

All trees should of course be pruned before they are sprayed and large apple trees should be headed back to a reasonable height, care being taken in doing so to give them a symmetrical, umbrella shape. If San José Scale is present, the rough, loose bark should be removed from apple trees.

Good spraying continued year after year should almost always result in from ninety per cent. to ninety-nine per cent. of absolutely clean, sound fruit. Unfortunately, not many of our fruit growers are good sprayers. The following are some of the chief reasons for this: First, their outfits are not kept in good condition to do rapid, thorough work; often the pump needs repacking or the hose is too short, or the nozzles are worn out or are the wrong kind. Second, they do not study the nature of the disease or insect they have to combat, and so do not recognize the importance of promptly spraying at the special times indicated in the spray calendar. A spray applied a few days too early or too late will often mean complete failure. Moreover, the omission of one or more of the regular applications will often mean cull fruit. Third, in many cases not nearly sufficient material per tree is used, frequently only about one-third of the proper amount. It is absurd to expect the spray to keep all of an apple free from scab if only half of its surface is covered by the mixture, or to kill all the San José Scale on a tree unless every particle of the bark is wet with the liquid. Fourth, the spray mixtures are sometimes not used at the strength recommended. Fifth, many men foolishly experiment with new mixtures instead of waiting until these have first been thoroughly tested by unprejudiced experimenters.

Before beginning to spray the machine must be put into good condition so that it will give good pressure and not leak. If two lines of hose are used, the one for the man on the ground should be from thirty to forty feet long, the other twelve to fifteen feet. The most satisfactory nozzles at the present time are those of the angle disc type. When the plates of these become much worn they should be replaced by new ones. If two nozzles are used on a T or a V they should not be set at a wide angle of divergence, but should be made to supplement each other and thus give a dense spray that will quickly wet the part being treated. Bamboo poles with aluminium rods inside are light and satisfactory if not roughly handled. A ten foot pole is about the right length for the man on the tower, and a six or eight foot one for the man on the ground. To prevent the drip running down the pole, a small rubber or leather disc about three or four inches in diameter cut out of an old shoe or rubber is helpful. It should be placed at the top of the rod just below the nozzle. Good pressure is necessary for speed and thoroughness. It should never be less than 100 pounds. With gasoline outfits about 150 to 200 pounds is high enough. Higher than 200 is liable to cause leaf injury. The mixture in the tank must, of course, be kept well agitated to prevent settling.

When spraying, especially in the first application, it is desirable to take advantage of the wind. A strong wind is a great help, as it carries the spray right through the tree. If the wind is weak and the trees are wide apple trees, it is necessary that the man on the ground go in underneath the tree to the far side, and shoot the spray up upon the branches and twigs or foliage and fruit, and gradually work his way back to the outside. This is the only way with these large trees to prevent the inner surface of upright twigs and small branches or later of the young fruits being unsprayed, for they will not be reached from the other side when the wind changes. It is on this inner side of young fruits that the scab nearly always first develops, hence the need of the step just indicated. In the case of San José Scale great care must be taken not to miss the tip of the branches. This is a very common fault with many sprayers.

In many instances there is too short a period to justify a person in waiting for changes of wind, hence under such circumstances the best method is to drive the team facing the wind and shoot the spray in at right angles to the row. This is a little slower, but if care is exercised is satisfactory. Moreover, by coming back and going up the other side, also against the wind, it enables a person to finish the trees the same day.

Thorough spraying requires great care and constant study. One should always follow some system with each tree, otherwise he will be missing parts here and there. Sometimes the best way is to take the tree branch by branch. At other times it is better to move the rod slowly up and down and work gradually from left to right or right to left, seeing that everything is covered as one goes. The angle on the nozzles permits the spray being directed first one way then back in the opposite, so that both sides of a branch or of fruits may be more easily covered. Often both sides may be covered by holding the nozzles against the wind and allowing this to drive the spray back. An apple tree capable of bearing five or six barrels of fruit will usually require from eight to ten gallons of spray, especially for the Codling Moth or for San José Scale.

Dusting Trees for Insects and Diseases.

During the last few years considerable success has been obtained, especially in New York State, in treating trees with dust instead of liquid sprays. The dust used consisted of from 85 per cent. to 90 per cent. of very finely ground sulphur

Dusting fruit trees for insects and diseases.

and 10 per cent. to 15 per cent. of the powder form of arsenate of lead. It is applied by means of a blower driven by a gasoline engine. (See figure.) This is a very rapid and clean way of treating trees. At least twenty acres of large apple trees can be done in one day. The above substances, however, are useless against San José Scale, and also against Aphids and Pear Psylla. Other dust materials to combat these are being manufactured, but their success is still uncertain. We ourselves have had only one year's trial of dusting, and are unable therefore to speak with certainty as to its merits. Should the method after further experiments prove satisfactory, it will lessen the fruit-grower's task greatly.

Spray Calendars.

From time to time improved methods of combating insect pests and plant diseases are discovered. These new methods are incorporated in the Spray Calendar from year to year. Hence every fruit-grower should each spring write to the Fruit Branch, Toronto, and request a copy of the latest Spray Calendar, so that he may have the most up-to-date information available.

INSECTS ATTACKING THE APPLE.

Codling Moth (*Carpocapsa pomonella Linnaeus*).

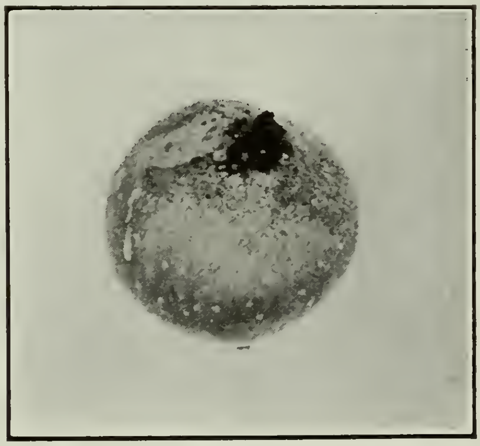
Injuries from the Codling Moth larvæ are familiar to everybody, as these are the insects that cause by far the most of the worm-holes so commonly found in apples and pears.

The adult moth is greyish-brown with a well-marked golden brown patch near the apex of each front wing and with a wing expanse of about ¾ of an inch. The full grown larvæ are moderately stout, about ¾ of an inch long, white or often pinkish in colour with a brown head. Young larvæ have the head black.

Adult Codling Moths, natural size. (After Slingerland.)

Full-grown larva about natural size. The dark spots on the body are not often so conspicuous. (Reduced from Simpson.)

They attack chiefly apples and pears though occasionally the other orchard fruits and haws are slightly infested. The injury is caused by the larvæ boring into the fruit, feeding on the pulp and seeds and causing the fruit either to fall prematurely or to be unfit for sale. Dropping of infested fruit begins early in the summer and continues to the time of picking. In some orchards, especially those



Castings at calyx end, showing clearly where larva entered the apple.

Work of lesser Apple-worm. (Original.)

in the warmer districts, the loss is often very heavy, sometimes 75 per cent. or upwards of the crop; in others, especially in the colder parts, it may be as low as 5 per cent. The average for the province in unsprayed orchards is probably between 30 and 40 per cent.

Life History. The winter is passed in the full grown larval stage in a little nest or cocoon under the shelter of the loose bark or in crevices or holes on the trunks or main branches of the trees, or in any other fairly dry, good hiding place near the apples from which the larvæ emerged. In spring the larvæ change to pupæ in their cocoons and the earliest moths begin to emerge soon after the blossoms fall. Emergence continues for a month or more, so that the earliest larvæ of this first brood may be more than a month older than the latest. A few days after their appearance the moths lay their eggs, placing most of them on the leaves and the rest on the fruit and twigs. The eggs hatch in a little over a week and the young larvæ almost at once seek the fruit. On finding it about 75 per cent. of them work their way into the interior through the calyx end, this being the easiest place of entrance at this stage of the fruit. Here they feed for a few days and then proceed to the core and feed on the seeds and pulp. In about 25 days the larvæ are full grown and make their way out of the fruit either by the same place as they entered or at some other point. The apples usually, but not always, fall before the larvæ leave them. After emergence the larvæ seek the sort of places mentioned above and make their cocoons. In the warmer part of the province many of these earliest first brood larvæ soon pupate and transform into moths which lay eggs for a second brood. The larvæ of this brood do not all appear at the same time but continue to hatch out for several weeks. As a large percentage of the new brood enter the fruit by the side instead of by the calyx they often cause great loss. When these larvæ are full grown they, along with the larvæ of the first brood that did not pupate, remain over winter in the larval stage in their cocoons.

Natural Enemies. The Downy Woodpecker and to a lesser extent the Hairy Woodpecker and the Chickadee destroy the larvæ and pupæ. These birds should, therefore, be encouraged to live in the orchard. A few meat bones hung out in winter for them to feed upon will help. The larvæ and adults of two or more species of beetles prey upon the Codling Moth larvæ and pupæ. Diseases attack them. Very wet springs or summers also help in control and the complete failure of a crop owing to early frosts or other causes will usually destroy nearly all of this pest in an orchard.

Methods of Control. The best, and in fact the only necessary, means of control is thorough spraying immediately after the blossoms have all or nearly all fallen. This spraying in the case of apples must be all done before the calyces close, because if this takes place it will be impossible to get the poison into them, and so the young larvæ on entering will not be killed, but if the poison is placed in the calyx before it is closed it remains there all summer and will kill the larvæ whenever they enter; so that a well-sprayed orchard will have almost no calyx-end wormy fruit.

As this is also the proper time to spray for the Apple and Pear Scab, the poison—arsenate of lead—should be used with the fungicide-lime-sulphur. The latter should be at the strength of 1,008 sp. gr. (1 gal. of the commercial lime-sulphur to 35 gals. of water), and the arsenate of lead at 2 lbs. of the paste form or 1 lb. of the powder form to every 40 gals. of the above strength of the lime-sulphur.

One cannot be too careful in spraying; to secure the best results in the double object of keeping off the Scab and killing the insects every calyx must be wet. It will not do merely to cover the tree with a fine mist and stop as soon as it begins to drip; the spraying must continue regardless of the dripping until the work is thoroughly done. This will often mean as high as 10 gals. or more per tree in the case of large apple trees that bloomed heavily. For these large trees a tower is nearly always a necessity. The nozzles should be of the angle type and have fairly coarse openings. High pressure will help greatly to drive the spray well through the tree and to make thorough work easier. Many advocate a second application about two weeks later but, if the first is well done, another will seldom be necessary; in fact one good application each year will, after two or three years almost annihilate the Codling Moth in the orchard or at least result in 95 per cent. annually of worm-free fruit. The destruction of the first brood means there will be no second brood or only the small number that may fly in from other orchards.

Lesser Apple-worm (*Enarmonia prunivora Walsh*).

The adult of this insect is a small, dark gray moth about half the size of the Codling Moth. Its larva resembles so closely the Codling Moth larva that very few fruit-growers even suspect that it is a different insect. The larva is, however, much smaller, being when full grown never more than 2/5 of an inch long, whereas the Codling Moth larva is about ¾ of an inch. The color is a deep flesh or reddish, whereas that of the Codling Moth larva is either a white or light pinkish. An easier way to distinguish the two insects is by their work. The Codling Moth larva makes a definite hole in the fruit from which it throws out its castings and from this hole it makes a tunnel to the core where it feeds on the seeds and pulp; the Lesser Apple-worm larva as a rule leaves no definite hole, but feeds on the pulp just under the skin. This part of the surface then wrinkles, turns brown and forms a large blotch that badly disfigures the fruit. These blotches may occur on almost any part of the apple, but are usually most numerous at the calyx end.

Apples are much worse affected than any other orchard fruit, in fact it is only occasionally that plums, cherries and other fruits are infested at all. The native food plants of the insect evidently are the various kinds of haws. From these it has spread to the apple.

The total amount of injury to apples in the province is not nearly so great as that from the Codling Moth, probably not more than 1/5 as great. We have been surprised, however, to find an occasional tree on which the amount of injury reached as high as 50 per cent.

Life History. The life history is so similar to the Codling Moth's that it need not be given. The only important difference is that there is apparently a full second brood. The larvæ of this brood are often found in the fruit even when the winter apples are being picked.

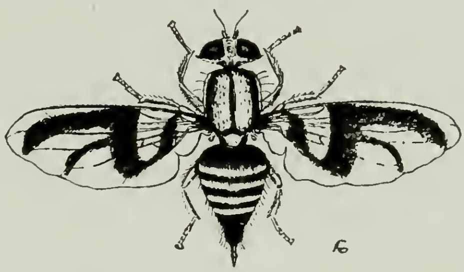
Methods of Control. Experience shows that the same spraying as for the Codling Moth will control this pest satisfactorily. Spraying should be supplemented by the cutting down of all hawthorn trees near the orchard, as the fruit of these is even more of a favorite with the insect than apples, and therefore these trees serve as a breeding place.

The Apple Maggot (*Rhagoletis pomonella Walsh*).

The Apple Maggot or Railroad Worm, as it is sometimes called, occurs here and there throughout almost all the fruit growing counties of the Province. Its chief ravages are usually confined to small orchards or individual trees in towns and villages or to badly neglected, unsprayed orchards in rural districts, especially if the soil in the latter is overgrown with weeds and long grass. Well cared for orchards that are properly sprayed are as a rule almost entirely free from this pest.

The adult insect is a pretty two-winged fly, a little smaller than a house-fly, and of a general blackish color, but with the eyes golden-green and the head and lower part of the legs yellow. The abdomen of the female is crossed by four con-

A female adult of the Apple Maggot on the fruit, natural size. (Original.)



A female adult of the Apple Maggot or Railroad Worm, much enlarged. (Drawing by Cory.)

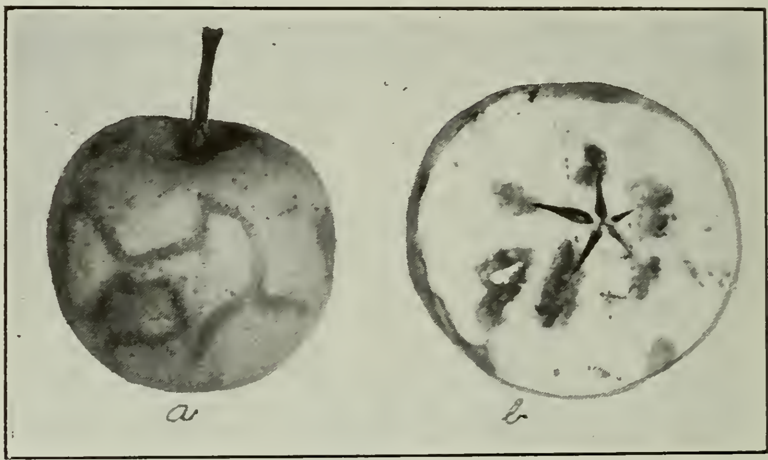
spicuous white bands, and that of the male by three. Near the middle of the back is a small, distinct triangular white area. The wings have conspicuous black cross bands arranged on the definite plan shown in the illustration. The full grown larva

Apples showing the egg punctures of the Apple Maggot, natural size. (Original.)

is a small, legless and headless white maggot, about one-quarter of an inch long. One end of the body is blunt, and the other pointed. At the latter end are two little black hooks which are used to rasp and tear the pulp of the fruit and to free the juices, which are then absorbed through a small opening close to the hooks.

The food plants so far as known, are apples, haws and blueberries. Almost every variety of apple and some crabs may be attacked, but the common varieties worst infested are: Early Harvest, Sweet Bough, Astrachan, Golden Sweet, St. Lawrence, Gravenstein, Alexander, Wealthy, Cayuga, Snow, Tolman and Spy. Of these the sweet varieties suffer most, but the summer and early fall apples, owing to the fact that a much larger proportion of the larvæ mature in these than in later apples, are the chief breeding sources for the insect.

The injury to the fruit consists chiefly in the brown tunnels made in every direction by the maggots (hence the name Railroad Worm). The extraction of so much juice leaves the apples tough or woody and often unfit either for private use or for sale. In addition, the surface of the apple is disfigured by the small depressions produced where the eggs are laid and by the ridges that result where the larvæ feed close to the surface. Badly infested fall and winter apples usually drop prematurely. When the insects are abundant practically every apple in the orchard may be so severely infested as to be useless.

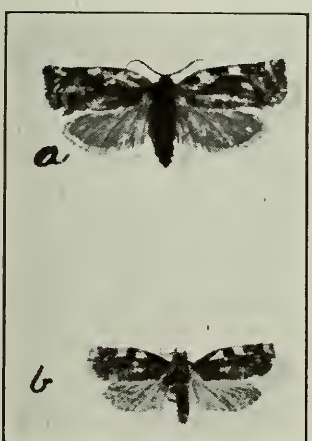


(*a*) Tunnel or burrow of Apple Maggot larva showing through the skin; (*b*) cross-section of a ripe apple infested with Apple Maggots, natural size. (Original.)

Life History. The winter is passed in the pupal stage in the soil a short distance below the surface. In the warmer parts of the Province the flies begin to emerge about the last week in June or the first week in July. In the colder parts emergence is a week or more later. Emergence continues throughout July and the most of August. In a week or more (the exact time is not known) after emergence the females begin to lay eggs in the fruit. The ovipositor resembles a bee-sting and is thrust to its full depth through the skin into the fruit and the egg deposited a short distance below the surface. The eggs hatch in about five days and the larvæ work their way through the apple, rasping the pulp and absorbing the juice. They do not grow rapidly until the fruit is nearly ripe, and never become full grown or emerge until the apples are over-ripe and often not until they have begun to decay. By this time of course all but a very rare apple will have fallen. After working their way out through the skin, the larvæ search for an easy place to enter the soil and pupate. There is practically only one brood a year, though some years in the warmer districts a very few adults emerge from the new pupæ and produce a second brood. By far the most of the pupæ that overwinter emerge the next July and August as adults, but a small percentage remain dormant in the soil over a second winter and emerge the succeeding summer. The adults have extensible mouth parts with a large, nearly circular structure at the apex. This they use as lips to gather their food. They may easily be observed moving about on the leaves and fruit with their mouth parts protruded, searching for juices or anything that they can devour. This manner of feeding is very important, for it enables us to take advantage of it to poison them before they can lay their eggs.

Methods of Control. By far the simplest and easiest way to control this pest is to spray the trees with 2 or 3 lbs. of arsenate of lead in 40 gallons of water. A gallon or a little less of cheap molasses may be added to this to sweeten it, but cage experiments and our experience with the closely allied Cherry Fruit-Flies tend to show that the molasses is not necessary. The first application should be made the last week in June in the warmer parts of the Province and about the end of the first week in July in the remaining parts. A second application should be given two weeks after the first. A fine nozzle may be used and the spray shot up into and upon the foliage. About 3 gallons per tree is sufficient for apple trees 30 years of age and upwards. At the first spraying all the trees should be treated but at the second the early varieties should be omitted as they are almost ready to pick. Every effort should be made to induce owners of nearby infested orchards to spray their trees also, because the flies move about much more than is usually supposed. For this reason spraying trees in a village or town will not control the pest unless all the trees for twenty rods or more around are also treated. All hawthorn trees close by should also be sprayed or cut down.

Another method of controlling the apple maggot is to gather up and destroy either by feeding to stock or by burning (not by burying) all ripe apples, especially all early varieties, soon after they fall. This method destroys the larvæ, but is very laborious and very few persons will carry it into effect. Sometimes the object can be attained by allowing hogs or other stock to run in the orchard.



(*a*) Adult female; (*b*) adult male of Fruit-tree Leaf-roller, both natural size. (Original.)

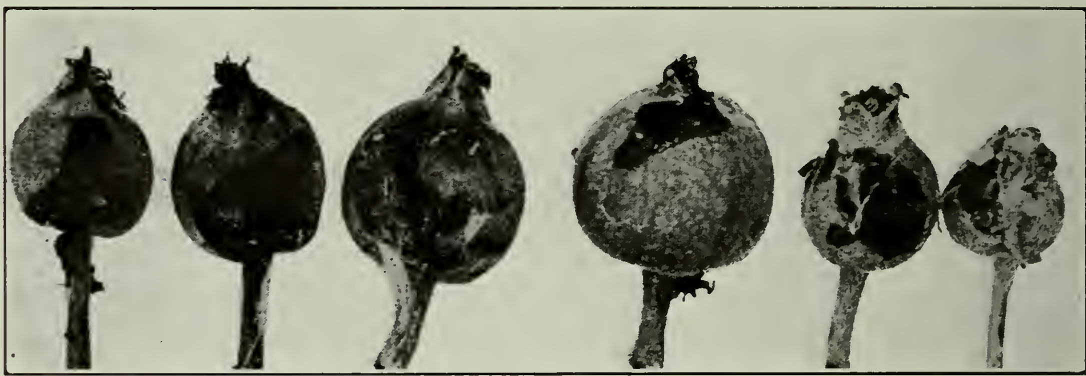
Egg-masses of Fruit-tree Leaf-roller. Those on the twigs to the left are unhatched, those to the right hatched, natural size. (Original.)

FRUIT-TREE LEAF ROLLER (*Tortrix argyrospila Walker*).

There are several species of Leaf-rollers the larvæ of which resemble each other closely, and have the same general habit of feeding and of rolling the leaves. By far the most destructive of these is the so-called Fruit-tree Leaf-roller. The adult of this insect is a moth with a wing expanse of nearly an inch. The front wings are rusty brown with several silvery-grey markings which are most prominent along the front margin. The hind wings are light ashy-brown. The larvæ are somewhat slender caterpillars about an inch long when full grown and of a yellowish-green color with a brown head. In the younger stages the head is black.

The insect attacks all kinds of fruit trees, and also some shade and forest trees, but it does far the most damage to apples, and after these to pears and plums. An interesting peculiarity about it is that though it is found all over the fruit growing portion of the Province it has hitherto localized its attack to three or four orchards in widely separated districts. Other orchards close to these have so far been almost entirely uninjured. In the badly infested orchards the loss has been heavy, averaging about 50 per cent. of the crop. The chief injury is caused by the larvæ eating cavities out of the fruit while this is still small—not more than two-thirds of an inch in diameter—and causing it either to fall or to become badly deformed and unfit for sale. The foliage is also much eaten and presents a very tattered appearance.

Life History. The winter is passed in the egg stage, the eggs being laid in small, brown, oval clusters one-quarter of an inch or less in length. The clusters



Fruit injured by larvæ of Fruit-tree Leaf-roller, natural size. (Original.)

are situated on the upper and lateral surfaces of the twigs and small branches. The eggs hatch in spring about the time the leaf-buds of the apple have opened. The tiny larvæ at once work their way into the opening buds and feed on the inner parts, and often retard the opening of the leaves by fastening them together with silken threads. They attack the fruit buds in the same way, and web together and destroy the opening blossoms. On the opened leaves they fold the one edge over and fasten it there with silken threads. It is from this rolling of the leaves they get their name of "Leaf-rollers." The larvæ hide inside the rolled leaf, sometimes feeding on the leaf itself and sometimes coming out to feed on other leaves and especially upon the fruit; for as soon as this appears they prefer it to everything else, and soon eat out large areas, thus forming cavities that may reach even the core. About the time the apples average two-thirds of an inch in diameter most of the larvæ are full grown and have begun to pupate. This takes place for the most part inside the rolled leaves, though many pupæ may also be found on the ground among the weeds and grass. In uncultivated or weedy orchards many larvæ drop by means of a silken thread to the ground and complete their development upon any kind of succulent plants they find there. In about two weeks the moths begin to emerge and egg laying soon commences. The moths hide during the day, darting away in a zigzag manner if disturbed. They fly around late in the evening and at night.

Methods of Control. The only successful way of controlling this pest is to spray the trees well with Scalecide or some other miscible oil at the strength recommended by the manufacturers for the San José Scale. Special care should be taken to see that every twig is well covered so that no eggs will be missed. The rest of the tree may be disregarded unless San José Scale is present. The spraying should be done just before the buds are ready to burst.

Larvæ of Fruit-tree Leaf-roller, all full grown and natural size. (Original.)

Apple leaves infested by Fruit-tree Leaf-rollers, natural size. (Original.)

Spraying with arsenate of lead, no matter how thoroughly done, fails to control the pest, partly because the larvæ in the early stages feed inside the opening leaves where the poison cannot reach them, and partly because when they become half grown or a little larger they are almost immune to the poison.

Keeping the orchard well cultivated in late May and early June should help by burying pupæ or crushing them. Chickens in the orchard would devour many larvæ and pupæ.

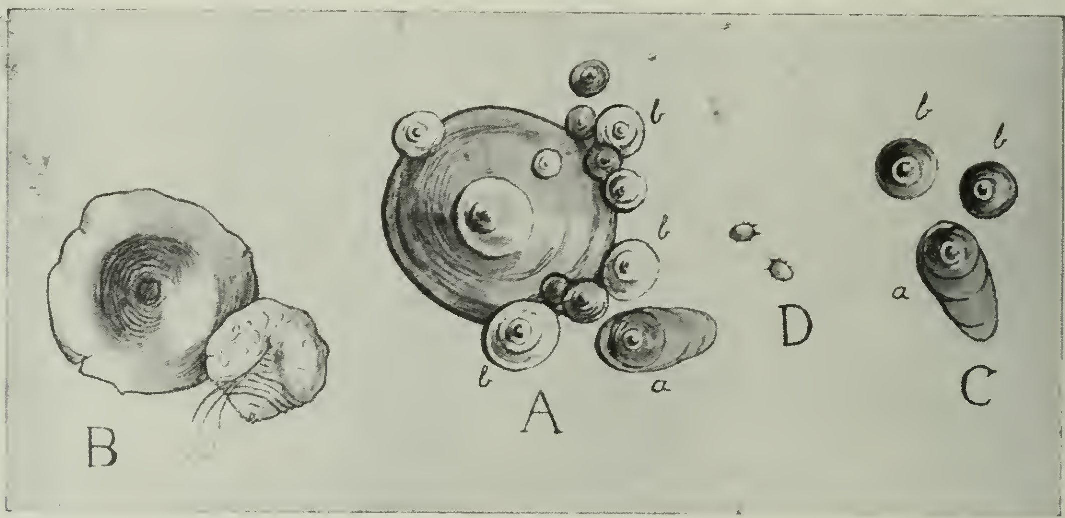
San Jose Scale (*Aspidiotus perniciosus Comstock*).

The San José Scale in Ontario does not, so far as is known at the time of writing, occur north of a line drawn from Sarnia to Toronto, and in this district is most abundant in the counties bordering on Lakes St. Clair and Erie and on the south shore of Lake Ontario. Wherever it can thrive it has proven itself far the worst of all orchard insects.

The full-grown female scale is nearly flat, circular, about the diameter of the head of a pin, ashy-brown in color with the central area usually yellowish, though often about the same color as the rest of the scale. The males are much smaller, oblong, and usually blackish in color. The most common stage, and the one by which the scale is most readily identified, is the so-called black immature stage. This is in size a mere dot, but when examined with a hand lens is seen to be circular and to have a little nipple in the centre with a depression or groove around it. These characteristics separate it from other closely allied scales. The real insect in all cases lies beneath this scale covering, and is yellow, soft and pear-shaped.

The Scale in its various stages attacks all kinds of orchard trees except sour cherries, though Kieffer pears and some varieties of sweet cherries seem to be nearly immune. It also infests many shade trees and shrubs, such as mountain ash, hawthorn, Japanese quince, currants and roses.

The injury is caused by the tiny insects in almost countless numbers—often sufficient to cover completely the bark—inserting their long, slender, bristle-like mouth parts through the surface of the bark, leaves and fruit and extracting the sap. At the same time they seem to insert a poison which in many cases stains with a reddish color the inner bark and the part of the fruit around the insect itself. The result of these two kinds of injury is that not only is the fruit rendered unfit for sale, but the trees themselves are killed in from two to about six years, depending largely upon their size. Any severely attacked orchard is doomed to destruction in a short time if left untreated.

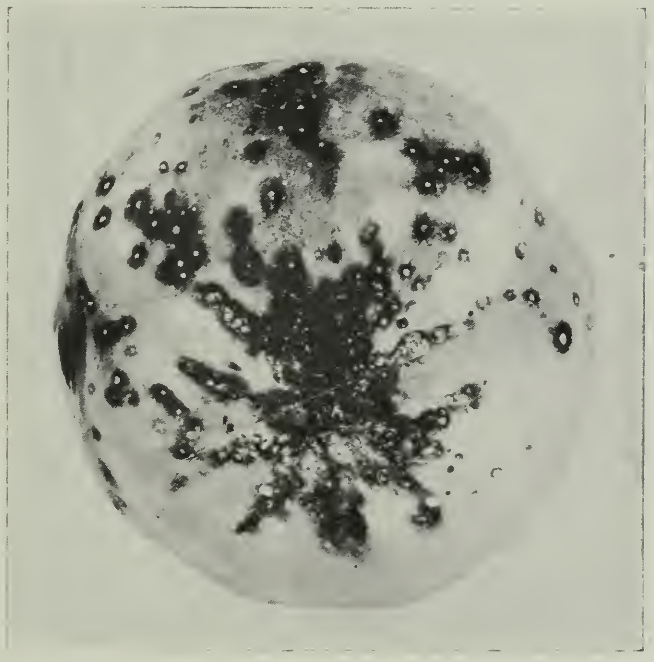


Various stages of San José Scale, all enlarged about fifteen times: A. Adult female scale with immature young of various stages settled down around or upon it; *a*, an adult male scale; *b*, *b*, *b*, three small black scales, winter stage. B. An adult female scale turned over, revealing the insect herself beneath with bristle-like mouth parts exposed. C. *a*, an adult male scale; *b*, *b*, two immature black winter stage scales. D. Young active larvæ soon after birth. Note the nipples and little grooves around them in A *b*, *b*. *b*, and in C *b*, *b*. (B redrawn from Alwood, the remainder original drawings by Miss A. Hearle.)

Life History. The winter is passed on the bark of the twigs, branches and trunks in the immature black stage described above. About May 24th the males are full grown and begin to come out from under their scale covering, fly around and fertilize the females. In a month, or about the last week of June, these have become full size and now begin to give birth to little butter-colored larvæ which run about for a day, then settle down, insert their sucking mouth parts, begin to feed and to cover themselves with the wax which forms their covering or scale. Each adult mother in the course of about 40 days may produce a total of 400 or more offspring. About the time the last of these are born the first are full-grown and beginning to produce a new generation. In Ontario we probably have two full broods in a year, and sometimes a partial third; so that the total offspring from one fertile female by the end of the season may reach into hundreds of thousands or possibly even to a million.

Up to the present time this insect has comparatively few insect enemies in our Province, and the chief controlling factor is evidently the weather, especially our severe winters, cold late springs and wet autumns.

Methods of Control. Spraying, if thoroughly done, will control this pest in any orchard. The best mixture up to the present is the lime-sulphur wash. This should be used at the strength of 1.035 sp. gr. or one gal., commercial lime-sulphur to 6 or 7 gals. of water. The spraying, especially of apple trees, may be done any time in the spring after the ground is fit to go upon up to the time when the leaves are the size of a ten-cent piece. At the latter date there will be a little burning, but not enough to do any serious damage. Spraying may also be done in the fall on warm days after the leaves have nearly all fallen. It is not wise to spray on a day when the thermometer is as low as freezing point. All badly infested trees should be marked and receive two applications. One of these may be given in the fall and the other in the spring, or both may be given in the spring. Before spraying every orchard should be carefully pruned and, if the trees are very tall, headed



San José Scale on apple, showing both the scales themselves and discoloration caused by them, natural size. (Original.)

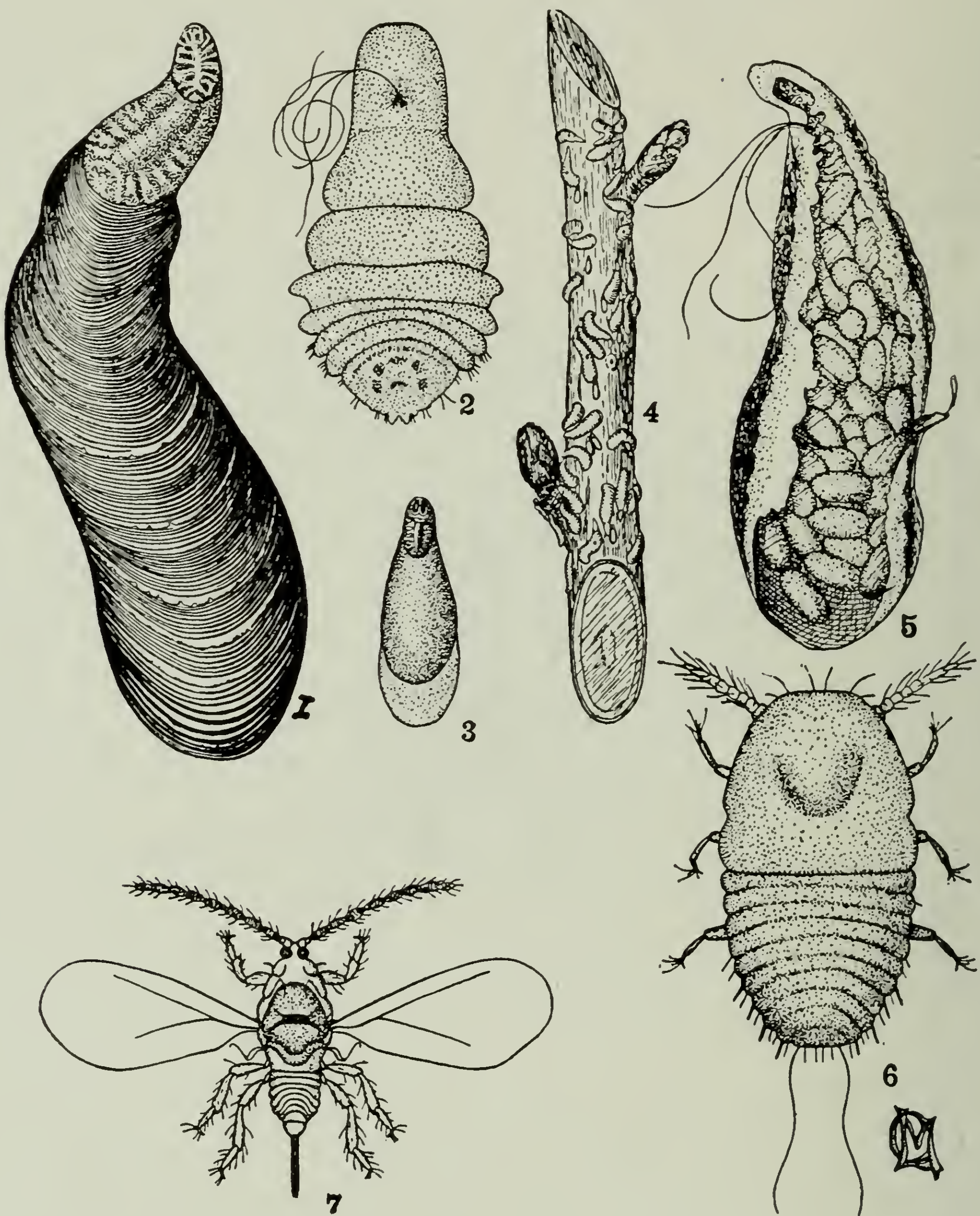
back. This saves material and makes possible a good job. The loose bark should also be scraped off the trunks and large branches. In spraying the utmost care must be taken to see that every part of the tree is covered. This is no easy task, and requires a good outfit and constant watchfulness and intelligence. To insure thoroughness, some men in the Niagara District spray large trees from all four points of the compass. The thought in fighting this pest should not be to economize with the mixture, but to see that every particle of the tree from the topmost twig to the ground is thoroughly wet.

Soluble-sulphur (12½ lbs. to 40 gals. water) and likewise miscible oils, such as scalecide, have also given good results against the scale, but must be used before the buds have burst because of danger of burning.

Oyster-Shell Scale (*Lepidosaphes ulmi Bouche*).

The Oyster-Shell Scale is larger than the San José, and is easily distinguished from it by the fact that it is elongated, being about three times as long as broad, whereas the San José Scale is circular. A full-grown Oyster-Shell Scale, as shown in Fig. 16 is about ⅛ of an inch long, tapers towards one end and as the name suggests, resembles in outline the shell of an oyster. Its color is nearly the same as that of the bark on which it is found.

This Scale is very common in all parts of the Province and attacks not only apple and other fruit trees, but also many shade and forest trees and many shrubs; apple trees, however, usually suffer most.



Various stages of the Oyster-shell Scale: 4. The scale slightly enlarged on a twig. The little holes in the scales indicate where parasites emerged. 1. The female scale very much enlarged, showing general shape. 5. A similar scale turned over to show the eggs beneath. The shrivelled body of the female herself is beyond the eggs at the small end. 2. A female removed from beneath the scale before she has laid her eggs. Note the bristle-like mouth parts similar to those of San José Scale. 3. A male scale. 6. Young larva, dorsal view. 7. Winged male. All except No. 4 much enlarged (after Sherman and Metcalfe).

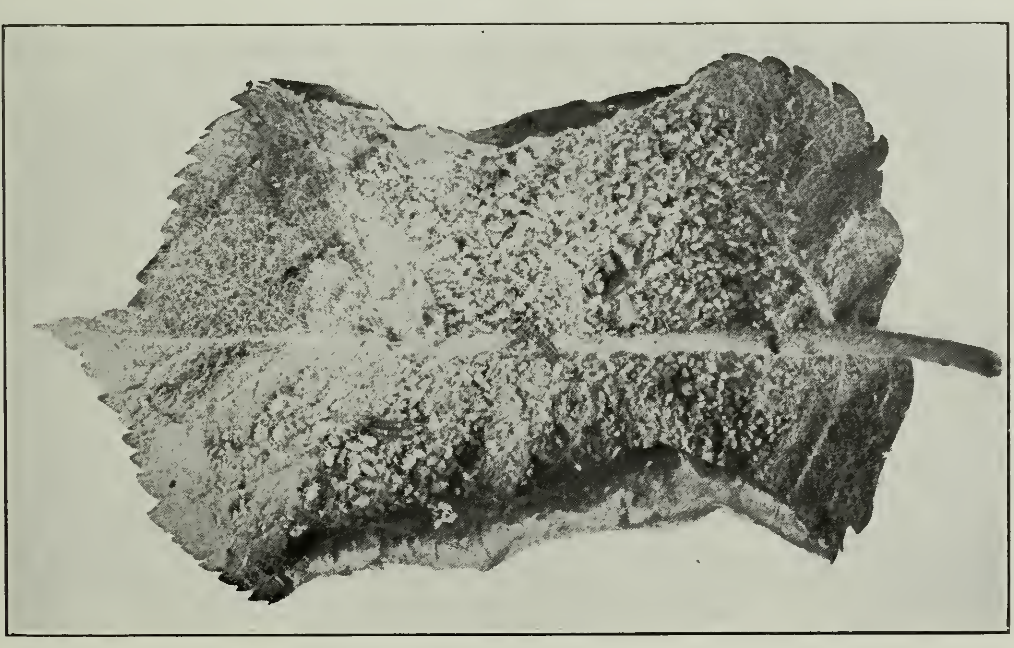
It is not nearly so prolific or so destructive as the San José Scale, and though it often kills individual branches, it comparatively rarely kills the whole tree. Badly infested trees are of course weakened and unable to bear good crops.

Life History. The insect winters in the egg state, there being an average of between 40 and 50 white eggs under each female scale. The eggs hatch about the time the blossoms are falling from the apple trees. The tiny white or cream colored larvæ move around for about a day then settle down permanently, work their long, slender, bristle-like mouth parts through the bark, and gradually cover their bodies over with the wax that forms the protecting scale. The females become full-grown and begin to lay their eggs in August. Soon after all the eggs are laid the insects themselves die. There is only one brood a year in Ontario.

Methods of Control. Thorough spraying each year with lime-sulphur (strength 1.030 sp. gr. or 1 gal. commercial lime-sulphur diluted with 8 or 9 gals. of water) any time in spring from a week or so before the buds begin to burst until the little leaflets are the size of a ten-cent piece will soon completely control this scale. The regular Codling Moth spray with arsenate of lead and lime-sulphur, will help by killing many of the larvæ while they are still small and delicate. Dead scales, of course, will remain on the trees for a year or two after they have been killed. Weakened trees can be assisted to recover their vigor by cultivation and the use of fertilizers.

Aphids—A General Description.

Aphids are tiny, soft-bodied, usually sluggish insects. There are a great many species, and so common are they that most of our plants are attacked by at least one species and sometimes by several. The different species often differ greatly in color: some are green, others black, others red, others brown, and so on. They all obtain their food by sucking the juices out of the plants after first penetrating the epidermis with their sharp needle-like lances. As they feed they exude from time to time a clear, sweetish liquid called honey-dew, of which ants are very fond. When



Dense colony of Rosy Aphids on under-surface of an apple leaf. Three ladybird beetle larvæ may be seen among them. All are natural size. (Original.)

the aphids are very abundant, such a large quantity of honey-dew is exuded that it covers the leaves and fruit and causes them to become sticky and later a dirty sooty color, due to a black fungus which grows in the honey-dew. There are many generations each year, some species having thirteen or even more. Each generation except the last consists entirely of females. The last is composed of true sexual forms, males and females. These mate and the females lay eggs for winter and then die. In all the preceding generations living young instead of eggs are produced, and that too without the presence of any males. The first generation in the spring is composed entirely of wingless forms, but in the later generations winged forms also appear. These can fly from tree to tree and so distribute the species. Some, but not all, species have what is known as an alternate host plant or plants; that is they remain for one or more generations in the spring on the plant on which they over-wintered, and then a winged generation appears which migrates to some other kind of plant and lives and reproduces on this until autumn, when another winged generation is produced, which migrates back to the original host.

The rate at which aphids can multiply is marvellous, and far surpasses that of any other common orchard pest. This is due to the fact that there are so many broods each year, and that each brood except the last is entirely composed of females. Very fortunately for us these insects have many enemies which do a great service in helping to control them. The chief of these are Ladybird beetles and their larvæ, Syrphus Fly and Lacewing larvæ and tiny four-winged parasites. In addition to these, disease often destroys countless numbers, and weather has also a great influence. Cool, moist weather seems to be favorable and hot, fine weather unfavorable to orchard aphids.

Aphids of the Apple.

There are three common species of aphids that attack the foliage and fruit of the apple, and one species known as the Woolly Aphis that attacks the bark and roots. Of the first three species two are green and the other usually purplish or pinkish with a whitish bloom over its body. Because of its pink or purplish color this last species is known as the Rosy Aphis—Aphis (sorbi) malifoliæ. Of the two green species the less important is often known as the European Grain Aphis (Aphis avenæ) because it is a European species, and has as its alternate host plants wheat, oats and rye, as well as several kinds of grasses. The third species, perhaps because it has no alternate host plant, but remains on the apple throughout the year, is usually called the Apple Aphis or the Apple Leaf-Aphis (Aphis pomi). The Rosy Aphis has as its alternate host plants the various kinds of plantains, especially rib-grass.

Aphis avenæ is some years abundant on the buds, young leaves and blossoms, but apparently does little permanent injury, probably because it usually migrates to its other host plants early in the season about the time the blossoms are out in bloom, not returning to the orchard until the fruit is mature in autumn. The Rosy Aphis seems usually to be responsible for most of the injury up to about the first of July, after which it migrates to its alternate host plants for the rest of the summer and early autumn. Consequently any further damage from aphids is caused almost entirely by Aphis pomi, which, as we have said, has no alternate host. This insect of course has also a share in the losses caused in the early part of season.

On bearing trees most of the damage done by the various species is on the lower branches. On these some years great numbers of the aphids attack the leaves, tender twigs and fruit, causing the leaves to curl, turn yellow and sometimes die, and the fruit to become dwarfed, woody and often pitted, and to hang on the branches in clusters. Such fruit is unfit either to sell or use.

Young trees and nursery stock commonly suffer more than bearing trees, because the aphids seem to prefer their tenderer foliage. Where badly infested these trees have their growth stopped and sometimes the upper parts of the branches are either killed or much weakened by the extraction of the sap. The new growth is the part of these most attacked.

Pears as well as apples may be attacked, but are seldom badly infested or suffer loss worth mentioning.

All the above species winter in the egg state. The eggs are laid on the bark of the branches and water sprouts, often being placed around the buds or in crevices. Hatching of these is usually completed in spring by about the time the leaf-buds have begun to burst, those of Aphis avenæ being usually a few days earlier in hatching than others.

Cluster of small deformed apples, showing the effect of Aphid attacks in June and July, about two-thirds natural size. (Original.)

If at this date the buds are examined, the young aphids can easily be seen without the aid of a magnifying glass. They are then of course very small, but this very fact, together with their exposed position shows that this is a good time in which to destroy them by spraying.

Methods of Control. Postpone the regular dormant spray with lime-sulphur —strength 1.030 sp. gr. or for San José Scale 1.035, (1.030 sp. gr. = 1 gal. commercial lime-sulphur to 9 gals. of water; 1.035 sp. gr. = 1 gal. to about 7), until the buds are beginning to burst and then add to the mixture a tobacco extract, either Black Leaf 40 or Grasselli's Nicotine-sulphate 40 per cent.. The amount of either substance to use is printed on the can in which the extract is bought. The spraying of course should be done so as to insure that every bud is well covered. If spraying is postponed until the foliage is out it is very doubtful whether it pays because many of the aphids are then so situated among the leaves that they cannot be reached.

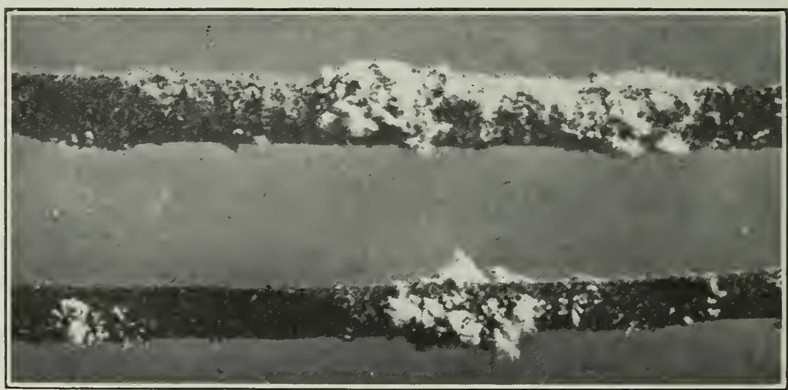
In many bearing orchards in Ontario aphids are seldom abundant enough to do much injury, and where this is the case it is doubtful whether it would pay to use the tobacco extract, especially as it is costly. Other orchards in different situations suffer considerable loss almost every year, and these it would clearly be wise to treat as described above.

Young trees being subject to severe infestation throughout the season would be benefited by the same treatment as given for bearing trees, but they should also be examined from time to time during the summer to see whether they have become re-infested, and if so should at once be treated with the tobacco extract combined with from 1 to 2 lbs. of common soap sliced and dissolved in boiling rain water and added to every 40 gals. of the liquid, the lime-sulphur being omitted. Instead of the tobacco extract and soap, whale oil soap 1 lb. to 6 gals. of rain water is sometimes used. Kerosene emulsion, if properly made, is also effective. (See Spray Calendar.)

Nursery trees may receive the same treatment as small orchard trees, but in many cases the best results on them are to be obtained by carrying the mixture in a large bucket and bending the top of each infested tree over into it, thus insuring that every aphid will be reached.

Woolly Aphis (*Eriosoma lanigera Hausmann*).

This aphid attacks the bark and roots, doing very little injury to the foliage of the apple. It can easily be identified by its conspicuous, white, waxy covering, which looks like a little tuft of wool or of cotton-batting. If the covering be removed the insect beneath is seen to be brown or reddish-brown. In parts of the United States the Woolly Aphis is considered a great pest because of the injury it does to the roots of the young trees. The root infesting individuals by their sucking



Woolly Aphids clustered on tender apple shoot, natural size. (Original.)

cause small nodules or swellings which ultiamtely kill the smaller roots and so either destroy or greatly weaken the tree. Fortunately, in Ontario this root injury is almost entirely absent, and it is only the insects above ground that do any appreciable damage, but even these do not cause much harm. Occasionally a few trees in an orchard will have a good many small branches, water-suckers and wounded areas heavily infested with the insects. In such cases on the branches and water-suckers little swellings which later may rupture and cause small cankers are produced while around the margins of infested wounded areas there is formed a conspicuous callous. These injuries however, rarely do much permanent damage to the tree itself.

Life History. This species has a somewhat complicated life history, which we need not go into further than to say that while some few individuals winter on the apple, the most of them migrate to elm trees, where the winter is passed in the egg stage on the bark. In the spring the first two generations from these eggs feed on the elm leaves, causing them to become rosetted, but the third generation flies back to the apple trees and serves as the chief source of re-infestation of these.

Methods of Control. Wherever the insects are abundant on small trees, the easiest way to treat them probably is to take a whitewash or paint-brush and a pailful of whale oil soap or even common laundry soap (either of them at the strength of 1 lb. to about 5 gals. of rain water), and with the brush wash the aphids off the branches or trunks. On larger trees a spray machine may be used, but the nozzle must be held close to the insects, so that the spray will break through the waxy covering and reach the insect's body beneath. Only the infested parts of the tree should be sprayed.

Leaf-Bugs (*Miridæ*).

Four species of Leaf-bugs have been found attacking the foliage and fruit of apples. These are *Heterocordylus malinus Reuter, Lygidea mendax Reuter, Neurocolpus nubilus Say and Paracalocoris colon Say.* They occur to some extent in many orchards in the Province, but are scarcely important enough to justify a detailed account of each. In all cases it is the nymphs that do nearly all the damage. The nymphs of the first two species are red; those of *Neurocolpus nubilus* are greenish

Work of Mirids or Leaf-bugs on apples. This is done when the apples are very small. (Original.)

mottled with dull red; and those of *Paracalocoris colon* reddish-brown with some whitish markings. The nymphs of all species when first hatched are only about one-tenth of an inch long, but when full grown and ready to change to adults are nearly one-quarter of an inch. They all have sucking mouth parts.

The injury is caused by the nymphs feeding upon the tender foliage and the terminal portions of the new growth, and also upon the young fruits from when they begin to form until they are half an inch in diameter.

The injury to the leaves and new growth is not usually of much importance: the chief injury is done to the fruit. When the nymphs penetrate this with their sharp beaks and suck out the juices they so injure some of it that it drops, and the rest often becomes badly deformed by the depressions and elevations that result from the feeding.

An adult Leaf-bug (*Neurocolpus nubilus*), and two nearly full-grown nymphs, natural size. (Original.)

Life History. The winter is passed in all cases in the egg stage. The eggs are situated in the bark of the twigs or small branches. Those of the first two species usually hatch before the blossoms burst, but those of *Neurocolpus nubilus* do not hatch until after the blossoms have fallen. The date of the hatching of the other species is unknown to the writer, but is probably about the time the blossoms are open. The nymphs feed as described above and become full grown in about a month. Adults in at least some cases live for several weeks and lay their eggs, usually singly, in the bark as said above. There is just one generation a year.

Methods of Control. The red nymphs of the first two species may be killed by adding a tobacco extract of the same strength as for Aphids to the spray just before the blossoms open, or if the infestation is severe, to both this spray and the one after the blossoms fall. The nymphs of *Neurocolpus nubilus* hatch too late for these sprays and are immune or almost immune to tobacco, but can be killed by thorough spraying with a sticky soap—common laundry soap—at the strength of 1 lb. to 10 gals. of rain water. The other species has not been known to occur in sufficient numbers to justify spraying for it.

Apple Tent-Caterpillar (*Malacosoma americana Fabricius*).

Webs of the Tent-Caterpillars are conspicuous objects in the spring of the year. They may be found on the twigs of many kinds of trees, including not only the various kinds of fruit trees, but also many kinds of forest trees, especially wild

Tent-caterpillar: Male Moth, natural size.

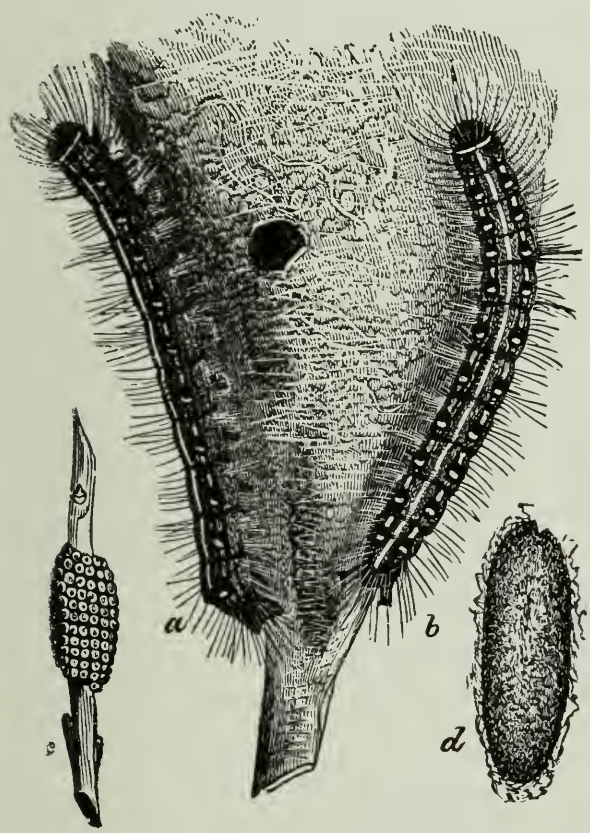
Tent-caterpillar: Female Moth, natural size.

cherries. Outbreaks of this insect occur periodically. For ten or fifteen years the country is almost free of them, then for a few years is overrun by them; then recur the years of comparative freedom, followed again by another outbreak.

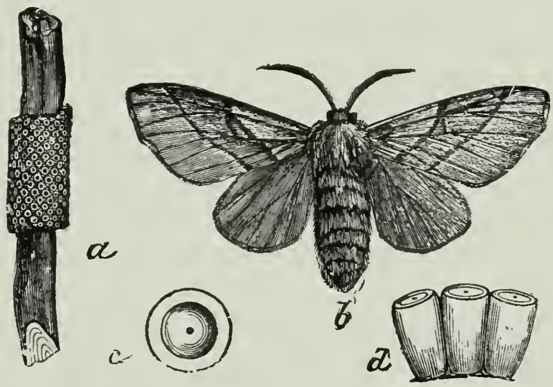
When the caterpillars are very abundant in the orchard they may defoliate practically every tree. Sometimes this defoliation takes place two or three years in succession. The result is that not only is the crop lost each year, but the trees are left in a greatly weakened condition and sometimes succumb to the strain of a severe winter.

The full-grown larvæ are about two inches long, of a general brownish-black color with a conspicuous white stripe down the middle of the back. The adults are reddish-brown moths with a wing expanse of from 1 to 1½ inches. The front wings have two white transverse bands parallel to the outer margin.

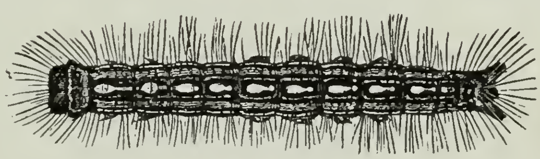
Life History. The winter is passed in the egg stage on the twigs of the trees, the eggs being in clusters that encircle or nearly encircle the twig. Each cluster is one-half to two-thirds of an inch long, elliptical in outline and a little darker in color than the bark. The eggs hatch about the time the apple buds are



a and *b*, Apple Tree Tent-caterpillars on their web; *c*, egg-cluster; *d* cocoon.



Forest Tent-caterpillar: (*a*) egg mass, (*b*) moth, (*c*) vertical view of much enlarged egg, (*d*) side view of eggs much enlarged.



Forest Tent-caterpillar.

ready to burst. The young larvæ from each egg cluster remain together in a colony and soon construct a little web, increasing in size as they grow and need more room. Into this they retire at night and part of the day when not feeding. They feed upon the foliage near their web, gradually extending their range as necessity demands. In June they become full grown and then wander in various directions from the web and often from the tree itself in search of sheltered places in which to spin their cocoons and pupate. The cocoons are elliptical and made of white silken threads covered over with a yellowish powder. During the latter part of June and the first two weeks of July the adults emerge, lay their eggs on the twigs and soon die. There is only one brood each year.

Many parasites and one or more destructive diseases play a very important part in the control of this pest. Birds also destroy many of them. The fact is that we owe to all these friends the disappearance of the great hosts of these insects before they have time to work irreparable ruin to many orchards and forest trees.

Methods of Control. Thorough spraying of the trees very soon after the leaves have begun to expand with either 3 lbs. of arsenate of lead or ¼ to ⅓ lb. of Paris green to 40 gals. of water will destroy the caterpillars. They should always be treated while still small and easily killed and before they have been able to do much damage. Orchards that received the regular three sprayings indicated in the Spray Calendar never suffer any loss from this pest no matter what the surroundings may be. It has been shown by Mr. E. P. Bradt, District Representative for Dundas County, that the first of these sprayings, the so-called dormant spray, if applied when the buds are bursting, will, without any poison, kill over 80 per cent. of the young caterpillars. Cutting down wild cherry and fruit trees along the fences and roadsides will help some, as will also the collecting and destroying of egg masses.

Forest Tent-Caterpillar (*Malacosoma disstria Hubner*).

This insect is very closely allied to the Apple Tent-Caterpillar, and like it is abundant only periodically. Though at times very numerous and destructive in orchards, it is also, as its name suggests, a great forest pest, especially in maple woods, which it sometimes almost defoliates.

There are several points by which the two species may be easily distinguished: The moth of the Apple Tent-Caterpillar has two white cross-bands on each front wing; that of the Forest-Tent has two brown cross-bands. The Apple-Tent larva has a white stripe down the middle of the back; the Forest larva has a row of white dots. The larvæ of the Apple species form a definite web or tent; those of the Forest do not, but merely spin silken threads here and there where they feed or travel. The cocoons of the Forest species are often spun in a folded leaf or cluster of leaves; those of the Apple species are not in leaves, but in any other good hiding place, such as the underside of fence rails or boards.

The life history of the two species is very similar, as are also the natural enemies and the artificial means of control.

Canker-Worms.

Two species of Canker-Worms infest our orchards and forests. These are the Fall Canker-Worm *Alsophila pometaria Harris*), and the Spring Canker-Worm (*Paleacrita vernata Peck*). The terms "fall" and "spring" are given because the moths of the former emerge chiefly in the fall, while those of the latter emerge in spring.

The larvæ of both species are slender and of a general blackish or brownish or sometimes green color, with lighter stripes down the back and sides. When full grown they are about an inch long. Both species move from place to place with a looping gait, due to the fact that they have fewer hind legs (prolegs) than most caterpillars. The Spring Canker-worm has only two pairs of these hind legs, the Fall Canker-worm has three pairs, though the first of these is not fully developed. When disturbed both species drop down on a silken thread. The moths of the two species are a light greyish-brown color, with slender bodies. They resemble each other closely. The male moths have wings, but the females are wingless.

It is only once in a long time that we have a very bad outbreak of these pests, but when they do become numerous they often remain so for about five years, after which they become scarce again. In years of great abundance they are very destructive and not infrequently completely defoliate whole orchards and numerous

(*a*) Spring Canker-worm, male adult; (*b*) Fall Canker-worm, male adult, both natural size. (Original.)

Female adults of Fall Canker-worm, natural size. (Original.) Spring Canker-worm female adults resemble these very closely.

forest trees as well. They feed on most orchard trees and also on many deciduous forest trees, but their favorites seem to be the apple, elm, and basswood.

Full-grown Fall Canker-worms and their work, natural size. (Original.)

Life History. The moths of the Fall Canker-worm appear for the most part in fall, in November, and the eggs are then laid in close irregular clusters on the trunks and branches. Each egg is set on its end and looks like a diminutive pail or flower pot. The cluster is nearly the color of the bark and is not covered over with any protecting substance. A few moths of this species do not emerge until early spring, and lay their eggs then. The Spring Canker-worm moths emerge in March and April and lay their eggs in more concealed places on the bark, such as under loose bark or in crevices. These are in a looser cluster and are oval in shape. The eggs of both species hatch about the time the apple buds are bursting and the young larvæ feed on the foliage as soon as it appears. They are full grown early in June and then drop to the ground where they pupate in the soil. There is only one brood a year.

Birds are said to play an important part in the control of these pests. There are also some parasites and other natural foes that help.

Methods of Control. 1. Experience shows that clean cultivation, extending as far into June as is safe, has a great effect in lessening the numbers of these insects.

2. Thorough spraying with arsenate of lead about 3 lbs. to 40 gallons of liquid will destroy the young larvæ. The best method is to postpone the dormant spray until the apple leaves are about half an inch long and then add to it the arsenate of lead. This should be followed by the regular spray just before the blossoms open and immediately after they fall. (For these see Spray Calendar.)

Shade trees may be protected from infestation by putting a band of tanglefoot on the trunk a foot or so above the ground. A band of cotton-batting about six inches wide, fastened with a string around the centre, and the upper half then turned down, will also prove effective except in very wet weather. These bands should be put on about the middle of October for the Fall Canker-worms and about the end of February for the Spring Canker-worms. They prevent the wingless females from climbing the trees after they emerge from the ground. They also keep down any larvæ that hatch from eggs laid below the band.

Bud-Moth (*Tmetocera ocellana Schiffermüller*).

The Bud-moth is a very common insect in Ontario, and causes considerable loss, but not nearly so much as in Nova Scotia, where it is probably the most destructive biting insect of the orchard.

Bud-moth, natural size.
(Reduced from W. E. Britton.)

The adult is a greyish-brown moth with a wing expanse of about half an inch. Across the middle portion of each front wing is a broad, greyish white, irregular area, occupying about one-third of the whole wing. The larvæ are the same shape as a Codling Moth larva, but are smaller, being only 2/5 of an inch long when full grown. They are reddish-brown and have glossy black heads.

The larvæ attack all kinds of fruit trees and also some other trees and shrubs. The injury is done in several ways: (1) The over-wintering larvæ in early spring bore into the green tips of the opening buds and feed upon the tender tissues within. (2) They fasten together the opening leaflets in the same manner as leaf-rollers, thus retarding their development, and feed inside upon the inner portion. (3) Fruit-buds are attacked in the same way as leaf-buds and the stamens and pistils often destroyed. (4) After the leaves have expanded, the larvæ commonly fold over part of the margin, fasten it securely, and each lives during the day in the little tunnel or nest thus made, going out to feed upon surrounding leaves in the evening or at night. Often the stem of such a leaf is nearly cut through, thus causing it to die. Partly to prevent the leaf's dropping and partly to secure still more shelter and food close at hand, the larva very commonly attaches it to one or more neighboring leaves. (5) Later in the season the young larvæ of the new brood are found on the under surface of the leaves, where they construct a fine whitish web alongside the midrib or one of the main veins and feed under this covering. Here they remove all the green tissues, leaving only the fine network of veins. (6) Not infrequently these second brood larvæ eat little holes

Work of Bud-moth larvæ, natural size. (Original.)

through the skin of an apple, where a leaf touches it and thus gives them the necessary cover and protection. Such injury is often attributed to Codling Moth larvæ.

Life History.—The winter is passed in the larval stage, the larvæ being only about one-third grown, and being hidden in little inconspicuous cases situated in the crotches of twigs or beside a bud or at other places on the bark. As soon as the buds are beginning to show green at the tip the larvæ leave their winter quarters, make their way to the buds and bore into them; later they feed on the fruit buds, leaves and other parts, as mentioned above. About the middle of June or a week or so after the blossoms are all off they become full grown and change into pupæ in their little nests or hiding places in the leaves. Towards the end of June and during the first half of July adults emerge. After a few days eggs are laid on the leaves. The young larvæ from these feed as described above, on the foliage and fruit. Early in September they cease feeding and go into winter quarters.

Methods of Control.—Observations in well-sprayed orchards show that if the regular three-spray applications recommended in the spray calendar for apples are applied systematically, year after year, there will soon be no trouble from Bud-moth. Of these applications the one just before the blossoms open is the most important. If this can be applied with high pressure as a driving spray, it will be more effective in reaching and controlling the pest.

Cigar Case-Bearer (*Coleophora fletcherella Fernald*).

The Cigar Case-bearer can be identified easily by the cigar-like shape and color of the little protecting case in which the larva conceals itself, both when resting and when feeding. These cases are about one-third of an inch long, and may readily be found in May, June and early July on the leaves and twigs of apple and pear trees, especially in uncared-for orchards.

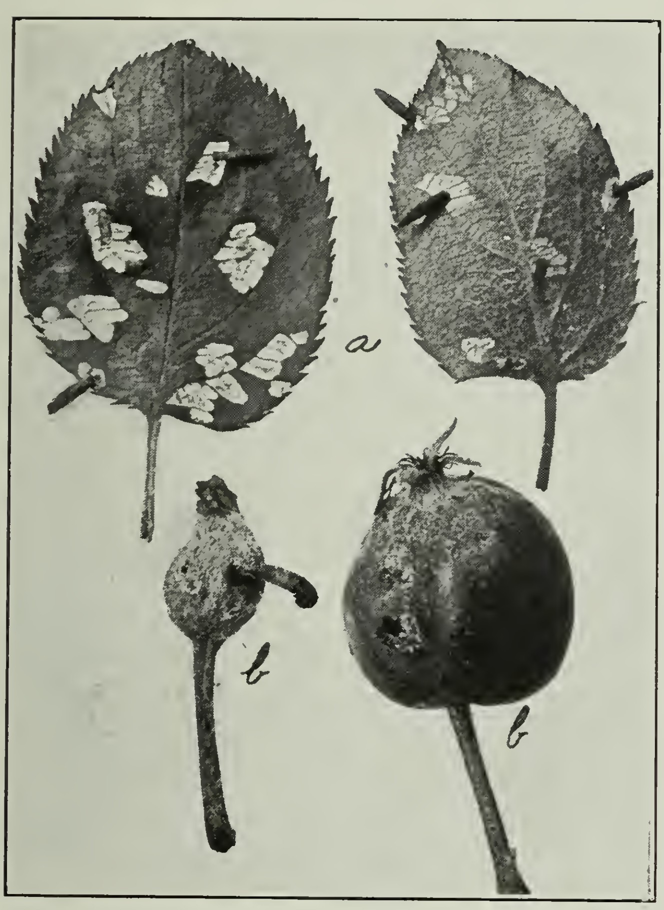
The injury is caused by the mining habits of the larva, which eats a little hole through the upper surface of the leaf, and then as a leaf-miner devours all the green tissues between the two surfaces as far as it can reach in every direction without letting go its case. Sometimes there are many of these brown mined areas on a single leaf, and if the pest is abundant the foliage may be much injured. Occasionally little holes are eaten through the skin of young fruits, apparently without leaving any permanent damage. In spite of the fact that this insect some years renders unsprayed orchards quite unsightly because of the injured foliage, it can scarcely be said to be a very important pest and plays a comparatively small part in commercial orchards.

Life History. The winter is passed in the larval stage, the larva being very small, not more than about one-quarter grown, and enclosed in a little curved brown case. These are usually situated in the axils of branches. When the buds are nearly ready to burst in spring the larvæ, still protected by their cases, move from winter quarters to the green tips of the buds and begin feeding on these, later, as already said, they make mined areas in the leaves and even feed a little on the fruit. Their little curved cases are first enlarged and then abandoned for the cigar-shaped larger cases. The larvæ are full grown towards the end of June, then attach their cases firmly to a leaf or to the bark and pupate inside them. The adults, which are delicate steel-grey moths, with a wing expanse of less than half an inch, emerge throughout most of July. Eggs are laid singly on the leaves and the larvæ, in hatching from these, act for a few days as leaf-miners without any case, then construct small curved cases, and early in September move into their winter quarters.

Methods of Control. Orchards that receive the regular three sprayings as stated in the Spray Calendar, are very little troubled by this pest. Of these three applications the one just before the blossoms open seems to be far the most important in destroying this insect.

Pistol Case-Bearer (*Coleophora malivorella Riley*).

The Pistol Case-bearer is a very near relative of the Cigar Case-bearer, but may easily be distinguished from it by its case being shaped like a pistol instead of a cigar. In Ontario it seems to be almost everywhere much less common than the Cigar Case-bearer. It attacks the foliage and occasionally the young fruit. On the latter it makes the same sort of small feeding punctures as the other species; but on the leaves, instead of acting as a leaf-miner, it eats holes,



(*a*) Cigar Case-bearers and their work on apple leaves, (*b*) Pistol Case-bearer and its work on young fruit, natural size.. (Original.)

Green Fruit-worms and their work on apples, natural size. (After Slingerland and Crosby.)

sometimes skeletonizing the leaves or destroying all but the main veins. Apples are its favorite food plant.

The life history is very similar to that of the Cigar Case-bearer. Control measures are also the same.

Green Fruit-Worms (*Xylina spp*).

There are several species of these Fruit-worms, but the larvæ resemble each other closely, and are stout, pale green caterpillars, a little more than an inch long when full grown. The head is a very light shade of green, almost white, and down the middle of the back and each side is a cream-colored stripe. These characteristics, and the fact that they do not lower themselves with a silken thread, easily distinguish them from the Leaf-roller larvæ. The adults are stout, greyish-brown moths, nearly related to and closely resembling the moths of Cutworms.

The injury is done by the larvæ. These feed on the leaves in spring until the fruit begins to form, then they attack this and eat deep holes about the thickness of a lead pencil into it, thus ruining the fruit and often causing it to fall. Fortunately, the larvæ are very seldom abundant enough to do much harm.

All kinds of orchard fruits are attacked. The larvæ feed also on the foliage of many deciduous forest trees.

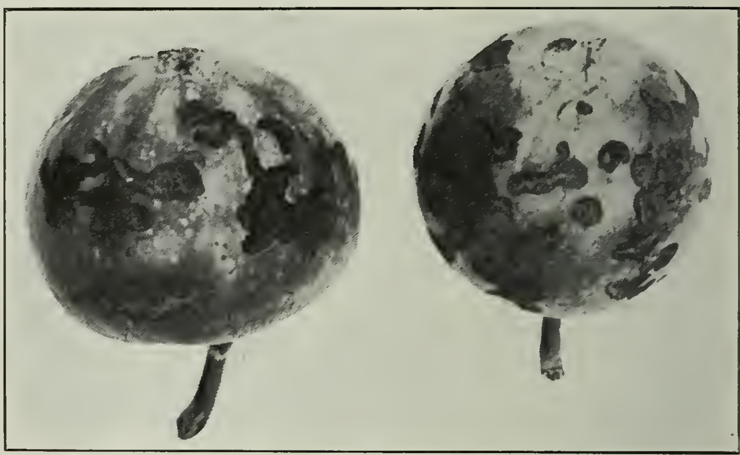
Life History. The moths lay their eggs singly on the bark of the twigs and small branches in spring. The larvæ on hatching feed upon the developing leaves and later upon the young fruit. They are full grown soon after the blossoms drop, and then enter the ground to pupate. In the autumn the moths appear and hibernate in sheltered places. There is only one generation a year.

Methods of Control. No special measures are necessary for this pest further than the regular sprayings indicated in the Spray Calendar. Of these the one before the blossoms is the most effective.

WHITE-MARKED TUSSOCK-MOTH (*Hemerocampa leucostigma Smith & Abbott*).

From time to time this moth's larvæ, which are great enemies of shade trees in cities, become abundant in orchards and injure not only the foliage of apples, plums and other fruit trees, but also often eat shallow areas out of apples themselves. A brown callous forms over the injured places, but leaves the fruit disfigured.

Larvæ of White-marked Tussock-moth, nearly full grown. (Original.)



Work on apples of the larvæ of the White-marked Tussock-moth, natural size. (Original.)

The larvæ are pretty, hairy caterpillars, about $1\frac{1}{2}$ inches long when full grown. They can easily be recognized by the red head, the two long black tufts of hair at the anterior end and a single tuft at the posterior and the four dense, cream-colored short tufts of hair on the back.

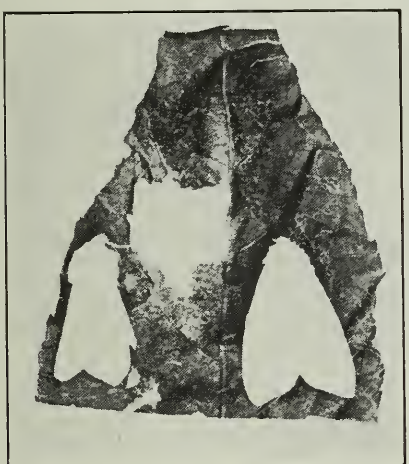
Life History. The winter is passed in the egg stage. The eggs are laid in a mass and are covered over with a white froth-like substance. Egg masses are usually situated on the bark of the trunk or larger branches, though they may sometimes be on a leaf. They hatch in June, usually a couple of weeks or more after the apple blossoms have fallen. The larvæ, as already mentioned, feed on foliage, preferably young shoots or suckers from the main branches, and also on the fruit of apples. Some are full-grown early in July, others not till well on in August. When full-grown they spin a thin silken cocoon in the places where we have said the eggs are placed. In these cocoons they pupate. In a couple of weeks the moths emerge. The males have ashy-grey wings and fly about, but the females are light grey and have no wings. They remain beside the cocoon until fertilized by the males, then lay their eggs and soon after die. There appears to be only one generation a year in this province.

Methods of Control. The young caterpillars can be killed by spraying with 2 or 3 lbs. arsenate of lead in 40 gals. of water, or of Bordeaux mixture or dilute lime-sulphur; but it is cheaper and more satisfactory, if the presence of egg masses shows there is likely to be a considerable number of the larvæ, to go around and remove and destroy the egg masses. Mr. W. E. Biggar, the provincial fruit pests inspector, informs the writer that a narrow wire brush about an inch wide and five or six inches long, fastened to a bamboo pole, is very satisfactory for removing egg masses from the higher branches. Some use a broad hook, like a bent spoon, instead of the brush. The egg masses are most easily seen when the leaves are off the trees. Some advocate destroying the eggs on tall trees by saturating them with crude coal-tar creosote, darkened by the addition of a little lampblack.

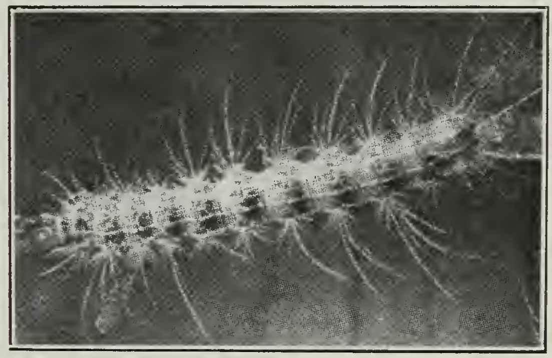
Fall Web-Worm (*Hyphantria cunea Drury*).

During August and September large webs, often a yard long, may be seen here and there on trees throughout the orchard and also on many kinds of shade and forest trees. These webs are caused by the so-called Fall Web-worms. The webs of the Apple Tent-caterpillar can be easily distinguished from these by the fact that they are made in the early part of the season and are much smaller.

The adults of the Fall Web-worms are pretty little white moths, with a wing expanse of about an inch. The larvæ are greyish-brown caterpillars about one inch long when full grown, and thinly covered with tufts of long hair.



Fall web-worm adults and egg mass on a portion of a leaf, natural size. (Original.)



Fall Web-worm: full-grown larva, slightly enlarged. (Adapted after Slingerland and Crosby.)

Life History.—The winter is passed in the pupal stage in the ground or under rubbish. In the spring, towards the end of June, the moths begin to emerge. These lay their eggs in a dense cluster on the leaves. On hatching, the young larvæ all feed together, remove the green substance of the leaves, and leave only a network of veins. Soon they cover themselves over with a web and extend this as they require more food. They feed under cover of the web until nearly full grown, and then wander around in various directions and finally select a place in which to pupate. There is only one generation in a year.

Fortunately natural enemies are so effective in the case of this insect that all that is necessary is to examine the trees from time to time, and whenever an infested branch is seen, cut it off at once and destroy the caterpillars. Usually this can be done most easily by trampling them under foot. The branches or twigs should be removed while the webs are still small and before many leaves have been destroyed. Spraying is not necessary.

Buffalo Tree-Hopper (*Ceresa bubalus Fabricius*).

The Buffalo Tree-hopper is found in all the fruit-growing districts of the province, and sometimes does much injury, especially to young apple and pear trees. The injury is almost entirely due to the egg-laying habits of the insect. The eggs are deposited on the upper side of the smaller branches and also in the case of young trees on the trunks. In each instance before laying her eggs the female, with her sword-like ovipositor, makes a small, more or less crescent-shaped cut through the bark and then places the eggs in this. As soon as this is done, she makes another similar slit close to and just opposite the first, and deposits eggs in it too. The wood beneath these two slits does not heal, but causes an ugly scar which continues to enlarge for several years. As the whole upper surface of the branches and also, in exceptional cases, the trunks of young trees may be almost covered with these slits and scars, it naturally follows that such trees are weakened, dwarfed and more likely to succumb to severe winters or disease than uninjured trees. Some forest trees and shrubs are also infested.

Buffalo Tree-hopper adults and egg scars on branch, natural size. (Original.)

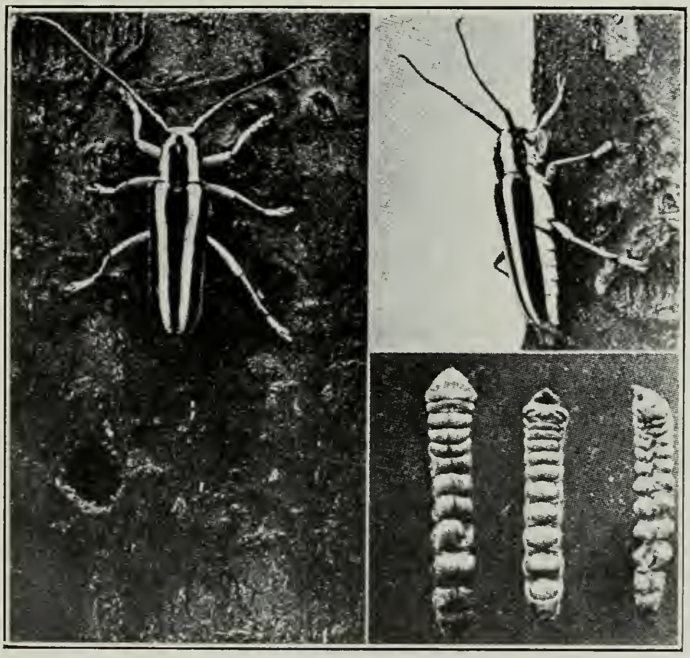
The adult Tree-hopper is about one-third of an inch long, moderately stout, triangular in front with the two upper angles projecting somewhat and suggesting the name "Buffalo Tree-hopper." The upper surface of the body slopes gradually back from the front to rear, so that from a side view also the insect has a triangular appearance. The general color is pale green.

Life History. The winter is passed in the egg stage in the slits of the bark. The eggs hatch about the time the leaf buds burst. The young nymphs after a very short time go to the ground, where they feed on almost any kind of succulent weeds, sucking the juices out of these. In July they begin to transform into adults which soon fly to trees and shrubs to lay their eggs. Oviposition continues all through August and September up to the first severe frost, which kills the adults.

Means of Control. A simple means of control is suggested by the fact that the nymphs cannot thrive on the foliage of trees, but go to the ground and feed on plants such as thistles or other weeds; hence if the orchard is plowed and kept free of weeds during May and early June the nymphs will be starved. Trees that have already been weakened should be given good cultivation and fertilized to stimulate growth and enable them to recover more rapidly. Of course, care should be taken not to cultivate too long for fear of winter injury.

Round-Headed Apple-Tree Borer (*Saperda candida Fab*).

This borer works in the trunks of apple trees usually near or a short distance below the surface of the ground. Here it feeds upon and makes tunnels in the inner bark and the wood. Trees of almost any age may be attacked, but far the most damage is done to young trees from three to ten years old. These not infrequently are completely girdled and killed. The insect is not found in all orchards but often localizes itself in an orchard here and there, while orchards not far away may be free from it. Apparently it is most numerous in the neighborhood of woods which contain such trees as hawthorn, juneberry, choke-cherry and mountain ash, all of which are host plants and so may serve as breeding quarters. In addition to these trees and the apple it attacks also quince and pears.



Round-headed Apple-tree Borer, adults and full-grown larvæ, natural size. (After Rumsey and Brooks.)

The adults are handsome, nearly cylindrical, stout beetles about an inch in length and having long antennæ. They may easily be identified by the white color of the under surface of the body, the brown color of the upper surface, and the two conspicuous white bands that extend along the back the whole length of the insect. The larvæ, which do the injury, are stout, nearly cylindrical, whitish grubs about an inch long when full grown, with a brown head, and the segments just below this a little larger than the remaining segments.

Life History. The beetles emerge from the trees in May and June and in a week or two begin laying their eggs in the bark near the base of the trunk. Egg-laying continues for about two months, after which the beetles die. The larvæ on hatching feed the first season chiefly on the inner bark, though some enter the sapwood. During the winter they remain dormant but next spring resume their feeding and work into the solid wood. Throughout the course of their feeding a considerable amount of the sawdust-like borings are thrown out through the bark. Some of the larvæ are full grown or practically full grown at the end of the second season, and next spring pupate and emerge as adults, but others are smaller and pass a third season as larvæ, pupating and emerging as adults the next year. Where there have been several borers in a small or moderately small tree, there are naturally many burrows in the wood. The writer has seen mountain ash trees so infested that a person by pushing hard could break off at the base a tree of four inches in diameter.

Methods of Control. Unfortunately, there is no method of control that is at the same time easy, rapid and effective. The one most commonly used is to remove the borers from the trees with a sharp knife and a fine wire with a little hook on the end. The wire is worked into the holes where the borers cannot be easily reached with the knife. If a bottle of carbon bi-sulphide and some cotton batting are carried along, a small wad of the batting may be saturated with this liquid and forced into a hole to kill any borer that cannot easily be destroyed otherwise. The hole should at once be stopped up with moist earth to keep the fumes in. When cutting, do not injure the trees unnecessarily. The cutting out of the borers should be done in May and October each year so as to destroy as many larvæ as possible while they are still small, easily reached (just under the bark) and have not done much damage. The earth should always be removed for a few inches around the base of the trunk and each tree examined even though no saw-dust may be visible on the bark or ground.

It is claimed that pure white lead and linseed oil of a little thicker consistency than ordinary paint can be safely applied to the trunks in May or early June and will prevent egg laying. The lead should thoroughly cover the trunk from about two inches below the ground to one foot above it and must be renewed yearly. Newspapers or building paper wrapped around the trunk and securely tied at the top so the beetles cannot get in to lay eggs is also said to give good results. It should be put on towards the end of May and the earth heaped up a few inches around the bottom so the beetles will not get in below it. These wrappings should be removed in early September.

Clean cultivation by keeping the weeds down during the earlier part of the summer seems to help in keeping orchards free, for the beetles seem to prefer neglected orchards and shady surroundings.

Other Insects Attacking The Apple.

Plum Curculio.
Red Spiders.
Fruit-tree Bark-beetle.

INSECTS ATTACKING THE PEAR.

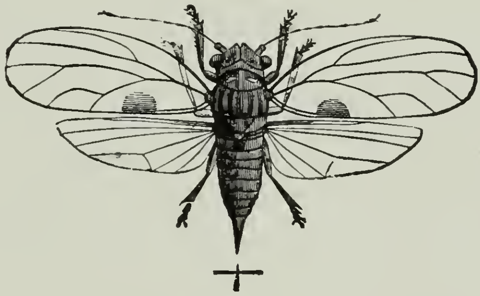
Pear Psylla (*Psylla pyricola Forester.*)

The Pear Psylla, though not so destructive in Ontario as in some other parts of North America, is a very troublesome pest and a source of much worry to pear growers. Fortunately, it is not abundant every year, as some years it almost disappears, at least during all the earlier part of the season, but the next year it may again be almost as numerous as ever. These fluctuations seem to be largely determined by weather conditions, especially spring conditions. Cold, backward weather after the buds have begun to burst seems to be the chief factor in lessening its numbers by destroying the eggs and newly hatched nymphs.

The adult Psyllas are, as shown in the photograph, very tiny insects, not more than one-tenth of an inch long. Seen through a hand lens they resemble a diminutive cicada. To the unaided eye the color of their bodies appears black or brownish, but closer observations show that the ground color is reddish.

The nymphs are very different in appearance and color from the adults, being pale yellowish or whitish, with red eyes. The body, too, is broader and flatter in proportion to its length than that of the adult. Nymphs are usually most easily found on the leaves in a drop of honey-dew.

A group of Pear Psylla adults, natural size. (Original.)



Pear-tree Psylla, greatly enlarged. (After Marlatt.)

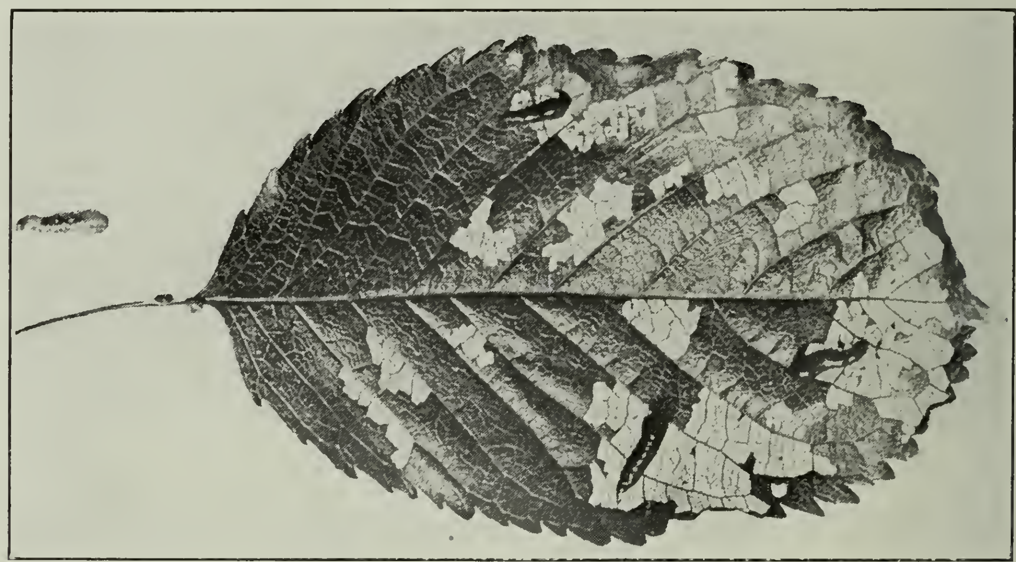
The injury is done by both the adults and nymphs, and is caused by their sucking the juices out of the leaves, leaf-stems and fruit-stems, thus weakening the trees and dwarfing the fruit. As the insects feed they send out great quantities of honey-dew, which falls everywhere on the leaves, fruit and branches, and makes these not only sticky but also black and unsightly. The black or sooty appearance is due to a fungus which grows in the honey-dew. In addition to its dirty, sooty appearance the foliage on badly infested trees has a sickly yellowish color which indicates clearly the drain the insects make on the vigor of the tree. Pears seem to be the only plants attacked.

Life History. The winter is passed in the adult stage. The adults are hidden in crevices on the trees or under loose bark or under other shelter, usually on or near the infested trees. In spring, when the bright sunny days towards the end of March or in early April arrive, the adults come forth from their hiding places and after a short time commence egg-laying. These eggs are just visible to the naked eye. They are yellowish or pale orange in color, more than twice as long as broad, and are placed chiefly on the twigs and fruit spurs, usually in some little crevice. If the weather is mild the eggs begin hatching about the time the buds have begun to burst, and continue to do so for some time longer. The nymphs feed as mentioned on the leaves and the stems of the leaves and fruits, and become adults in about four weeks. The new generation of adults lay their eggs chiefly on leaf-stems and on leaves, in the latter case usually along the midrib or the margin of the leaf itself. There are at least three and probably four generations a year in Ontario. Adults of the last generation continue feeding until the severe cold weather in late fall drives them into winter quarters.

Methods of Control. Postpone the so-called dormant spray with lime-sulphur, using in this case a strength of 1.030 sp. gr. (1 gal. commercial lime-sulphur diluted with 8 or 9 gals. of water) until the leaf buds have just opened, and then spray the trees thoroughly. This kills recently hatched nymphs and eggs that are near hatching. Some of the more tender varieties of pears may be a little injured by this application, but as a rule not much injury is done. As a supplement to this spray, add nicotine sulphate 40%, or Black Leaf 40 to the Codling Moth spray. (See Spray Calendar.) Directions as to the proper amount of these tobacco extracts are given on the cans. This application should be done very thoroughly and in such cases will sometimes, even without the delayed dormant spray, give satisfactory control. It is wise, however, in all orchards that suffer much from this insect to give both treatments.

Pear (and Cherry) Slug (*Eriocampoides limacina Retzius.*)

The Pear Slug is even more common on sweet and sour cherries than on pears. It is a slimy, blackish or greenish-black larva, a little more than half an inch long when full grown and distinctly enlarged toward the head end, having thus the appearance of a tiny tadpole. The larva is found on the upper side of the leaves of cherries, pears and occasionally plums, where it devours the green tissues, leaving an unbroken network of large and small veins, which, of course, soon turns brown. Some years the insects are very abundant, and acres of sweet or sour cherries may be so injured that the foliage appears as if it had been smitten by some blight and killed. Trees severely attacked for two successive years are much injured and sometimes many of the branches die. These years of great abundance are not very common and some seasons the slugs are so scarce that they do almost no damage.



Pear Slugs and their work on Cherry leaves, natural size. (Original.)

Life History. The winter is passed in the full grown larval stage in a small earthen case in the ground a short distance below the surface. In this in the spring it pupates and soon after the blossoms have dropped from the pears the adults emerge. These are little black sawflies, about a quarter of an inch long. They lay their eggs in the tissues of the leaves and about the middle of June the tiny slugs may first be seen feeding on the upper surface. Early in July these become full grown, and then drop to the ground, where they soon pupate in the soil. In about three weeks new adults begin to appear from these and continue to emerge for several weeks. Larvæ or slugs from this brood may be found late on into autumn. When full grown they all drop to the ground, work their way below the surface, form little earthen cases about themselves and remain there over winter.

Methods of Control. This is an easy insect to control. Arsenate of lead at the strength of 2 or 2½ lbs. (paste) to 40 gallons of water applied to the foliage as soon as there are seen to be sufficient of the slugs present to justify spraying, will destroy them. Sometimes a second application may be necessary for the second brood of larvæ. The chief difficulty is that the injury is usually done, especially on small trees, before the owners notice the presence of the insects. This is, however, merely due to failure to look for them and not to any difficulty in determining their presence. If only a few trees are affected, dusting them several times with fine dust or air-slaked lime will kill the larvæ.

The Pear-Leaf Blister-Mite (*Eriophyes pyri Pagenstecher.*)

This mite is a tiny, white or pinkish, nearly cylindrical creature, about five times as long as wide and so small that it is scarcely visible without the aid of a hand lens. It is not a true insect and has only two pairs of legs in the adult stage, whereas insects have three pairs.

Blister Mite work on apple and pear leaves. (Original.)

The pest is widely distributed throughout the province, and attacks apples as well as pears. The injury is done almost entirely to the foliage. On this the mites cause numerous little blisters on the under surface. Sometimes these are so abundant that there may be more than one hundred to a single leaf. As the immediate portion of the leaf where the blister is formed soon dies, this means that on badly infested trees a large part of each leaf may be killed. Many of these leaves turn yellow early in the season and drop, and the remainder through the loss of some of their green matter (*chlorophyll*), are unable to perform fully their proper function of manufacturing food for the fruit and other parts; consequently the whole tree is weakened. The mites often attack the fruit and fruit stems while these are still very small and cause little blisters on them, but later these blisters all disappear without leaving any visible injurious effects. On the leaves blisters are at first light colored, sometimes yellowish-white, but later on the pear they turn first nearly red and then nearly black, and on the apple reddish-brown.

Life History. The winter is passed by the mites under the protection of the bud scales. In spring, soon after the buds have burst and the leaflets have begun to expand, they move about and soon work their way through the epidermis of the under surface and feed in the interior of the leaf, gradually causing a blister to appear. Inside these blisters or burrows they lay their eggs and produce their offspring. The young mites when full grown work their way out through a little hole in the blister and soon make new blisters on the same or on other leaves. There are several generations in a season. Towards the end of October the mites desert all the leaves and go into winter quarters in the buds.

Methods of Control. This is one of the easiest of all our pests to control. The best method is to spray the orchard thoroughly with lime-sulphur, strength about 1.030 sp. gr. (1 gal. commercial lime-sulphur to 9 gal. of water) any time in the spring from the time the ground is fit to drive on until the buds are actually bursting. It is claimed by some that fall spraying after the leaves have fallen is equally effective, but the writer has not been able to test it. One thorough application in spring covering every bud will practically annihilate the pest.

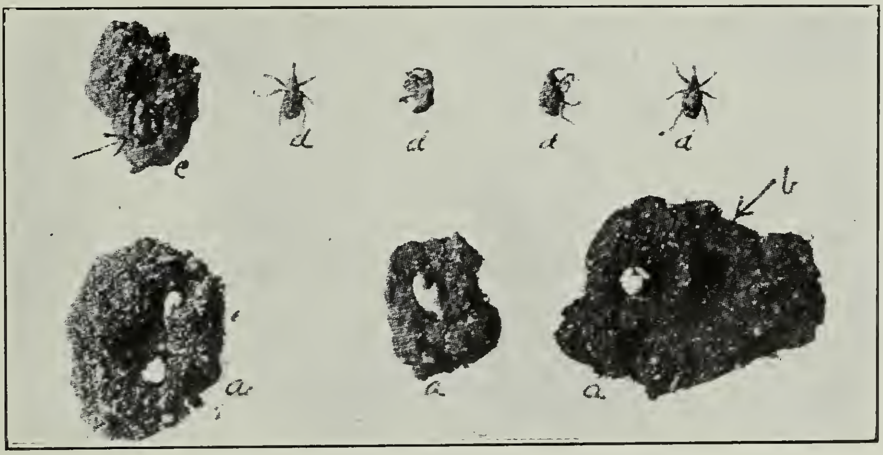
Other Pear Insects.

Codling Moth.
Green Fruit-worms.
Bud-moth.
Cigar-case-Bearer.
Fruit-tree Leaf-Roller.
White-marked Tussock-moth.
Fall Web-worm.
Apple Tent-caterpillar.
Forest Tent-caterpillar.
San José Scale.
Oyster-shell Scale.
Fruit-tree Bark-beetle.

INSECTS ATTACKING THE PLUM.

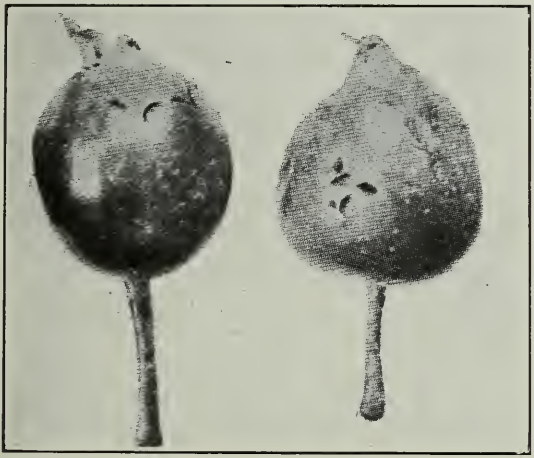
Plum Curculio (*Conotrachelus nenuphar Herbst.*)

The Plum Curculio is a small, hard-shelled, rough-backed, greyish-black beetle about 1-5 of an inch long, and with a conspicuous snout, at the end of which are little, inconspicuous, biting mouth parts. The larva is a stout, curved, whitish grub about 2-5 of an inch long, with a brown head and no legs. Both the adults and larvæ injure the fruit. The insect occurs in all the fruit growing parts of the Province. It does not, as the name would suggest, confine itself to the plum, but attacks the fruit of all our orchard trees and also of wild plums, haws and occasionally gooseberries. It usually does most damage to apricots, plums and sweet cherries, but apples, pears and peaches are also often much injured. Orchards situated near woods or thickets or where long grass, weeds, brush and other rubbish abound are worst attacked, because such places afford ideal winter quarters for the beetles. For the same reason rubbish, weeds and long grass inside the borders of the orchard itself will lead to an increased infestation. There are several kinds of injuries done to the fruit. First, many apples and pears and some peaches become deformed as a result of early feeding punctures and egg-laying injuries. Second, nearly all apples, pears, plums and most of the peaches in which the larvæ occur drop prematurely. Cherries are an exception, as they remain on the

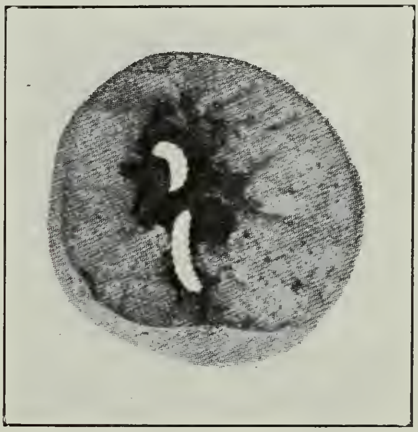


a, *a*, *a*, Small lumps of earth showing the pupæ in their little oval chambers; *b*, a dark circular area in the lump showing the empty chamber after the pupa has been removed; *c*, an adult beetle after transforming and still in the pupal chamber; *d*, *d*, *d*, *d*, adult beetles, all natural size. (Original.)

trees and usually rot. Third, the adults in late summer and autumn eat holes through the skin of apples and peaches and feed on the pulp beneath, thus making cull fruit. Fourth, disease, especially Brown Rot, gets into peaches and sometimes other fruits through the wounds made by these beetles. In these various ways orchards in situations specially favorable for the Plum Curculio often suffer very



Apple showing the crescent-shaped cuts made by the females after laying eggs, natural size. (Original.)



Full-grown larvæ and their work in a fallen apple, natural size. (Original.)

heavily. Sometimes plum and cherry trees have almost every fruit destroyed. Apples and pears are seldom so badly affected as this, though the loss in their case is sometimes severe.

Life History. The Curculios winter in the beetle stage in any good hiding place such as long grass or rubbish in or near the orchard. In Ontario they usually seem to come out of their winter quarters about the time the apples are in bloom.

Egg-laying begins almost as soon as the various kinds of fruit are set and continues actively for a month, after which it quickly slackens off. The eggs hatch in about five days and the larvæ work their way into the fruit and feed upon the pulp. The infested fruit, as we have said above, with the exception of cherries, nearly always drops soon and the larvæ finish their development in it on the ground. They are full grown in about two weeks, then enter the soil from about one-half to two inches and pupate in little oval earthen cases or chambers, which are easily broken. In about a month the new generation of beetles begins to emerge, and after feeding for some time on the fruit and foliage seeks good hiding places and hibernates.

Methods of Control. The first step in control is to secure as clean conditions as possible in and around the orchard by removing all sorts of rubbish and sheltering places in which the adults may hide for winter. It is wise, whenever practicable, to cut down and burn all shrubs or thickets nearby. The next step is to cultivate the orchard well as long as one may without fear of winter injury. Cultivation destroys the pupæ in the soil and also helps in other ways. The last step is to spray with a poison. Spraying is very important but no more so than

Fall or late summer injuries on apple made by the feeding of the new generation of beetles. These injuries, though natural size, are larger than the average. (Original.)

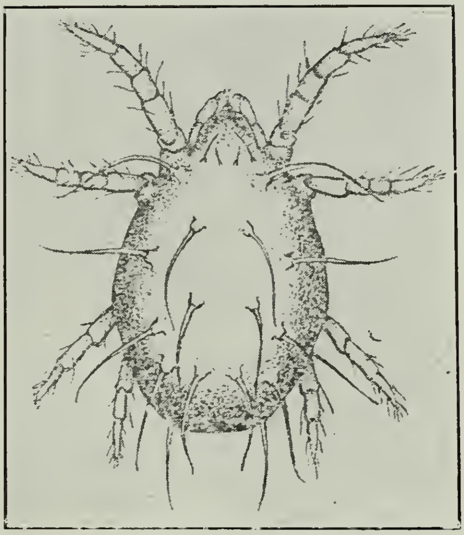
Fall or late summer injuries made on peach by the feeding of the new generation of beetles, natural size. (Original.)

the cultivation and destruction of rubbish. The first spraying for apples and pears should be with the same mixture and at the same time as the Codling Moth spray. (See page 7). If the insects are very abundant a second application should be given about two weeks later. In this the lime-sulphur may be omitted if the weather is warm and dry and thus unfavorable for the development of Apple Scab.

Plums and cherries should be sprayed just as soon as the fruit has set and the calyces have dropped. The mixture should be about 3 lbs. of arsenate of lead added either to 40 gals. of lime-sulphur diluted to 1.008 sp. gr. (1 gal. commercial lime-sulphur to 35 gals. of water) or to 40 gals. of Bordeaux mixture (4.4.40 formula). A second application of the same mixture should be given in two weeks or a little less. Peaches often do not require any spraying for this insect, but in a situation favorable to the insect they should be sprayed once with 2 to 3 lbs. arsenate of lead in 40 gallons of water as soon as the fruit is all well set. No lime-sulphur or Bordeaux mixture should be used with the poison.

Red Spiders.

Red Spiders are very small, eight-legged, oval-bodied creatures, not so large as the head of a pin. In Ontario there are two common species that attack fruit trees, one of these, *Tetranychus bimaculatus Harvey,* is a common pest on greenhouse plants, sweet peas, phlox and many other plants, but fortunately does very little damage to fruit trees; the other species, whose presence in Ontario was not discovered until 1912, is of much more importance in the orchard, because it occurs



Red Spider (*Tetranychus pilosus* or possibly *mytilaspidis*), much enlarged. (Original drawing by Miss M. Hearle.)

in all our fruit districts and often attacks in great numbers the leaves of European plums. It is found also on apple, cherry and pear foliage, but usually to a much less extent, though it sometimes does considerable damage to apples.

There is some doubt as to the name of this species. Mr. Nathan Banks thinks it is probably a European species, *Tetranychus pilosus,* but says that apart from its feeding habits it would appear to be identical with the Citrus Mite, *Tetranychus mytilaspidis Riley.* In any case, it is easily distinguished from the common Red Spider mentioned above in the following ways: (1) It is always, even in the youngest stages, red, whereas the other species may be a very pale yellowish-white, or green or red. (2) Under a hand lens it is seen to have little whitish tubercules on the back from each of which a fine hair arises. These tubercules are lacking in the other species. (3) It feeds on both surfaces without any web, whereas the other species feeds almost entirely on the under-surface and under the protection of a very fine web. (4) Its eggs are red and are laid on both surfaces, whereas the eggs of the other species are colorless like a little drop of dew, and are laid in or beneath the web. (5) It winters in the egg stage, the winter eggs being red, and situated on the branches of trees, especially at the forks of branches; the other species winters as adults in the ground or under good shelter.

The injury done by this newly discovered species is brought about by numerous individuals feeding on both surfaces of the leaves and sucking the juice out of them. Badly infested European plum foliage becomes covered with countless little whitish blotches, and after a time looks at a distance as if it had been dusted over with fine road dust. The injury to the foliage weakens the trees and results in small fruit of poor quality.

Life History. The winter, as stated, is passed in the egg stage on the bark, there often being thousands of eggs on a few square inches of surface. They hatch in spring soon after the buds burst and the young begin to feed on the developing leaves. When full grown they lay their eggs on the leaves. There are several, probably many generations a year. In September and October eggs for winter are laid on the bark and the adults are later killed by the cold.

Methods of Control. Experiments on a small scale lead us to believe that lime-sulphur, though it will not kill the eggs, will kill the mites themselves; hence trees, especially plum trees, that are badly infested, if sprayed with this mixture instead of Bordeaux at the times and at the strength indicated in the Spray Calendar, are not likely to suffer much. The liquid should be applied to both surfaces of the leaves.

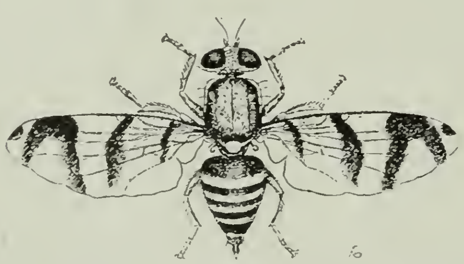
OTHER PLUM INSECTS.

Green Fruit-worms.
Bud-moth.
Cigar-case-bearer.
Fruit-tree Leaf-roller.
Canker-worm.
White-marked Tussock-moth.
Apple Tent-caterpillar.
Forest Tent-caterpillar.
Buffalo Tree-hopper.
San José Scale.
Oyster-shell Scale.

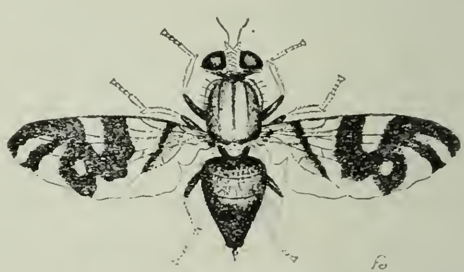
INSECTS ATTACKING THE CHERRY.

CHERRY FRUIT-FLIES (*Rhagoletis cingulata, Loew and R. fausta Osten Sacken.*)

Cherry Fruit-flies are two-winged flies a little smaller than the House-fly and closely related to the Apple Maggot. They are the insects which cause the little white maggots often found in ripe cherries or sometimes at the bottom of baskets of this fruit. Infested fruits may appear to be sound but on opening the



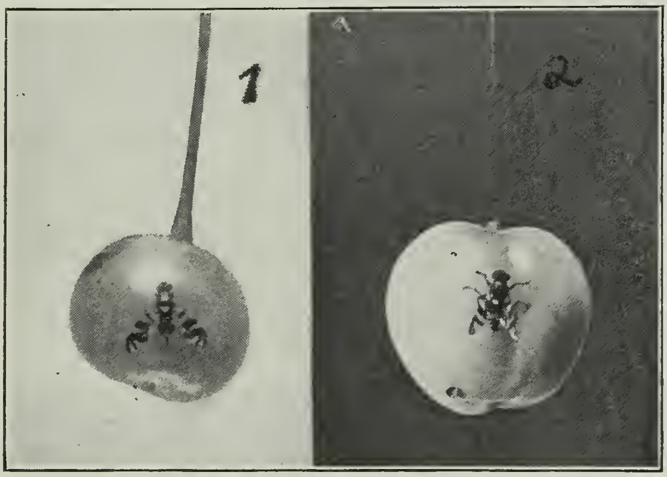
A female White-banded Cherry Fruit-fly, much enlarged. (Original.)



A female Black-bodied Cherry Fruit-fly, much enlarged. (Original.)

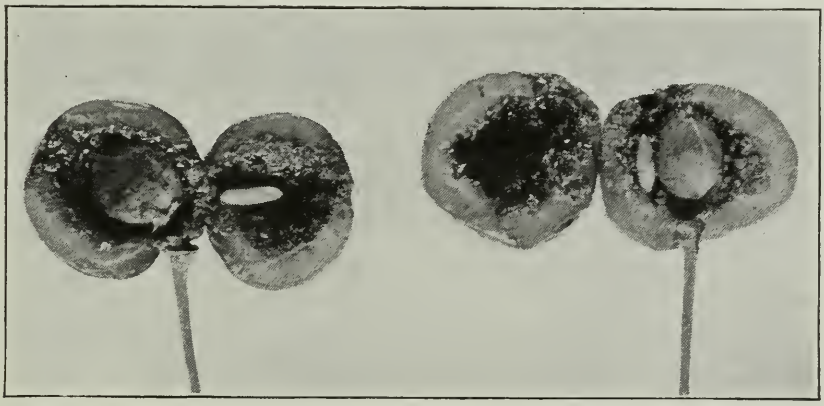
maggots can be seen clearly and also the filthy brown mass that results from their feeding.

There are two species of these flies, which we have named from their respective appearance, the White-banded Cherry Fruit-fly (*Rhagoletis cingulata*) and the Black-bodied Cherry Fruit-fly (*Rhagoletis fausta*). The former species is a little smaller and is characterized by three distinct white crossbands on the abdomen of the male and four on that of the female, and also by the arrangement of the dark markings on the wings, as illustrated. The latter species has its abdomen entirely black without any white crossbands, and has the markings on the wings arranged as in illustration. The larvæ of both species are so nearly alike that



Cherry Fruit-flies on the fruit: (1) the Black-bodied Cherry Fruit-fly; (2) the White banded Cherry Fruit-fly.

they cannot be distinguished except by a trained entomologist. They are when full grown about one-quarter of an inch long, nearly cylindrical, blunt at one end and tapering to a point at the other. Their color may be either white or yellowish. There is no head and no legs, but at the small end are two little black hooks used to tear the tissues of the fruit and set free the juice upon which the larva feeds.



Full-grown larvæ of Cherry Fruit-flies in the fruit, natural size. (Original.)

The White-banded species seems to be the more abundant in the Province and either it or the other species has been found in almost every country where cherries are grown on a commercial scale. They do not, however, infest all or nearly all the orchards in any county, but a sufficient number are infested to cause great loss. Early varieties as a rule are not much affected but late varieties such as Montmorencies, Morello and some of the late sweet kinds may have more than 90% of the fruit infested and therefore not be worth picking. Wormy fruit is very subject to Brown Rot disease. The insects do not attack plums or other orchard fruits.

Life History. In June, when the Early Richmond cherries are just beginning to show the least sign of red, the adult flies of the Black-bodied species begin to appear, followed about a week later by the other species. Both species move about upon the leaves or fruit of cherries or other fruit trees for about ten days before they begin to lay eggs. During this time they may often be seen to have their broad, rasping, lip-like mouths extended in search of juice or any little particles of food on leaves or fruit, just as a House-fly may be seen seeking its food. The eggs are laid in the fruit below the skin by the sharp, bee-sting-like ovipositor of the female. In five days or a little more they hatch and the tiny larva works its way at once to the pit, where it feeds on the juices of the pulp. It is not full grown until the fruit is ripe or even over-ripe. Then it works its way out, drops to the ground and burrows beneath the surface a short distance. Soon after this it changes its form until it resembles a small, plump grain of wheat (*puparium*). Inside this it pupates and remains in this stage over winter and until it emerges as an adult in spring.

Methods of Control. Extensive tests have shown that these insects can be thoroughly controlled by spraying the trees with 2 or 2½ pounds arsenate of lead (paste), with or without one-half gallon of cheap molasses to 40 gallons of water. The first application should be just as the fruit of the Early Richmond variety is beginning to show the first sign of red and the second application just as the Montmorency variety is beginning to show this red tint. The object of both sprayings is to kill the adults before they can lay their eggs. Therefore, promptness in applying the spray at the right time is very essential. At the first application the foliage of all kinds of cherries except very early sweet cherries should be sprayed. It will also pay to spray the foliage of any other kind of fruit tree nearby, as the flies often frequent them for a few days before ovipositing. At the second application only the late varieties should be treated as the early ones are too nearly ripe at this time. About one gallon of the material shot up into and upon the leaves is sufficient for a good sized tree, so that one barrel will suffice for forty or fifty trees. The cost per tree for the mixture need not exceed two cents. Neighbors should be encouraged to spray their orchards at the same time, because the insect moves about freely. Moreover, all wild sweet cherry or all useless cherry trees should be cut down that they may not serve as breeding grounds.

Cherry Aphis (*Myzus cerasi Fabricius.*)

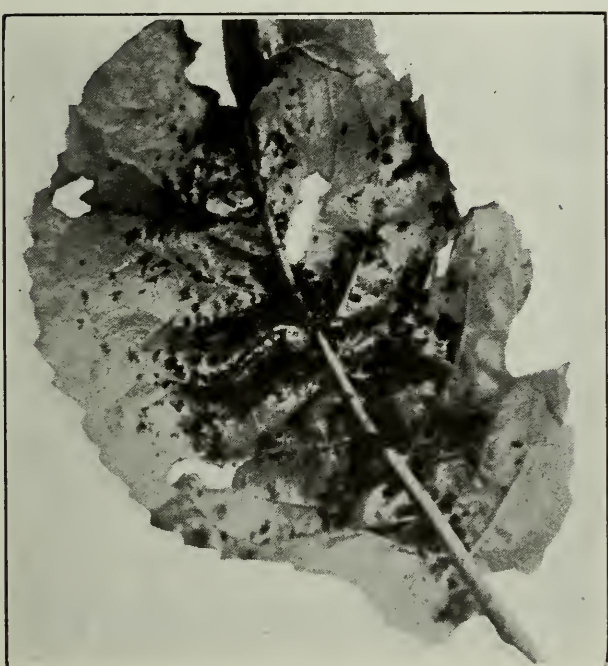
This is a glossy black aphid which attacks the leaves, especially of sweet, and more rarely of sour cherries. On the latter the leaves are seldom rolled, but on the former they are much rolled, curled, and distorted. Leaves on new shoots are usually worst affected. When badly infested they turn yellow, die, and later may drop off. Sometimes the aphids get on the fruit itself and cause it to become sticky and dirty. Badly infested trees are rendered very unsightly and are weakened.

Life History. The winter is passed in the egg stage. The eggs are glossy black and situated chiefly between the buds and the bark. They hatch in spring about the time the buds have become green and just begun to open at the tips. So far as known, these aphids have no alternate host plant or plants to which they migrate in summer.

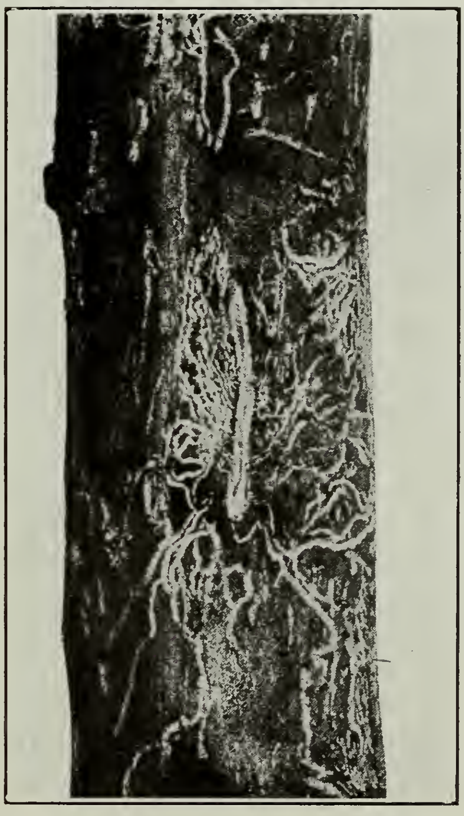
Means of Control. It is seldom necessary to treat sour cherries, but sweet cherries should be sprayed heavily with lime-sulphur, strength 1.035 sp. gr. (1 gal. of commercial lime-sulphur diluted with 7 gals. of water) and nicotine sulphate 40%, or Black Leaf 40, as soon as the eggs have hatched. This, as said above, is when the buds have just begun to burst, but the leaflets and blossoms have not actually opened. This spraying, of course, takes the place of the dormant spray. To give the best results care should be taken to cover every bud thoroughly. It is almost impossible to obtain good results after the leaves have curled. If, however, the early treatment which has just been recommended has been omitted, the next best time to spray is just after the fruit has set. Here the tobacco extract may be used with the regular second spray of lime-sulphur or Bordeaux mixture and arsenate of lead as given in the Spray Calendar. The proper strength of the tobacco extract is stated on the cans.

Fruit-Tree Bark-Beetle or Shot-Hole Borer (*Eccoptogaster rugulosus Ratzeburg.*)

Sometimes in peach, cherry and plum orchards a tree here and there will be found with numerous small gum masses exuding from the bark of the trunk and branches. If the outer bark at these spots is removed with a sharp knife



Cherry Aphids on underside of sweet cherry leaf, natural size. (Original.)



Work of Fruit-tree Bark-beetles and their larvæ, natural size. (Original.)

and there is revealed a little eaten area through which the gum is exuding, it is evidence that the injury has been caused by one of the Fruit-tree Bark-beetles (Ipidæ) of which by far the most common species in Ontario is the one mentioned above. The adult is a tiny reddish-black beetle about one-tenth of an inch long. It usually infests only dead or dying branches, attacking healthy ones only where these others are absent. Some years, however, the beetles seem to have a fondness for boring into the base of buds on healthy trees and killing them. We have frequently seen this occur on sweet cherry trees, and it is not uncommon also on pears. In the latter case if the beetles have previously been feeding on the dead bark over a blighted portion of a pear tree they may communicate this disease to healthy pears.

Though the beetles may feed on healthy tress and weaken them by the great amount of gum that exudes from numerous holes, yet they cannot lay their eggs in such trees, because the gum drives them out, hence they breed only in dead or dying trees.

All kinds of fruit trees, and also wild cherry and Juneberry trees are subject to attack.

Life History. The beetles appear in June and soon begin eating holes through the bark of dead or dying trees. Underneath this they construct a burrow about an inch long (illustration) and lay their eggs along each side of it. The larvæ from these eggs make little burrows more or less at right angles to the main burrow, and feed on the wood and bark as they do so. As they grow they increase the size of the burrows, and when full grown usually eat a little deeper into the wood and pupate there. Full grown larvæ are stout white little grubs without any legs. The new generation of beetles begins to appear about the middle of August and may be found in the orchards until late fall. These in turn eat through the bark, construct their egg burrows and produce a second brood of larvæ. All the adults die before winter, but the larvæ remain as such in their burrows under the bark until next May and June, when they pupate. Hence there are two full generations a year.

Methods of Control. The fact that the insects pass the winter only in the larval stage and only in dead or dying trees or branches, shows that the best method is to remove during late autumn or winter or early spring all dead or dying trees and branches, and burn them all before June to destroy the larvæ. It is not safe even to cut off the larger branches and trunks and pile them up as cordwood and leave them there. We have seen several severe attacks on healthy trees come from such piles. Where healthy trees have been attacked these need not be cut down unless the trees are clearly so weakened as to be dying. They should instead be pruned and the ground well fertilized and cultivated. Where this is done they usually recover. Attacks on healthy trees can sometimes be warded off by promptly whitewashing the bark with thick whitewash made of freshly slaked lime and water, to every pailful of which about one-quarter lb. of salt has been added as a sticker.

Other Cherry Insects.

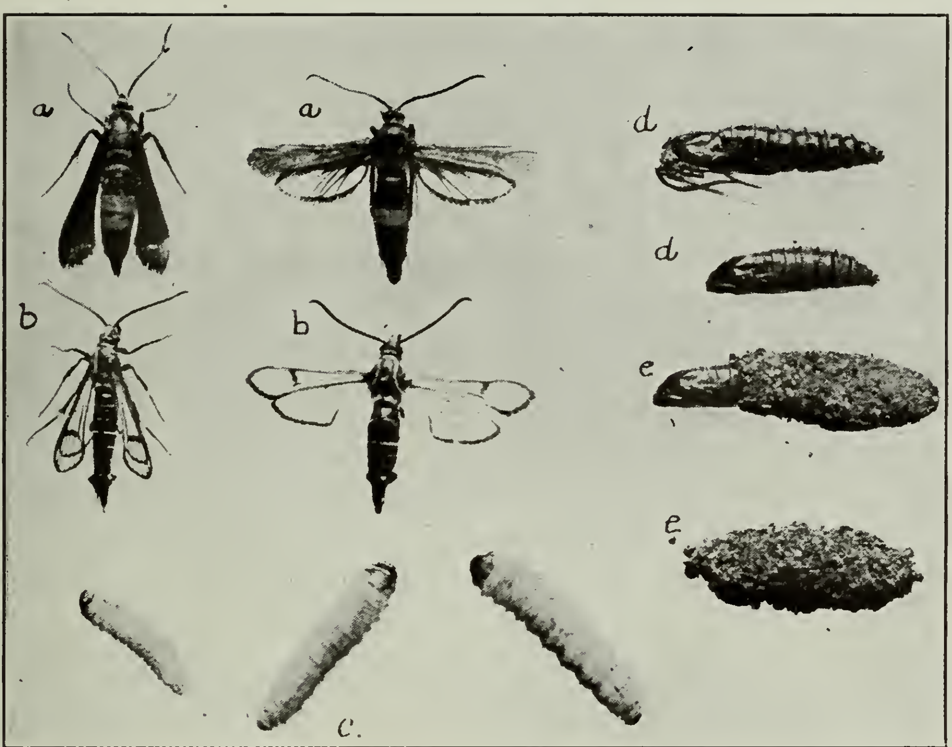
Bud-moth.
Fruit-tree Leaf-roller.
Canker-worm.
Apple Tent-caterpillar.
Buffalo Tree-hopper.
San José Scale.
Pear and Cherry Slug.
Plum Curculio.

INSECTS ATTACKING THE PEACH.

PEACH-TREE BORER (*Sanninoidea exitiosa Say.*)

This is the most common insect enemy of the peach in Ontario. It occurs in almost every orchard. In some it causes much damage, but in others very little. Plum, cherry and apricot trees are also occasionally attacked, but the insect much prefers the peach to these.

The injury is caused by the larvæ, which act as borers and feed on the inner bark and sapwood of the trunk, usually at or a little below the surface of the ground. Many larvæ may attack a single trunk at the same time; for instance,



The Peach-tree Borer: *a*, *a*, adult females; *b*, *b*, adult males; *c*, full-grown or nearly full-grown larvæ; *d*, *d*, pupæ, the upper one being empty; *e*, *e*, cocoons or pupa cases, the pupa protruding from the upper one; all natural size. (Original.)

we have taken twenty from a four-year-old tree. Badly infested trees are either killed by the girdling of the trunk or are much weakened and are therefore liable to perish during the winter. The presence of the borers is usually indicated by large gum masses which exude from the injured area, but often these masses cannot be seen without removing the earth from around the base of the tree.

Life History. The winter is passed in the larval stage either in the burrows in the wood or in little winter cases on the bark. Some of the larvæ at this stage are quite small, while others are nearly full grown. The larger ones are usually in the wood and the smaller ones in the little cases. A full grown larva is about one inch or a little more in length, moderately stout, cream to pale yellowish in color, with a brown head and with three pairs of true or jointed legs and five pairs of prolegs or false legs.

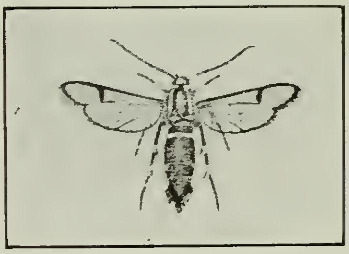
In the spring the larvæ resume their feeding, and when full grown pupate in silken cocoons covered with brown castings (illustration). These cocoons may easily be found in the soil close to the trunk. The adults that emerge from them are pretty, clear-winged moths, resembling considerably some of our common wasps. They fly in the daytime. The female can readily be distinguished from the male by the presence of a broad orange band around the abdomen. Moths, judging from our observations in the year 1915 in Norfolk County, may begin to emerge as early as July 1st, and may continue to do so until the first week in September. The writer saw an adult female in the Niagara district on September 11th, 1915. Egg laying begins soon after emergence. As many as 800 eggs may be laid by a single individual. These are deposited chiefly on the trunk of the trees, but we found many also on both surfaces of the leaves. The young larvæ on hatching work their way to the ground and there feed for a time on the bark, gradually as they become older eating into the sapwood. When cold weather arrives they become dormant and remain so until the next spring. There is only one generation a year. Possibly a few individuals spend two winters in the larval stage.

Methods of Control. Many control methods have been recommended, including several washes, but it is very doubtful whether any is so safe and effective as the old one of cutting out the borers with a knife, aided sometimes by a wire. This work should be done in late May or early in June before pupation begins and again in October. In doing it care should be taken not to injure the tree more than necessary and always to cut with, not against, the grain. The soil to the depth of a few inches around the base of the trunk must always be removed first with a trowel or other implement to get access to the larvæ below the ground. If earth is mounded up around the trunk to the depth of eight or ten inches in June, it prevents the larvæ working so low down and by removing it when cutting them out with the knife they can much more easily be found and destroyed. The mounds should be restored before winter.

Tree protectors have been tested, but in our experience are far from satisfactory.

LESSER PEACH-TREE BORER (*Sesia pictipes,* Grote & Robinson).

Both in the adult and larval stage this borer closely resembles the one just discussed. It is, however, in both stages a little smaller and the female has not the broad orange band around her abdomen, but resembles closely the male.



Lesser Peach Tree-borer, adult female, about natural size. (Reduced from King.)

There is considerable difference in the habits of the two species, for the Lesser Peach-tree Borer does not, like the other species, confine itself to any one part of the tree, but attacks indiscriminately the trunk, crotch and branches. Moreover, it does not enter the tree through the healthy bark, but always through some wound. The more wounds there are, the more abundant the borers usually are.

Consequently, orchards severely infected with cankers usually have many borers. This has led some growers to think that the borers are largely responsible for the cankers; but such is not the case. The most that can be said is that by working between the healthy and diseased tissues around the edges of cankered or wounded areas, they interfere with nature's healing process and gradually enlarge the dead area at the point where they feed. So far as our observations go, it is seldom that they actually cause the death of a tree or even of a branch; for, though many cankered branches die, their death can usually be shown to have been due chiefly to other causes than the borer.

In addition to the peach, the insect also attacks to some extent plum and cherry trees.

Life History. The chief differences between the life history of this and the preceding species is that the adults of this one begin to emerge about a month earlier (about June 1st) than those of the other species, and do not continue to emerge for so long a time, and that pupation takes place in the canker or wound near where the larvæ has fed. The winter is, of course, passed in the larval stage.

Methods of Control. From what has been said it is clear the best method of control would apparently be to keep the bark of the trees free from injury of any kind, but this cannot always be done. In cases where there are many cankers much can be gained, if, when pruning, all cankered branches that can be spared are cut off and burned. The remaining cankers should be examined in spring before the middle of May and as many of them as time permits cleaned out with a drawknife and stout sharp knife, care being taken of course to search for and kill the larvæ. Wounds may be painted with white lead. This cutting and painting process is also the chief way to stop a canker from spreading, even where there are no borers.

Other Peach Insects.

Green Fruit-Worms.
Bud-moth.
Apple-tree Tent-Caterpillar.
Forest Tent-Caterpillar.
San José Scale.
Plum Curculio.
Fruit-tree Bark-Beetle.

SPRAY CALENDAR

PLANT AND PESTS.	1ST APPLICATION.	2ND APPLICATION.	3RD APPLICATION.	REMARKS.
APPLE. Scab or black spot, canker, leaf spot, codling moth and other biting insects, scale insects, blister mite and aphids. (Consult bulletins 187, 194, 198 and 219).	Either before or soon after the leaf-buds burst, preferably the latter. Use A1 or B. For San José Scale prune severely, scrape off loose bark and drench the whole tree, paying special attention to outer twigs.	Just before the blossoms open. Use A2 or D, with 2 or 3 lbs. arsenate of lead to each 40 gals. of the liquid.	Immediately after the blossoms have all, or nearly all, fallen, and before the calyces close. Use A3 or D, with 2 lbs. arsenate of lead to each 40 gals. This is the application for codling moth.	For Scab, a 4th application about 10 days after the 3rd is necessary if June is wet, also an intermediate one between the 2nd and 3rd with A3, *without any poison*, if the interval, owing to cool damp weather, threatens to be long. Spraying with the weaker A3 early in August is an insurance against sooty fungus and late scab. If Aphids are annually troublesome, delay 1st application till buds begin to burst, then add Black Leaf 40 or nicotine-sulphate 40 per cent. to A1 or B and cover every bud. For Cankers cut out diseased bark, disinfect and cover with white-lead paint free from turpentine. For Blight on young trees keep suckers rubbed off trunk and main branches and cut out promptly any diseased branches or twigs well below the diseased bark. Always disinfect both cuts and tools with corrosive sublimate (1 to 1,000).

Stages for 1st application. Stage for 2nd application. Stage for 3rd application.

PEAR. Scab or cracking, blight, codling moth, other biting insects, scale insects, blister mite, psylla and slug. (Consult bulletins 176, 187 and 219.)	Shortly before or just after the bud bursts. Use A1 or B. For San José Scale see above under Apple.	Just before the blossoms open. Use A3 or D, with 2 or 3 lbs. arsenate of lead to 40 gals. of liquid.	Just after blossoms have fallen. Use A3 or D, with 2 lbs. arsenate of lead to 40 gals.	Pears subject to Scab should always receive a 4th application 10 days later than 3rd with same mixture. For Blight cut out carefully in winter all blighted branches and twigs, cutting several inches below the diseased part. Also remove and burn trees too severely blighted to save. Throughout growing season watch for and remove promptly in the same way all blighted twigs or branches. Disinfect at once tools and all cuts with corrosive sublimate (1 to 1,000). For Psylla delay 1st spraying with A1 or B until leaf buds have burst and add Black Leaf 40 or nicotine-sulphate 40 per cent. to Codling Moth spray if necessary. Arsenate of lead will kill Slugs (3 lbs. to 40 gals.).
PLUM AND CHERRY. Black knot, brown rot, leaf blight or shot-hole fungus, curculio, slug, aphids and cherry fruit - flies (Consult bulletins 219, 226, 227 and 230.)	Just before or as the buds are bursting. Use A1 or B. For San José Scale see above under Apple.	Soon after the fruit is set. Use A2 or D, with 3 lbs. arsenate of lead to 40 gals.	Just before the cherries begin to color. Use A3 or D, with 3 lbs. arsenate of lead to 40 gals.	For Rot keep fruit well covered with A3 or D or sulphur dust in moist weather. May dust just before picking. For Cherry Fruit-flies (the cause of the little white headless maggots in cherries) use 3 lbs. arsenate of lead to 40 gals. of water. Apply to all cherry trees just as Early Richmonds are getting a reddish blush, and again to only Montmorency and late varieties about 10 or 12 days later. Cut out and burn all Black Knots in winter and whenever seen in summer. For Slugs see under Pear above. For Aphids on Sweet Cherries postpone the 1st application until the buds are just bursting, and then add nicotine-sulphate 40 per cent. or Black Leaf 40. Good pruning with plenty of sunlight and air help against Rot.
PEACH. Leaf-curl, scab or black spot, yellows, little peach, curculio, borer, San José scale, shot-hole borer. (Consult bulletin 241.)	Before the buds begin to swell. (All must be done before any sign of bursting of buds.) Use A1 or B. This is usually the only spraying peach trees receive.	Soon after fruit is set. Use 2 or 3 lbs. arsenate of lead and 1 or 2 lbs. freshly slaked lime to 40 gals. water for curculio. Omit if curculio is not troublesome.	About one month after fruit is set. If troubled by Brown Rot use C or dust with sulphur. Good pruning and thinning the fruit help to control this disease.	If brown rot is likely to be troublesome use C again about one month before fruit ripens, or dust with sulphur. Destroy mummied fruit in autumn. Remove at once and burn any tree attacked by yellows or little peach and also all suspected trees. Dig out borers at base of tree with knife in May and again in October. For shot-holt borer cut down and burn before April all dead or dying trees or branches, and leave no brush heaps near orchard.

Note.—A1=Concentrated lime-sulphur strength 1:030 specific gravity (1:035 for San José scale) (1:030=1 gal. commercial to 9 gals. water, and 1:035=1 gal. commercial to 7 gals. water).

A2=Concentrated lime-sulphur strength 1:010 or 1:009 specific gravity=1 gal. Commercial to from 30 to 35 gals. water.

A3= " " " 1:009 or 1:008 specific gravity=1 gal. Commercial to from 33 to 40 gals. water.

B =The old home-boiled lime sulphur, 20.15.40 formula. **C** =Self-boiled lime-sulphur. **D** =Bordeaux mixture, 4.4.40 formula.

FORMULAE FOR INSECTICIDES

INSECTICIDES FOR BITING AND LAPPING INSECTS.

1. ARSENATE OF LEAD PASTE.

Use 2 to 3 lbs. to 40 gals. of water, or of lime-sulphur or of Bordeaux mixture.

2. ARSENATE OF LEAD POWDER.

Use 1 to 1½ lbs. to 40 gals. of water, or of lime-sulphur or of Bordeaux mixture.

3. ARSENATE OF LIME (Calcium arsenate).

Use ¾ to 1 lb. if in powder form to 40 gals of Bordeaux mixture. Double the amount if in paste form. (There is some doubt yet whether this poison is always safe with lime-sulphur. It is not safe alone).

4. PARIS GREEN.

Use ¼ to ½-lb. with 40 gals. of Bordeaux mixture. (This poison is not safe with lime-sulphur.)

FORMULAE FOR FUNGICIDES

I.—BORDEAUX MIXTURE.

Copper Sulphate (Bluestone) 4 lbs.
Unslaked Lime .... 4 lbs.
Water . . ..40 gals.

Dissolve the copper sulphate in a wooden or brass vessel with hot water, pour into a barrel and add cold water to make 20 gals.; slake the lime, preferably with hot water; add cold water to make 20 gals. Stir both barrels well and pour lime into the copper sulphate barrel. (Never mix concentrated milk of lime and copper sulphate solutions).

A stock solution of each may be made and kept indefinitely if not mixed:—Dissolve 40 lbs. copper sulphate in 40 gals. of water by suspending just below the surface of the water in a coarse sack. Each gallon of the liquid will now contain 1 lb. copper sulphate. Slake any desired quantity of lime and put into a box or barrel in shaded place, or sunk in the ground. Keep covered with small amount of water to exclude the air. Calculate how much is required for 4 lbs. lime if well stirred.

To test Bordeaux mixture, let a drop of ferro-cyanide of potassium solution fall into a little of the mixture in a saucer. If this causes it to turn reddish brown, add more lime until no change takes place.

II.—LIME-SULPHUR WASH.

1. Home Boiled (for use on dormant wood only):

Fresh stone lime ....20 lbs.
Sulphur (flour or flowers)..15 lbs.
Water . . ..40 gals.

Slake 20 lbs. of lime in about 15 gals. or more of boiling water in a kettle or other boiling outfit. While slaking add the 15 lbs. sulphur made into paste by the addi-

240 divided by 30=8. This means that each gallon of such a wash must be diluted to 8 gals. with water to give us a strength of 1:030, the proper spring strength. For the second application 1:009 is about the right strength. To get it divide the 240 by 9, which gives 26⅔, or roughly speaking 27. This means that each gallon of a wash of the strength of 1:240 must be diluted to 26⅔ or 27 gals. to make the right strength for the second application. For the third application and any later ones 1:008 is about the right strength, and to get this we proceed in the same way and divide 240 by 8=30, so that each gallon must be diluted to 30 with water for this application. If the strength of the concentrated were 1:212 or any other number, you would in the same way divide the three figures to the right by 30, 9 and 8 respectively to get the proper dilutions for each spraying.

TABLE FOR CHANGING BEAUME READINGS INTO THEIR EQUIVALENT SPECIFIC GRAVITY READINGS.

Beaume.		Specific Gravity.	Beaume.		Specific Gravity.
18	=	1:141	27	=	1:230
19	=	1:150	28	=	1:240
20	=	1:159	29	=	1:250
21	=	1:168	30	=	1:260
22	=	1:178	31	=	1:271
23	=	1:188	32	=	1:282
24	=	1:198	33	=	1:293
25	=	1:208	34	=	1:305
26	=	1:219	35	=	1:317

Note.—Commercial lime-sulphur should be tested with the hydrometer and diluted according to the same rules as the home-made concentrated form.

INSECTICIDES FOR SUCKING INSECTS ONLY.

1. LIME-SULPHUR.

For scale insects, Blister Mites and Red Spider.

2. TOBACCO EXTRACTS.

For Aphids, Leaf-Hoppers, Psyllas, etc.

(*a*) BLACK-LEAF 40, strength to use is indicated on the cans.

(*b*) NICOTINE-SULPHATE 40%. Strength is indicated on the cans. (Practically same as Black Leaf 40).

(*c*) HOME-MADE EXTRACT. Soak 1 lb. tobacco refuse in 1 gal. water for 24 hrs. with occasional stirring, or steep 1 lb. in 1 gal. water for 1 hr. Make up for water that evaporates. Use at once without dilution: spoils in a few days if not used.

3. KEROSENE EMULSION.

Kerosene (Coal Oil) ....2 gals.
Rain Water ....1 gal.
Soap ....½ lb.

Dissolve the soap in water by slicing and boiling; take from fire, and while hot pour in kerosene and churn vigorously for five minutes. For use dilute with 9 parts of water, so that the above 3 gals. of stock emulsion will make 30 gals. of spray mixture.

4. WHALE OIL SOAP.

For brown or black aphids, 1 lb. in 4 gals. rain water. For green aphids, thrip and leaf-hopper, 1 lb. in 6 gals. rain water.

tion of a little water. Boil vigorously, with stirring, for 1 hour. Dilute to 40 gals. with cold or hot water. Strain and apply at once.

2. COMMERCIAL LIME-SULPHUR. (Factory-made concentrated lime-sulphur).

This as purchased is usually about 1.290 specific gravity strength or 33° Baume.

3. HOME-MADE CONCENTRATED LIME-SULPHUR.

This may be used as a substitute for commercial lime-sulphur, but is only about ⅔ as strong as a rule.

Sulphur (a fine grade).....100 lbs.
Fresh stone lime, high in percentage of calcium... 50 lbs.
Water . . ..40 or 50 gals.

Put about 10 gals. water in the boiling outfit, start fire, add sulphur, stir to make paste and break lumps, then add remaining water, and when near boiling put in lime. Stir frequently while slaking and until all the sulphur and lime are dissolved. Add water from time to time to keep up to 40 or 50 gal. mark. Boil 1 hour, then strain through a screen of 20 meshes to inch into storage barrels. Make enough at once for season's work. Cover well to keep out air, or pour oil of any kind over surface to depth of ⅛ inch for same purpose.

To determine how much to dilute for different applications use a hydrometer with specific gravity readings, and apply the following rule:

Put the hydrometer in the clear liquid when it is cold and the sediment has all been settled for a day or two. Note the number to which it sinks. Suppose this is 1:240. The strength for use before the buds burst should be 1:030 or stronger. To determine how much to dilute a strength of 1:240 to get 1:030, divide the three figures to the right in 1:240 by 30, that is

4. SELF-BOILED (chiefly for use on peach foliage).

Fresh stone lime .... 8 lbs.
Sulphur (flour or flowers).. 8 lbs.
Water . . ..40 gals.

Best prepared in quantities of 24 lbs. at a time to get sufficient heat. Place 24 lbs. lime in a half barrel, add enough cold water to start it slaking well and to keep the sulphur off the bottom. Dust the 24 lbs. sulphur over the lime, having first worked the sulphur through a screen to break lumps, then add whatever further amount of water is necessary to complete the slaking. Stir well with a hoe to prevent the lime caking on the bottom. As soon as the slaking is over, add enough cold water to cool the whole mass and prevent further combination. Strain into spray tank. Keep well agitated while spraying.

5. DUST.

For biting insects and fungus diseases the substances used now are 85 to 90% of sulphur and 10 to 15 % of arsenate of lead powder. Dusting at this date (1917) is only in experimental stage.

III.—DISINFECTANTS (for pruning tools and for wounds on trees):—

1. CORROSIVE SUBLIMATE, 1 part to 1,000 by weight=1 tablet to 1 pint of water. Apply with a swab on end of a stick.

Caution.—Corrosive sublimate is a deadly poison to man or beast if taken internally. It will also corrode iron or metal, so use in a glass or wooden vessel and be sure to wash these out very thoroughly when through using them.

2. LIME-SULPHUR about twice spring strength, or bluestone, 1 lb. dissolved in about 14 gals. water, may be used to disinfect wounds or cankers, but is not satisfactory in case of Pear Blight.

INDEX

BULLETIN 251 JULY, 1917

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Insects Affecting Vegetables

By C. J. S. Bethune.

Every vegetable grower, whether in town or country, on a small or a large scale, finds from time to time that his plants are attacked by some destructive insect and that serious injury is threatened to his crop. It is desirable, therefore, that some convenient manual should be provided for the identification of the ordinary pests and to describe the remedies which experience has proved to be the

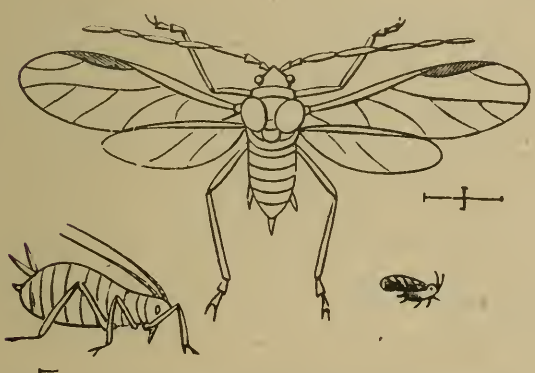


Fig. 1.—Winged Aphis and wingless form —much magnified.

Fig. 2.—Winged and Wingless Aphids—greatly magnified.

most effective in each case. In the following pages an effort is made to furnish in simple terms and without the use of technical language the information which will fulfil these requirements.

As a general rule it will be found that thorough preparation of the soil, a short rotation of crops, ample manuring and clean cultivation are the best of all remedies. All refuse remaining on the ground after the crop has been removed, such as stalks, roots, and leaves, should be got rid of by feeding to pigs or cattle, burning or burying, in order to leave no shelter for wintering insects. Weeds of all descriptions, especially in fence corners and waste places, should be cut down before they go to seed, or plowed under from time to time; they harbour many of our worst pests in summer and winter, and often afford convenient breeding places for enemies which the vegetable grower is endeavoring to combat on his cultivated plants.

General Feeders.

Before taking up in order the insects that attack the various plants grown in our vegetable gardens, attention may be drawn to a number of kinds that are general feeders, not limiting themselves to any particular varieties, but attacking almost everything that comes in their way; on that account they are the most serious foes that we have to contend against and in many cases the most difficult to keep under control.

Aphids or Plant Lice (Figs. 1 and 2) are minute, pear-shaped, soft-bodied insects that may be found on almost every kind of plant, usually in dense colonies clustered thickly on the terminal twigs and buds, on the under-side of leaves, on

Fig. 3.—Lady-bird beetles and a larva.

stems and other parts, and even underground on roots. Wherever situated they are occupied in the same manner—sucking out the life-juices of the plant and multiplying their own numbers by constant reproduction of living young all through the summer. There are a great variety of species, most of them varying shades of green in color, some are shining black, others bright red; some again are covered with waxy filaments resembling threads of cotton wool, and others with a dusting of a mealy substance composed of the same material. Singly they are insignificant creatures, but occurring as they do in enormous numbers and multiplying with amazing rapidity, they are able to seriously injure and often to destroy the vegetation they attack, Fortunately they are devoured by many predaceous insects, such as Ladybird beetles and their larvæ (Figs. 3 and 4), and those of the

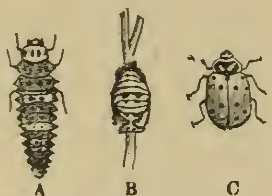


Fig. 4.—Lady-bird beetle, pupa and larva.

Fig. 5.—Lace-winged fly and its eggs on stalks.

Lace-winged (Fig. 5) and Syrphus flies and other creatures; washed off and drowned by heavy rains, and reduced in numbers by internal parasites; otherwise they would in time destroy all vegetable life. Ants are usually to be found prowling about the colonies; they do not eat the aphids, as might be suspected, but are attracted by the sweet "honey-dew" that exudes from them, and take them under their special protection.

In gardening operations nature's checks are not sufficient, but require to be supplemented with artificial remedies such as kerosene emulsion, strong washes of soap-suds or tobacco decoction. In greenhouses they can be kept in control by burning the commercial preparation of tobacco.

Soap washes are made by dissolving one pound of whale-oil soap in four gallons of warm water for black or brown Aphids, and one pound in six gallons for green Aphids. Common laundry soap will answer, using a larger proportion.

"Black-Leaf-40," a preparation of tobacco, which can be procured at the large seed stores, is a most effective remedy for Aphids and many other sucking insects.

Ants. These insects are often suspected of injuring the plants over which they are seen running, but as a rule they are only indirectly responsible. A few species, such as the large black Carpenter Ants, form their galleries in trunks of trees, posts and timber and do a considerable amount of damage, but the great variety of smaller species which infest our gardens do not feed upon foliage or injure growing plants. Sometimes they may be found upon unopened flower buds, but they are only attracted by some sweet secretions on the surface; as a rule their presence indicates that there is a colony of aphids near by, which they take under their protection in order to obtain from them the sweet "honey-dew" exuded by these minute creatures. The worst injury for which they are responsible is the establishment of colonies of Aphids upon the roots of many plants; the ants collect

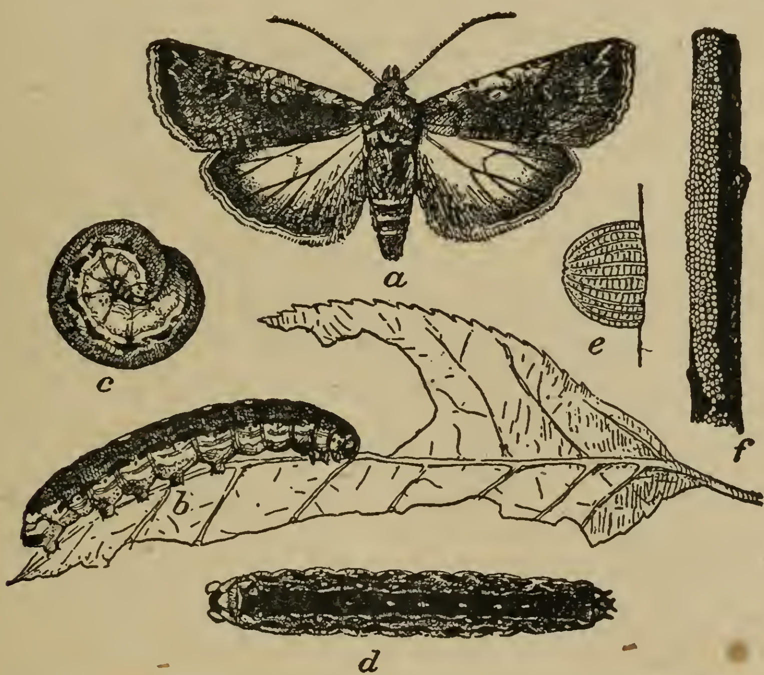


Fig. 6.—Variegated Cutworm: (*a*) moth; (*b c d*) caterpillars; (*e*) egg (magnified); (*f*) eggs on a stem.

the eggs and take care of them during the winter and when growth is sufficiently advanced carry them to the roots and look after them during the summer, in order to have a constant supply of "honey-dew." These colonies increase rapidly, soon check the growth of the plant, and ultimately destroy it. Where ants' nests abound, frequent digging and stirring of the soil, and in field cultivation repeated disking and harrowing, will get rid of many, or they may be treated with carbon bisulphide; a small quantity should be poured into the entrance of the nest or into a hole made with a stick and quickly covered with earth; the fumes will speedily kill all the inmates. It is best to perform the operation towards evening when all the ants are within the nest. This is a very effective mode of getting rid of the large colonies which make mounds of rubbish on lawns and in fields.

Cutworms (Figs. 6, 7 and 8). At the beginning of the growing season the gardener often finds in the morning young plants cut off near the surface of the ground that the evening before were strong and healthy. On stirring up the soil nearby he may find hidden in the ground a greasy-looking caterpillar, the culprit in the case. Cutworms, so called from this habit, are the caterpillars of dull-colored night-flying moths of a great variety of species and varying to some extent in their habits. As a general rule they are partly grown at the approach of winter and hide away in a torpid state during the cold weather; when restored to activity by the warmth of spring, which causes the buds to open and the growth of plants to begin, these worms come out in search of food and attack any kind of tender vegetation they meet with. They are nocturnal in their habits and hide away during the hours of daylight under any shelter they can obtain or just below the surface in the loose soil of newly made beds. Owing to their destructive practice of cutting off a whole plant in order to devour a portion of its foliage, they do a great deal of apparently needless damage.

After they have become fully grown they change to the chrysalis stage in the ground and in early summer the moths appear, many of them making their presence known in our houses by their attraction to light. Before very long another brood of caterpillars comes upon the scene, often more numerous and more destructive than the first. Some of them climb up into fruit trees and destroy the

Fig. 7.—Cutworm moths.

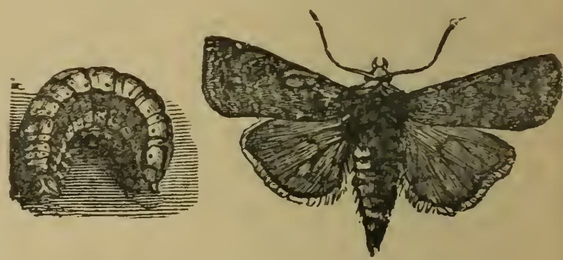


Fig. 8.—Cutworm and moth.

foliage, others attack farm crops, vegetables, grape vines, the plants in flower gardens, etc., while occasionally a single species appears suddenly in enormous numbers and sweeps like an army over the land, devouring everything that comes in its way.

Happily, a very simple and completely effective remedy has been found for these destructive creatures. It is called the "poisoned bran-mash" and is made in the following manner: Mix half a pound of Paris green in 20 lbs. of bran (the proportion for larger or smaller quantities is 1 to 40); the poison should be added to the dry bran little by little and stirred all the time till the whole is tinged with the green color, then add water sweetened with sugar or molasses, till the mixture is sufficiently moistened to fall like sawdust through the fingers. Two gallons of water and half a gallon of molasses are the usual quantities. The addition of two or three lemons renders the bait more attractive. The juice of the fruit should be squeezed into the mixture and the pulp and rind added after being minced in a meat chopper. If bran cannot be procured, shorts or flour may be used, and for field work may be distributed by means of a seed drill. The mash should be scattered about the plants that are liable to attack in the evening, and strange to say the worms will devour it in preference to their ordinary vegetable food. When they begin to feel the effects of the poison they wander off to find a hiding place or burrow in the ground and there die. Their dead bodies will be readily found in the morning just below the surface of the ground, often in surprising numbers. Young plants, such as cauliflowers, tomatoes, etc., may be protected when set out by wrapping a bit of newspaper around the stem between the root and the leaves and reaching a little below the surface of the ground. The worms will not attempt to bite through or climb over it.

Flea-Beetles (Fig. 9). There are several species of these minute insects which attack a large variety of plants; some confine their attentions to one or two kinds, while others are general feeders. The beetles are about one-tenth of an inch in length, oval and convex in form, usually shiny black or bronzed in color, sometimes ornamented with broad, pale stripes along the back; they all possess enormously developed thighs on the hind legs, by means of which they are enabled to jump with great agility, and hence have acquired the name of Flea-Beetles. They appear in early spring, often in large numbers, and eat small holes in the foliage of young plants, preferably the thick seed-leaves. The larvæ, as far as known, feed

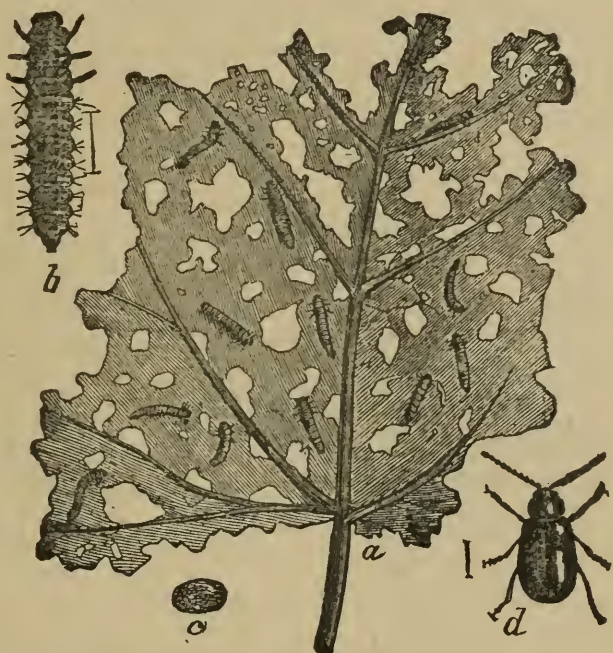


Fig. 9.—Flea-beetle.—(*a*) leaf with larvæ at work upon it; (*b*) larva, greatly enlarged; (*c*) pupa; (*d*) beetle, magnified.

for the most part on the roots of weeds, as well as upon some garden vegetables; clean cultivation, especially of fence corners and bits of waste land, is therefore of much importance in the control of these and many other kinds of insects. The beetles may generally be found all through the summer, when they especially attack the foliage of potatoes, turnips, beets, tomatoes and many other plants. In many cases fungus diseases, such as Potato Blight, find suitable places for the growth of their spores in the holes made in the leaves by these beetles.

Cheese-cloth screens are very effective in warding off attacks upon young plants, such as cucumbers, etc., but where their use is not convenient or practicable the beetles may be controlled by the use of the poisoned Bordeaux mixture, the combination being effective against both the insects and the fungus diseases. For tender foliage arsenate of lead is preferable to Paris green as it is not so likely to cause injury by burning.

Grasshoppers (or Locusts, as they should be called)—Fig. 10—are often very destructive in the later summer months, especially if the weather should be dry and hot. They are general feeders, few kinds of vegetation coming amiss to them when they are numerous and the supply of food is at all scanty. Usually they are most abundant in dry pastures and the neighboring grain fields; this is due to the fact that their eggs are laid in grass lands, especially where the soil is dry and sandy, and the young nymphs grow there to maturity. They do not pass through any chrysalis stage, but gradually become bigger after each moult till the full-winged adult stage is reached. Many mechanical devices have been employed for their destruction, but the use of these troublesome methods can now be dispensed with since the discovery of the "Criddle mixture," a poisoned bait which derives its name from Mr. Norman Criddle, of Aweme, Manitoba, who proved its complete efficiency after a series of experiments. It is made and applied as follows: Take a three-gallon patent pail and fill it with fresh horse droppings, then empty into a barrel; repeat this five times. As each pailful is poured in, mix thoroughly with the manure about a quarter of a pound of Paris green and half a pound of salt which has been dissolved in water. There would thus be used about one pound of Paris green and two pounds of salt to half a barrel of manure. The mixture may be drawn in a cart to the infested places and scattered broadcast with

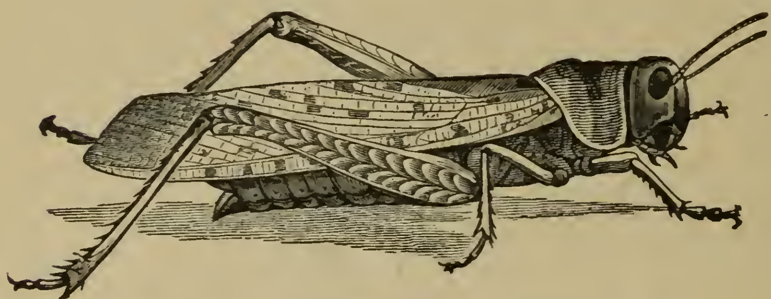


Fig. 10.—Grasshopper or Locust.

Fig. 11.—Tarnished Plant-bug.

a trowel or wooden paddle. The grasshoppers are attracted to it from considerable distances and are killed in large numbers. It has been found most effective to distribute the mixture on alternate days, a little at a time, rather than to use larger quantities at longer intervals. In the case of grain fields, oats being especially liable to attack, the mixture should be thrown into the grain along the sides of the field and the grasshoppers will eat it in preference to anything else. Care should be taken not to allow cattle or poultry to have access to it. In some localities, however, this mixture has been found to have no attraction for the grasshoppers, but another method, which is effective wherever tried, has been discovered. This is the use of the poisoned bran mash recommended for the destruction of Cutworms (page 4). Double the quantity of Paris green should be employed, that is 1 pound to every 20 pounds of bran, and the mixture should be applied in the morning between 5 and 7 o'clock by scattering so thinly over the infested field, fence corners, and roadsides, that the above quantity will cover four or five acres. It may be necessary to make a second application a few days later. It is advisable to apply this remedy as early in the season as possible, that is, as soon as the young grasshoppers are observed. They are then more readily killed by the poison and have also inflicted less damage than if allowed to devour the grass or crops for several weeks longer.

PLANT-BUGS. In the American use of the word, the name "Bug" is erroneously applied to insects of every kind—to a beautiful butterfly or moth as well as to the disgusting bed-bug. The name, however, when correctly employed, denotes insects belonging to the order Hemiptera, which are provided with sucking and not biting mouth-parts, and which do not pass through any quiescent chrysalis stage, but are gradually developed from the newly hatched nymph to the winged adult. To the true bugs belong two species which are very abundant in gardens, attacking plants of all descriptions, flowers and vegetables alike. These are the Tarnished and Four-lined Plant-bugs.

THE TARNISHED PLANT-BUG (*Lygus pratensis*)—Fig. 11—is to be found all through the season on plants of almost every kind, sucking the juices of flower buds and foliage and sometimes of the leaves of young fruit trees. The mature insects are oblong in form with a triangular head and prominent eyes, and tapering to a rounded angle at the other end. The color is variable, usually grayish-brown, marked with yellowish and black dashes, and having a slight bronzy reflection;

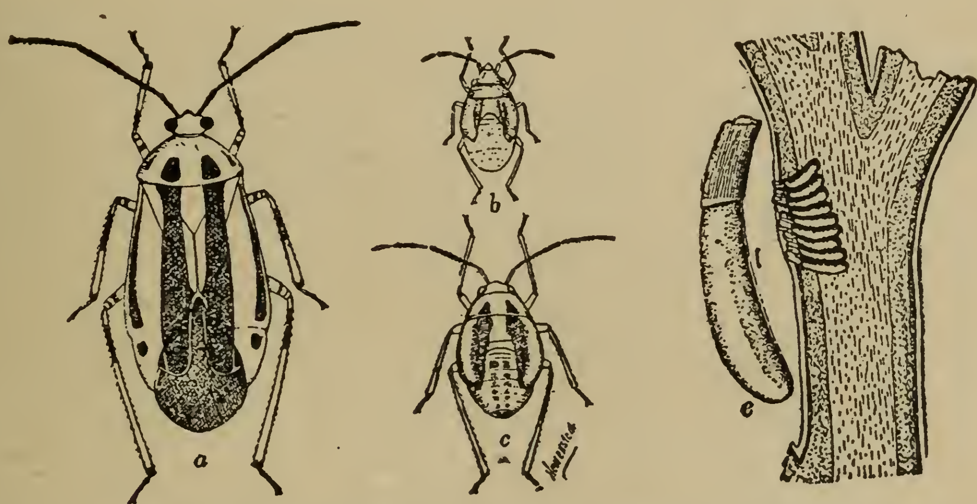


Fig. 12.—Four-lined Plant-bug: (*a*) adult; (*b* and *c*) immature nymphs; (*e*) eggs laid in a slit. (After Lugger).

its length is a little over a quarter of an inch. They are very active insects, taking flight readily when disturbed or dodging round to the other side of the plant.

THE FOUR-LINED PLANT-BUG (*Poecilocapsus lineatus*)—Fig. 12—is much the same size and shape as the preceding, but is yellow in color, with dark lines down the back and four black dashes along the thorax. Its attacks are most noticeable in early spring, when it may be found on mint, sage, currant and gooseberry bushes, and often also on potatoes. It sucks the juices of the tender terminal leaves, causing them to shrivel up and turn black, and frequently severely injuring the plant. The standard remedy for these and other sucking insects is spraying with strong kerosene emulsion; where this cannot be applied, as in the case of many flowering plants, dusting with pyrethrum insect powder has been found quite effective. Much may be done by knocking off the bugs with a stick into a pan containing a little water covered with a film of coal oil; this should be performed in the cool of the morning when the insects are less lively than during the heat of the day. For the control of both these bugs it is important to keep the surroundings clean of weeds and rubbish, which afford them shelter in winter and convenient breeding places in summer.

Slugs. These are not insects, but belong to the same family of creatures as snails, but are destitute of shells. As they are often very troublesome, especially in shady or damp city gardens, they may be referred to here. Like cutworms, they are nocturnal feeders, hiding under any convenient shelter in the daytime, and devouring during the night whatever succulent vegetation they may be able to reach. One method of getting rid of them is to go round the garden, where their presence has been made known, with a lantern at night, and dust their slimy bodies with lime or salt, which will soon destroy them. Another plan is to scatter freshly slaked lime over the ground for three successive nights; when the slugs come in contact with it their powers of mischief are at an end. Many may be got rid of in small gardens by laying pieces of shingle here and there on damp ground; the slugs will take shelter in such places when daylight sends them into hiding, and by going round in the morning they may easily be scraped off and crushed under foot.

White Grubs (Fig. 13). These are the larvæ of May-beetles or "June-bugs" (*Lachnosterna*), which breed for the most part in old pastures. The beetles appear about the end of May or early in June and attack the tender

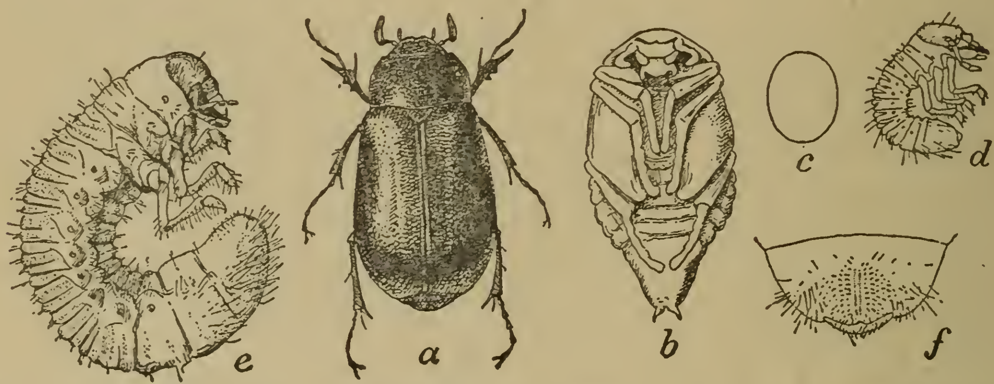


Fig. 13.—White grubs: (*a*) beetle; (*b*) pupa; (*c*) egg; (*d*) young grub; (*e*) mature grub. (*Chittenden, U.S. Dept. Agric.*)

foliage and buds of fruit and ornamental trees, often inflicting a considerable amount of damage. They come out at night and swarm about the trees, making a loud buzzing noise; many are attracted by lights in houses; and cause some consternation among the inmates through their clumsy flight about the room and the noise that they produce; as they can neither sting nor bite no alarm need be caused by their presence. During the night they feed and by morning all disappear, hiding underground where the soil is loose and under grass or rubbish about fences and buildings. At this period boys might be employed to search for and kill them; trap-lanterns have sometimes been used with advantage, and spraying the trees they frequent with Paris green will destroy large numbers. The beetles deposit their eggs on the stems or roots of grasses just below the surface of the soil; from these the grubs hatch out and feed for two or three years underground. During the summer of their third season they change to the pupal state and transform to beetles about September, but do not come out until the following spring. This long larval stage accounts for the fact that in some localities the beetles only appear once in three years.

The grubs, when fully grown, are thick, fat creatures, white in color—hence their name—with body partially curled up and the last segments discolored from the food showing through the skin. When an old pasture is broken up they live for a time on the grass and roots that have been turned under and then attack whatever plant may be grown. The first and second crops usually suffer most, especially strawberries and corn; clover is least affected by them and may be seeded down with rye, then small grains followed by corn or potatoes. Late and deep ploughing will break up the winter quarters of the grubs and beetles and expose them to the frost and also to the various animals that prey upon them. Pigs and poultry greedily devour them; crows and other birds and skunks also destroy large numbers when they can get access to them.

In gardens digging deeply and trenching in the fall is very useful, but in the flower beds where perennials are grown this is impracticable, and therefore recourse can only be made to disturbing the soil between the plants as much as possible in late autumn and early spring. Lawns and golf-links are frequently very badly affected as they are left for many years undisturbed; sometimes the roots of the turf have been so completely eaten off that the sod may be rolled up like a carpet. In such cases the best plan is to dig up the part affected and destroy the grubs, put in a fresh layer of soil and resod or sow with grass seed.

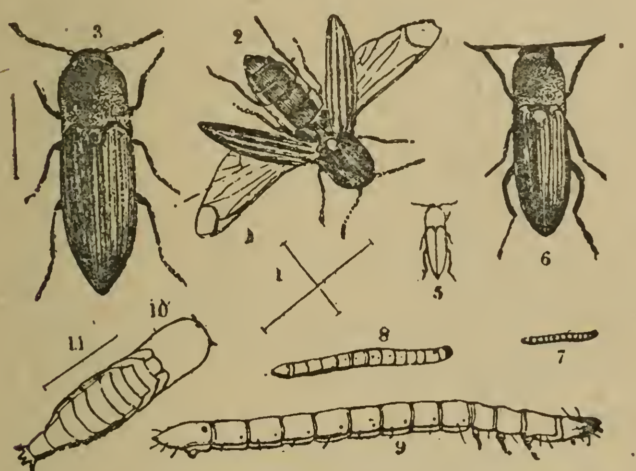


Fig. 14.—Wire-worms and Click-beetles.

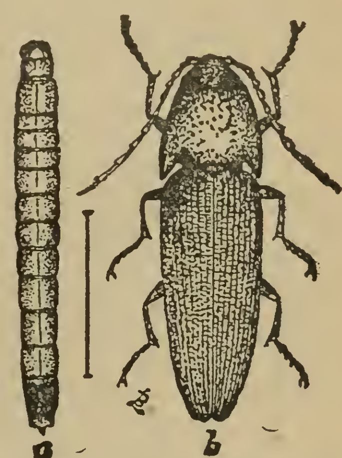


Fig. 15.—(*a*) Wire-worm; (*b*) Click-beetle.

For small patches, watering with kerosene emulsion, and washing it well in with plenty of water from the garden hose, will kill the grubs. Where large areas are found to be affected on golf-links or in pastures, the most effective plan is to enclose the place with hurdles and turn in a few young pigs; they will soon root out and devour all the grubs, and may then be removed to another spot.

Wireworms are the larvæ of Click-beetles (Figs. 14 and 15), so called from their curious habit of springing up in the air with a "click" when laid upon their backs. The beetles are long and narrow, rounded above with very short legs and usually dull gray or black in color. The grubs are long and cylindrical, with a very hard integument from which they get the name of "Wireworms," and yellow or whitish in color. The life history is very similar to that of the White Grubs; they breed chiefly in old pastures, take two or three years to mature, and feed upon the roots of any plants that may be convenient to them; they are especially injurious to corn, and often may be found during the winter feeding inside potatoes, in which they burrow great holes. No treatment of the soil with salt, poisons, etc., has any effect upon them; the only remedy is a short rotation of crops as in the case of White Grubs; ploughing in August and cross-ploughing again in September will destroy large numbers of them. In gardens, as the beetles usually spend the winter under any shelter they can find, clean cultivation, especially along the fences, is of great importance; in spring many may be destroyed by placing bunches of clover or weeds or slices of potatoes poisoned with Paris green under shingles or bits of board where the beetles go for shelter.

ASPARAGUS.

Asparagus Beetles (Figs 16, 17 and 18). The two species, the Blue (*Crioceris asparagi*) and the 12-spotted (*C. 12-punctata*), have spread over a great part of Ontario during the last few years and in many places are very abundant. Both species are often to be found upon the same plant; the former is shining blue-black in color, with creamy-white blotches on the wing-covers which vary a good deal in size and shape, and sometimes form a cross of the ground color of the back; the sides and the thorax are dull red and the head black. The

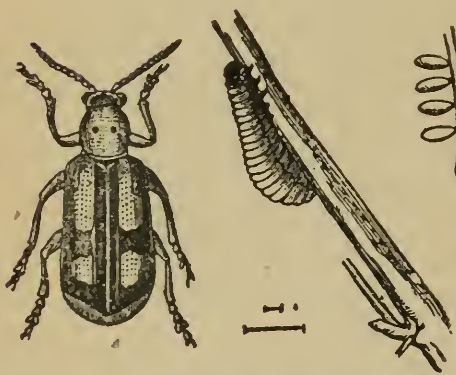


Fig. 16.—Blue Asparagus beetle, larva and eggs—magnified.

Fig. 17. Twelve-spotted Asparagus beetle,—magnified.

Fig. 18.—Blue Asparagus beetle, larva and eggs on a shoot.

other species is the same length, about a quarter of an inch, but is somewhat stouter; the whole insect is dull red and polished and has twelve round black spots on the wing-covers.

Both these beetles pass the winter in the adult stage and are ready to attack the asparagus shoots as soon as they appear above ground in the spring; these they gnaw and spoil for table use and the Blue species deposits upon them its shiny black eggs which are attached by the tip to the plants. Later on the eggs of both species may be found upon the growing plants and the larvæ soon appear. Those of the Blue beetle are dark olive gray grubs, which feed openly upon the foliage; the grubs of the 12-spotted are yellowish or somewhat orange in color, feeding at first upon the tender foliage, but boring into and devouring the pulp of the seed capsules as soon as they are large enough to attack. The life cycle of both kinds requires only six or seven weeks for its completion and we therefore find all through the season, till sharp frosts come in the autumn, eggs, larvæ and beetles in great numbers at the same time; the pupal stage is passed beneath the surface of the ground.

Remedies. The simplest and most efficient remedy is to let poultry have the run of the beds; they will devour both beetles and grubs and will not touch the asparagus.

Where this is not practicable, the young shoots should be dusted with fresh air-slaked lime when the morning dew is on the plants; this, of course, should be washed off before cooking. At the same time some slender shoots may be allowed to grow and attract the beetles, which may then be killed with Paris green or arsenate of lead. If the plants have many eggs upon them, they should be cut off and burnt and others left to grow in their place.

After the cutting season is over the plants should from time to time be sprayed with one of the arsenical poisons, but when the seed capsules are formed this will be of no avail against the grubs of the 12-spotted species. To get rid of it, the seed bearing plants should be cut off and burnt. In early autumn it will be well to cut down and burn the whole of the plants.

BEANS.

The Bean Weevil (*Bruchus obtectus*). (Fig. 19.) This insect has been reported from only a few places in Ontario and Quebec, and does not appear to have become established as a pest. It is a very small beetle, one-tenth of an inch long, only half the size of the Pea-weevil, which in other respects it closely resembles. It is grayish-brown in color, due to a coating of dense fine hair; the wing-covers are marked with a series of lines running lengthwise and have a mottled appearance. The beetle is oval in shape, the head is bent down and terminates in a short square beak; the end of the abdomen is not covered by the wings, and differs from that of the Pea-weevil in being destitute of the two oval black spots which are characteristic of the latter.

The eggs of the insect are laid upon the young bean pods; the grubs, as soon as they are hatched, bore through and enter the beans inside, several making their way into a single bean. Maturity is reached in the autumn, when the beetles emerge if the season is warm; otherwise they remain all winter in the ripened bean. If unmolested they will increase and multiply in the dry seeds and continue their work of destruction for a long time. It is therefore useless to hold over the seed for a year, as may be done to get rid of the Pea-weevil.

Remedy. Whenever this insect is found to be present, the beans should be fumigated as soon as practicable after they are harvested. This is done by putting them in a barrel or tight bin and pouring on them one ounce of bisulphide of carbon for every 100 lbs., and then closing the receptacle tightly and leaving it for 48 hours. At the end of this time every insect will be dead. As the fumes of this substance are inflammable and explosive, it should not be used near any light or fire. Beans that have been injured by the insect should on no account be used as seed, as most of them will fail to germinate, or at any rate will produce only feeble plants.

The Bean Plant-Louse (*Aphis rumicis*). Windsor or Broad Beans and Horse-beans are not much grown in this country, though in some places they are found of value as an addition to ensilage. Some difficulty is experienced in obtaining satisfactory crops owing to their liability to attack by this black Aphis, which is a serious pest in Europe. At the time of flowering the colonies of this insect are to be found covering the tips of the plants so thickly that they look as if dusted with soot; if let alone they soon multiply enormously and greatly reduce the vitality of the plants.

Remedies. The most successful plan is to cut off the tips of the affected plants and destroy the colonies of Aphids by burning or trampling under foot.

This has the additional benefit of checking the growth and causing the pods to fully develop. Spraying with kerosene emulsion or strong soap-suds will also be effective.

Root Maggot. Beans are occasionally attacked by the Seed-corn Maggot (*Phorbia fusciceps*), which also injures peas and several other vegetables. The chief mischief is done to the thick seed-leaves when they first push their way above ground; afterwards the maggots attack the roots and destroy the plant. Spraying with a carbolic wash has been found useful in deterring the parent flies from

Fig. 19.—(*a*) Bean-weevil, much enlarged and natural size; (*b*) infested bean.

Fig. 20.—Blister-beetles, magnified.

depositing their eggs. Good soil, well fertilized, to ensure a rapid growth of healthy plants, will enable them to resist the attack of the maggots and escape serious injury.

Other Insects. Beans, like other vegetables, are liable to be injured by Cutworms when the plants are small, and later on in the season by the Tarnished Plant-bug. Broad beans are also subject to attack by the Black-Blister-beetle, which is one of the enemies of the potato plant, and sometimes appears in destructive numbers.

BEETS AND SPINACH.

Beets and Spinach are liable to be attacked by many of the common garden pests that are general feeders, such as Cutworms which bite off the young plants close to the surface of the ground, Wire-worms and White-grubs which feed upon the roots, Plant Lice, Flea-beetles, Leaf-hoppers, the Tarnished Plant-bug and Grasshoppers which affect the foliage. Descriptions of these insects and the methods of dealing with them will be found elsewhere in the Bulletin. Mention may be made of a few other insects which occasionally attack these plants in injurious numbers.

Blister Beetles (*Epicauta cinerea, Pennsylvanica, etc.*) (Fig. 20.) These are long, narrow, soft-bodied insects which belong to the same family (*Meloidae*), and possess the same blistering qualities as the "Spanish-fly," which is used by druggists in the preparation of certain plasters. There are three species found in Ontario which may be distinguished by their color: the Black, the Gray and the Spotted; a fourth, the Striped, is occasionally to be found. Of these the Black is the most common and may often be seen feeding harmlessly on the flowers of the Golden-rod. At times these beetles appear in swarms and rapidly devour the foliage of beets, potatoes and a few other plants, and after inflicting a considerable amount of damage suddenly disappear. They may be controlled by spraying with Paris green, but this should not be resorted to unless the attack is serious, as their grubs have the very useful habit of feeding upon the eggs of grasshoppers and may therefore be included amongst the beneficial insects. A better remedy, which has been employed with success, consists in driving the beetles away from an infested field by a party of men or boys walking in a line across and waving branches from side to side. The beetles thus disturbed fly ahead, and by following them up may be cleared out entirely; once they are driven out of a field they seldom return. Spraying with Bordeaux mixture will keep them off the plants, and may be employed if necessary.

The Beet Leaf-Miner (*Pegomyia vicina*). Blotches may often be seen on the leaves of beets and spinach, which are found on investigation to be caused by a minute maggot which feeds on the green tissue below the skin. The parent insect is a two-winged fly about a quarter of an inch in length, which deposits its eggs on the foliage of these plants; the maggots when hatched immediately burrow beneath the surface and cannot therefore be reached by any applications. The only method that seems at all available is to pick off and destroy the infested leaves, a laborious plan which can only be adopted where the plants are grown on a small

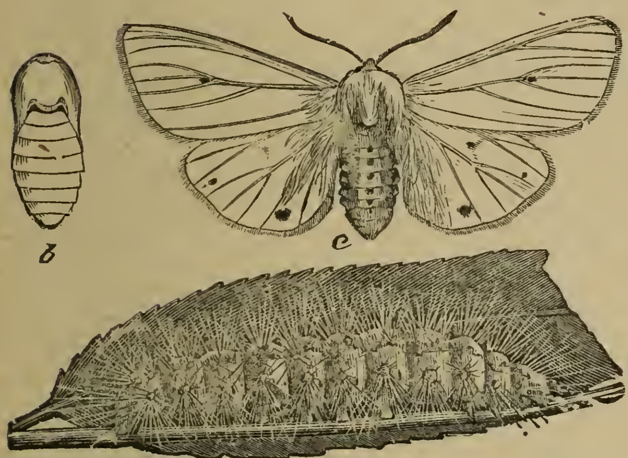


Fig. 21.—Yellow Woolly-bear: (*a*) caterpillar; (*b*) chrysalis; (*c*) moth.

Fig. 22.—White Cabbage Butterflies.

scale. If the attack is serious it would be worth while to adopt this method in order to get rid of the trouble and guard against its repetition.

Caterpillars. The foliage of beets and spinach is liable to be attacked by some caterpillars, but as a rule they are in small numbers, widely scattered over the plants and seldom inflicting much damage. This does not apply to the extraordinary outbreaks on rare occasions of the Army-worm and the Variegated Cutworm, which devour every green thing that they come to, beets as well as everything else. Among the others referred to may be mentioned the Yellow Woolly-Bear (*Diacrisia virginica*) (Fig. 21), which is a hairy caterpillar, readily seen from its bright yellow color, and attaining to an inch and a quarter in length when fully grown. It turns into a beautiful snow-white moth, with a few black dots on its wings and rows of black and yellow spots on its body. When feeding they are conspicuous, and may be picked off by hand; but usually they are beneath the leaves when at rest. If very numerous, Paris green may be employed. They are general feeders and do not confine themselves by any means to garden vegetables, but attack many kinds of weeds as well.

CABBAGE AND CAULIFLOWER.

These plants are subject to a series of attacks by insects from their first appearance above the ground to maturity. Cutworms destroy a great many seedlings and young plants when they are set out in the spring. Later on gray Plant-lice make their appearance, and cover the leaves with their colonies, sucking out the sap and causing the foliage to dry up and wither; they become excessively numerous towards the close of the season, and in addition to the injury they inflict, cause the plants to present a disgusting appearance. Throughout the summer the leaves are liable to be devoured by several caterpillars, and in August and September by Grasshoppers, while the roots are frequently caused to rot by the Maggots of a small fly. Aphids, Flea-beetles, Cutworms and other general feeders are treated elsewhere; reference will therefore be made here only to such insects as are peculiar to the Cabbage and other Cruciferous plants.

The White Cabbage Butterfly (*Pontia rapae*)—(Fig. 22). This insect, which came to us from Europe about sixty years ago, is now one of our commonest butterflies, and may be seen flitting about everywhere from early spring till cold weather sets in. It is one of the worst pests that the cabbage grower has to contend with unless measures are taken to prevent its ravages, and happily this is a matter of no great difficulty. The butterfly lays her eggs on the leaves of the food-plant; the caterpillars are velvety green and almost exactly the color of the leaves upon which they are feeding; when at rest they lie at length upon the midrib and are not easily seen. There are two broods in the year, the later being much the more numerous, and sometimes a third if the autumn should be fine and warm. The caterpillars riddle the outer leaves and then burrow into the heads, devouring the substance and spoiling the plant for table use by their excrement. Besides Cabbages and Cauliflowers, they attack also mignonette, stocks and nasturtiums.

Remedy. Pyrethrum insect powder is thoroughly effective. One pound should be mixed with four pounds of cheap flour and kept in an air-tight jar or canister for twenty-four hours so that the poison may be thoroughly incorporated with the flour. The plants infested by the caterpillars should then be dusted with the mixture, which can be applied with a small bellows, or in a cheese-cloth bag tapped lightly with a slender rod. This powder will kill insects but is perfectly harmless to human beings. Powdered White Hellebore may also be used in a similar manner. Another method, which is more rapid in its effects upon the worms, is to dissolve two ounces of the Pyrethrum powder in three gallons of luke-warm water and spray at once. The liquid kills immediately all the caterpillars it reaches, while the dry powder often takes many hours to produce the same result. Paris green and other virulent poisons should never be applied to cabbages and vegetables of any kind that are intended for table use.

The Zebra Caterpillar (*Mamestra picta*)—(Fig. 23). There may often be found feeding upon cabbages and some other garden plants of the same family, a handsome caterpillar about two inches long, when fully grown. It is velvety black on the back and has two bright yellow stripes along the sides, which are connected by a series of irregular yellow lines on a black ground-color; the head and feet are reddish. These strikingly contrasting colors render the caterpillar a conspicuous object on the green foliage that it feeds upon, and make it an easy task to pick them off by hand. There are two broods in the year, the moths, which are dull reddish-brown with white underwings, appearing in May and August. The young caterpillars when first hatched feed in colonies and devour the green substance of the leaves, thus producing white blotches on the foliage and rendering their presence easily noticeable. Should they be too numerous to be destroyed by hand picking, resort may be had to Pyrethrum powder applied as mentioned above, or to white hellebore, which may be dusted on the leaves or sprinkled by mixing one ounce in two gallons of warm water, stirring from time to time to prevent the powder from settling at the bottom of the watering can.

The Cabbage Plusia (*Autographa brassicae,* Riley)—Fig. 24). A pale green caterpillar, with whitish lines running lengthwise of the body, may sometimes be found devouring the leaves of cabbages, lettuce and other vegetables, feeding usually on the under side of the foliage. It is called a "Semi-looper" from its raising the middle of the body when walking, owing to the absence of some of the usual prolegs. Though abundant and destructive in the neighboring States, it has not often been found in injurious numbers in Ontario, but may at any time prove a serious pest. In the early part of the season they may be got

Fig. 23.—Zebra caterpillar and moth.

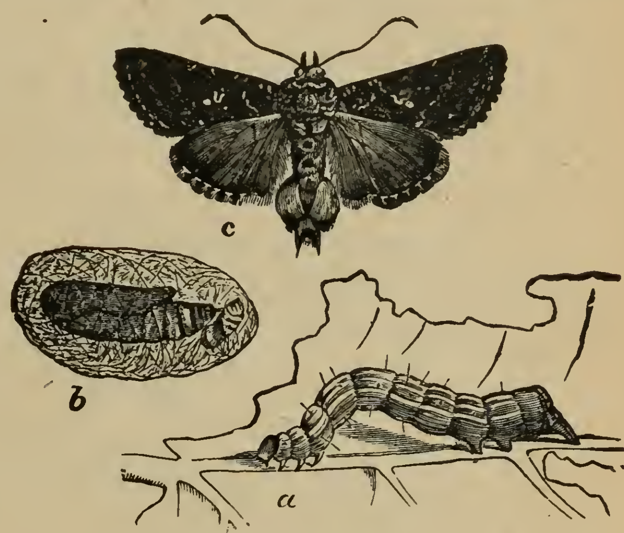


Fig. 24.—Cabbage Plusia: caterpillar, chrysalis and moth.

rid of by dusting with a mixture of one pound of Paris green in twenty pounds of lime, applying the powder to the underside of the leaves. A liquid spray may also be used of the ordinary composition.

The Diamond-Back Moth (*Plutella maculipennis,* Curtis)—(Fig. 25)—is from time to time a serious pest, as its caterpillars appear in large numbers and devour the foliage of cabbages, turnips and other cruciferous plants. These worms are much smaller than those of the preceding species; are green in color and remarkably active when disturbed; they will then wriggle about in a violent manner and drop to the ground by a silken thread from the leaf on which they are feeding. As they devour all the green substance of the foliage the plant attacked soon withers and dies. There are usually two broods in the year, the first set of caterpillars appearing at the beginning of July, and the second towards the end of the summer; in favorable seasons there may even be a third. The winter is spent in the pupal stage, the lace-like cocoon enclosing the chrysalis being attached to the underside of the leaves. The moth is a beautiful little creature, dark or ashen gray in color, with a series of white marks on the fore-wings which form, when the wings are closed, a row of diamond-shaped markings down the middle of the back; from this characteristic the moth receives its name.

The remedy that seems most effective is spraying the underside of the leaves wherever attacked with kerosene emulsion, at the same time applying fertilizers, such as nitrate of soda, to induce a vigorous growth. As a preventive measure all remains of stalks and foliage, after the crop has been taken in, should be destroyed in order to get rid of the wintering chrysalis. Though the insect is an importation from Europe, it is largely kept in check by parasites and only occasionally becomes a serious pest.

THE CABBAGE MAGGOT (*Phorbia brassicae*)—(Fig 26)—is one of the most serious insects that growers of this vegetable have to contend with. Young plants, soon after being set out in the spring, are often found to have their roots infested with these maggots, their presence being indicated by the dying of the plants. They are white, footless larvæ, the offspring of slender two-winged flies, smaller than the ordinary house fly; the eggs are laid on the stems of the plants close to or just beneath the surface of the ground; when hatched, the maggots burrow down into the roots, where they tear the tissue with the hooks which take the place of jaws, and live upon the sap; the breaking up of the cells of the plant causes a rot to set in and the entire destruction of the root soon follows. When full grown the maggots form their reddish-brown puparia in

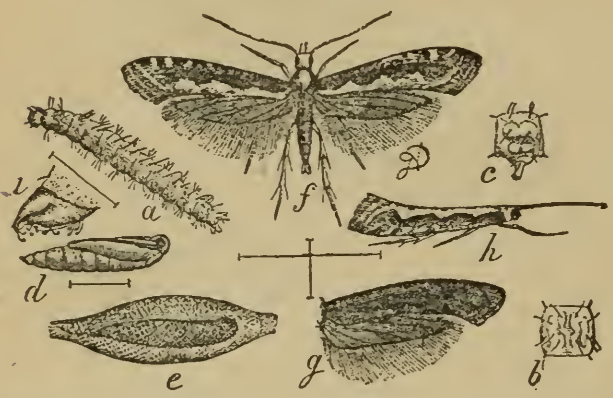


Fig. 25.—Diamond-back moth: (*a*) caterpillar; (*d*) pupa; (*e*) cocoon; (*f* and *h*) moths—all much enlarged.

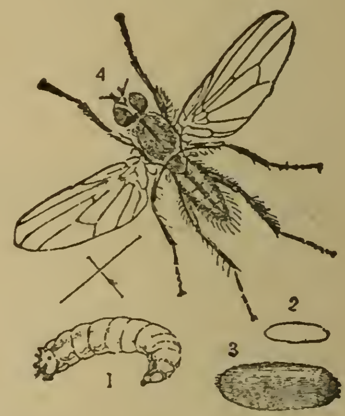


Fig. 25.—Cabbage maggot, puparium and fly—enlarged.

the soil near by, and from these a second brood of flies soon emerges. Working under ground as they do it is a difficult matter to apply any effective remedy; the one that has proved most useful is a solution of corrosive sublimate, four ounces to 50 gallons of water. The earth is drawn away from the root of an affected plant and half a teacupful is poured in; the soil is then replaced and hilled up around the stem. This treatment should be applied soon after the plants are set out and repeated once a week for five weeks. This substance is a deadly poison and must be used with the greatest care; also it should not be brought in contact with anything of metal but put into wooden or crockery vessels. Cyanide of potassium may be used in the same proportions, but is more expensive at the present time. A decoction of pyrethrum insect powder or white hellebore, using quarter of a pound to a gallon of water, has been found effective and is not a dangerous poison as far as human beings are concerned.

Preventive measures are less troublesome and usually more effective. One of the best is the screening of newly set-out cabbages and cauliflowers with cheesecloth. Light frames of slats are made 8 feet long, 2 wide and 2 high; over these is tacked cheesecloth which should reach to the ground on all sides, and be prevented from blowing about by heaping a little earth on the edges. These frames cost very little and can readily be moved when required and stowed away for future use; they should be put on as soon as the plants are set out and left until they are well-grown. The frames not only prevent the flies from laying their eggs on the plants, but also keep off the other insects which are liable to attack them.

Another method of protection, which is now largely employed and is found very effective, is the use of tarred felt paper discs, which are placed around the stems of the young plants when they are being set out. These discs should be made of one-ply paper, not of the thick tarred building paper. For garden purposes the paper may be cut into three-inch squares, with a slit running to the centre, but for field crops it is worth while to procure a tool for cutting the paper into hexagons with a slit to a star-shaped cut at the centre. The discs should be carefully fitted to the stem so as to leave no space for the deposit of eggs by the fly, and should be pressed flat upon the ground. The time and labor required for making and applying these protectors are inconsiderable, and their adoption has proved to be a great success.

In the case of this and other root-infesting maggots, it is important that the same kind of plant should not be grown where an attack has occurred during the previous year, and that all refuse should be removed and destroyed after the crop has been gathered in.

CARROTS.

The Black Swallow-Tail Butterfly (*Papilio asterias* [*polyxenes*])—(Fig. 27). There may often be found feeding on the foliage of carrots and parsnips a handsome velvety green caterpillar ornamented with bands of yellow. This is the larva of one of our largest and most beautiful butterflies, black in color, ornament-

Fig. 27.—Black Swallow-tail Butterfly.

ed with rows of bright yellow spots. The caterpillars do not feed in colonies and consequently are not often injurious, the amount of foliage consumed by an individual seldom affecting the vitality of a plant. Being conspicuous, they may, if sufficiently numerous to require repression, be picked off by hand and crushed under foot. They are kept in check, however, by a large parasitic fly, which lays an egg on a caterpillar from which hatches out a grub that feeds within the body of its host until the chrysalis is formed, and then completes its work by devouring all that remains, a fly with four clear membraneous wings coming out instead of the butterfly.

THE CARROT RUST-FLY (*Psila rosae*)—*Fig.* 28)—is a much more serious enemy to the plant than the preceding species. It is a comparatively recent importation from Europe, having been first observed in this country about thirty-five years ago. It is a great pest in the Maritime Provinces, but so far is only locally found in Ontario. Its attack may first be noticed in spring when the leaves of young carrots turn reddish, and on examination the roots will be found covered with rusty blotches—hence the name of the insect. The parent of the mischief is a small two-winged fly, quarter of an inch long, body dark green, head and legs pale yellow and the eyes red. From the eggs, which are laid on the stem below the surface of the ground, the young maggots make their way into the root, and tear the tissues in a similar manner to the cabbage maggot described above; the attack causes the rusty blotches to appear. The maggots of a later brood infest the full-grown roots and continue their work of destruction in the root-house during the winter. Celery and parsnips are also attacked.

Preventive measures seem to be the only remedies available. To deter the fly from laying her eggs, the rows of young carrots, when ready for thinning out, should be sprayed with kerosene emulsion, or dusted with sand or plaster in

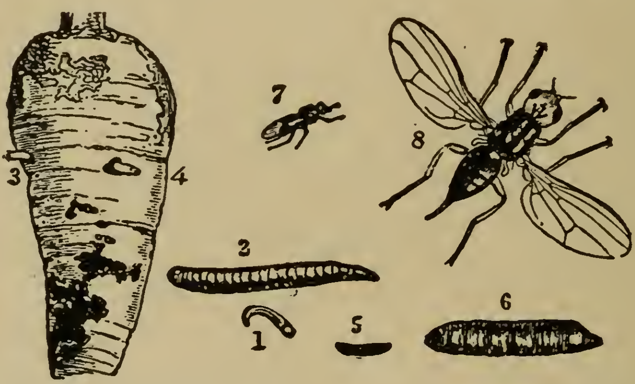


Fig. 28.—Carrot Rust-fly: 1, 3, 4, 5, 7, natural size; 2, 6. 8, enlarged.

which coal-oil is mixed, half a pint being used to a pailful of the material. The application should be made weekly, and especially after hoeing, until about the middle of July.

In gardens where carrots are grown for table use and size is not an object, late sowing is found to be advantageous, the plants thus escaping the egg-laying of the fly. Repeated sowings a week or so apart, will secure the freedom of some of the crops from attack. The plants should not be grown two years running on the same piece of ground. Stored roots, if found affected in the winter, may be treated with carbon bisulphide, one ounce to 100 lbs. of roots, placed in pans on top of the pile, provided that they are in fairly air-tight bins. They should be left for 48 hours and then exposed to the air in order to get rid of the fumes, which are very inflammable; no light or fire should be anywhere near when this substance is being employed.

CELERY.

Celery, as a rule, is not much affected by injurious insects; those that do attack it are the same as the enemies of carrots and parsnips, to which reference is elsewhere made. The handsome caterpillars of the Black Swallow-tail Butterfly (*Papilio asterias*) may often be found eating the foliage, but they are never very numerous and can easily be controlled by handpicking. A small caterpillar called the Celery Leaf-Tier (*Phlyctaenia ferrugalis*) is sometimes abundant and injurious; it feeds for the most part at night; when young it eats small holes in the leaves which are hardly noticeable, but as it grows larger it becomes more voracious and consumes a considerable amount of foliage. When fully grown it rolls up a leaf and ties its edges together with silk, forming thus a convenient case in which to pass the chrysalis stage. The moth is about three-fourths of an inch in expanse of wings, pale brown in color with a reddish suffusion; the wings are marked with irregular cross lines of black and some circular spots. There are at least two broods in the year. The insect is sometimes known as the Greenhouse Leaf-tier from its attacking a variety of hot-house plants; out-of-doors it by no means confines itself to celery, but may be found on a great variety of vegetables. As soon as the caterpillars are noticed the plants attacked should be sprayed with Paris green, applied to the underside of the leaves. In the greenhouse any infested leaves should be cut off and destroyed.

One of the most serious enemies of celery is the Rust-fly described among the insects affecting carrots. The maggots attack the thick part of the roots of young celery plants and prevent their proper growth; they also produce the characteristic rusty blotches on the stems and spoil them for table use.

CORN.

The insect enemies of Indian Corn are legion, and may be found attacking every part of the plant, root and stem, leaves and ears, the tassel and silk, and the ripe harvested corn; about 350 different species are recorded from North America. Happily a large number of these insects are not found in Canada, and many others are only of occasional occurrence; it is, therefore, unnecessary to describe more than a few species which are always with us and against which constant warfare has to be waged.

Attacking the roots we find White-grubs and Wire-worms very destructive, especially where corn is planted on old pasture land broken up a year or two before. These insects have already been described. Another serious enemy is the Corn Root-aphis, which is attended by its ant protectors; it is especially injurious to the plants when young. The winged forms migrate to various common weeds such as plantain, pigweed, etc., showing the importance of keeping fields and gardens free from these places of refuge.

As soon as the tender blades of corn appear above the soil they are liable to be cut off by those nocturnal marauders, the Cutworms, which can be circumvented by the use of the poisoned bran-mash. The grubs of the 12-spotted Cucumber beetle often infest the roots of corn when the plants are young, and a great deal of loss is occasioned by them. Later on, as the plants grow bigger, they may be attacked by Grasshoppers and seriously injured.

The Corn Stalk-Borer (*Papaipema nitela*)—(Fig. 29)—is an occasional destroyer of the plant. The caterpillar, which grows to an inch and a half in length, lives inside the stem and devours all the interior to such an extent that the plant withers and dies; when approaching maturity the worm works its way down to the root and there changes to the chrysalis stage. The moth, which is fawn-colored and has the front pair of wings crossed by a pale curved line, comes out in the autumn and lay her eggs on the stems of a variety of plants as well as on the corn. The caterpillar is known to infest the tomato, potato, dahlia, and many other cultivated plants as well as many kinds of weeds. The only remedy seems to be clean cultivation and the destruction in the fall of all stems and roots of plants which are likely to have eggs laid upon them. Being an internal feeder

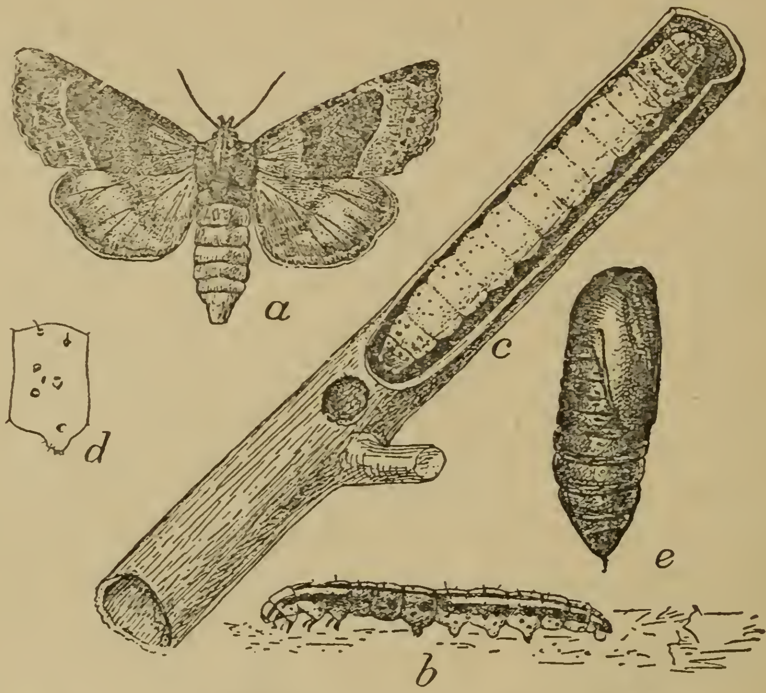


Fig. 29.—Corn Stalk-borer: (*a*) moth, (*b*) half-grown caterpillar; (*c*) mature larva in stalk; (*e*) pupa. (*Chittenden, U.S. Dept. Agric.*)

there is no way of poisoning the caterpillar, and usually its presence in a stalk is only known by the premature withering of the plant.

The Corn Ear Worm (*Heliothis armiger*)—(Fig. 30)—is another general feeder, which includes corn in its attacks. In the south it is the notorious "Boll-worm" which is so destructive to cotton; here it attacks tomatoes and a few other

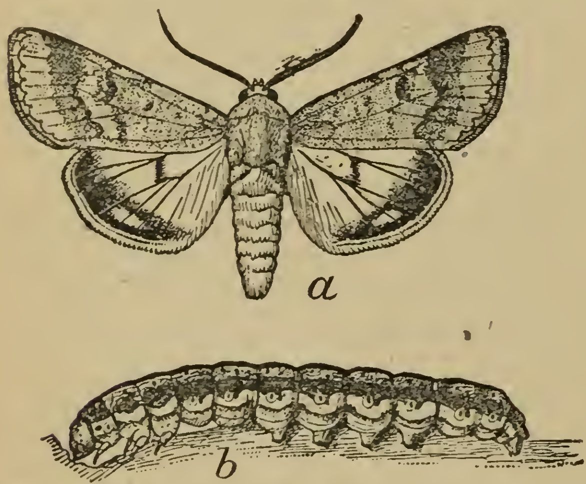


Fig. 30.—The Corn-Ear Worm: (*a*) moth; (*b*) caterpillar.

Fig. 31.—Chinch-bug, greatly magnified.

plants as well as corn. The presence of the caterpillar is first made known by small holes to be seen in the leaves enveloping the growing ear; on investigation the worm will be found devouring the milky grains and spoiling the ear by its excrement and the rot which usually sets in; sweet corn is especially liable to be spoilt by this attack. Any ear that is seen to be affected should be opened and the caterpillar destroyed; this seems to be the only thing that can be done. The moth is a handsome creature, ochre yellow in color, with darker bands across the wings, which measure an inch and a half when expanded. With us there is but one brood in the year, and much may be done to keep the insect in check by clean cultivation in the fall of the year.

In the great corn-growing States to the west and south the crop is very seriously injured year after year by the CHINCH-BUG (Fig. 31), a small black bug, with a white mark on each side of the wings. As it appears in millions, these hosts inflict an enormous amount of damage by sucking out the juices of the plant. We are fortunately free from this pest in Canada, though occasionally a colony has been found in Ontario.

CUCUMBER, MELON AND SQUASH.

CUCUMBER BEETLES. The Striped (*Diabrotica vittata*)—(Fig. 32)—and the Spotted (*D. 12-punctata*)—(Fig. 33). The former of these insects may be found all through the season on cucumbers, melons, squashes and pumpkins from

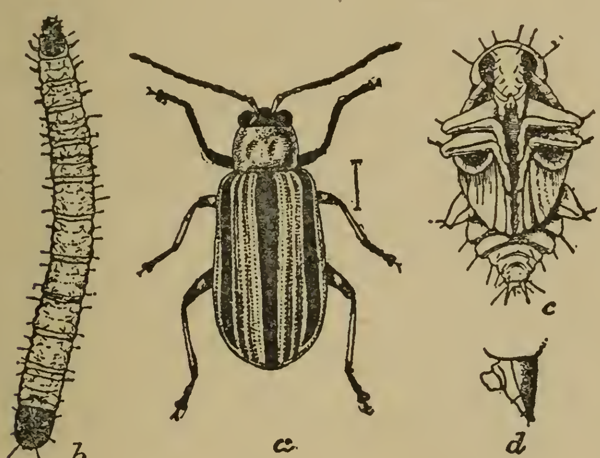


Fig. 32.—Striped Cucumber-beetle, grub and pupa, much enlarged.


Fig. 33 Spotted Cucumber beetle, somewhat enlarged.

the time that the plants are first set out till the frost destroys the foliage in the autumn. The beetles hibernate in the adult stage and are ready to attack the seedling plants as soon as they appear above the soil; oftentimes they are sufficiently numerous to kill the tender plant by eating the leaves and gnawing the stem; later on they may be found in the flowers, where, however, they seem to feed on the nectar and not to do much harm. The beetle is less than half an inch in length, oval in shape, yellow in color, with a black head and three black stripes down the back. The larvæ are slender white grubs which feed upon the roots of the plants and sometimes burrow up into the stem, continuing their injuries for about a month, when they change to the pupal stage and later on come out as a second brood of the beetles. The latter are very lively insects, flying quickly from plant to plant when disturbed; sometimes when their usual food is not available they attack the young pods of peas and beans, and may be found on a variety of other plants.

The Spotted Cucumber Beetle (Fig. 33) is larger than the Striped, and less oval, broadening considerably towards the posterior end of the body; its color is yellowish green, with a black head and three rows of four black spots, making twelve in all, on the wing-covers. It is a more southern insect than the Striped beetle, and in many parts of the United States it does serious injury to the roots of corn. In Ontario it is usually found associated with the other species on cucurbitaceous plants, but in fewer numbers; it is also a much more general feeder, attacking a great variety of plants; its life history is somewhat similar to the preceding, but it seems to feed mostly upon the pollen of blossoms in the beetle stage, the grubs being the chief cause of injury by their attacks upon roots and stems.

The treatment for both these insects is chiefly preventive. Young cucumber and melon plants should be protected as soon as they are set out with the cheese-cloth screens described as a protection against Flea-beetles, or by smaller screens made with two flexible sticks crossed at right angles and with their ends securely fixed in the ground, and then covered with a piece of cheesecloth, which can be kept from being blown about by heaping a little earth on the edges. These screens may be safely removed when the plants have grown too big to be covered by them. Another plan is to grow a few squash plants earlier than the others so as to attract the beetles to them, and then treat them with Paris green, one pound mixed with 50 lbs. of lime or plaster; this may be dusted over the plant when the beetles congregate upon it. In the autumn all the refuse of the vines should be gathered up and either burned or buried in a compost heap, so as to kill the hibernating beetles. Spraying the young plants with poisoned Bordeaux mixture has also been found effective.

The Squash-Bug (*Anasa tristis*)—(Fig. 34). This insect is usually very abundant and injurious through all the south-western counties of Ontario, but during the last few years it has almost entirely disappeared. It will not be long before it again becomes numerous and troublesome. The bugs are much larger insects than the beetles described above, being nearly three-quarters of an inch in length, of a dirty blackish color above and speckled creamy beneath; they have the usual repulsive odor common to the "stink-bugs," to which family they belong. Late in autumn the bugs may be found in all sorts of places, crawling about in search of winter quarters, and should then be crushed under foot. In the spring they come out, and begin their injurious work of sucking out the juices of young cucurbitaceous plants. The eggs, which are metallic in color, are laid in batches on the underside of the leaves near the base of the plant; from them soon hatch out the young bugs, but not all at once, so that we may find nymphs of all sizes on the underside of the same leaf. They not only injure the foliage by sucking out its juices, but also poison it as well, causing a speedy wilting of the leaves they attack. If any withering leaves are observed they should at once be inspected, and if a colony is found at work it can soon be exterminated by crushing under foot.

These bugs are difficult to get rid of, as the usual remedies for sucking insects, kerosene emulsion, for instance, have but little effect upon them, except when applied to the colonies of young nymphs. The methods recommended above for Cucumber Beetles are also the best remedies for these disagreeable insects. In the early part of the season the parent bugs may be trapped by laying pieces of shingle or board near the plants; the bugs will be found taking shelter under them in the morning, and can easily be destroyed.

Flea-Beetles, described above, are often very injurious to young cucumber and melon plants, and also a species of Aphis. Occasionally the fruit is attacked when green by small caterpillars, one called the Pickle-worm (*Diaphania nitidalis*) and the other the Melon Caterpillar (*D. hyalinata*); both turn into beautiful little moths. In the south they are regularly injurious year after year, but with

Fig. 34.—Squash-bug: (*a* to *e*) nymphs in different stages of growth; (*f*) adult bug, much enlarged.

us, happily, they are quite rare; should they become numerous at any time they could be easily controlled by the use of arsenical poisons.

ONION.

The Onion Maggot (*Phorbia ceparum*)—(Fig. 35)—is very similar in mode of attack and life-history to the Cabbage Maggot already described; it is unnecessary, therefore, to repeat these particulars. It is often extremely destructive, and has almost driven market gardeners to despair. The preventive measures referred to above are hardly suitable for a plant whose style of growth is so different from that of a cabbage, and few persons would take the trouble to protect onion beds with cheesecloth screens, nor could tarred paper disks be employed. There is, however, a simple method of protection which has been found effective; as soon as the tiny shoots of the onions begin to appear above the soil, the rows should be treated with a whitewash made of lime and water and thick enough to form a thin crust over the surface. The effect of this is to close up all crevices and openings in which the parent fly would lay her eggs, and prevent the maggots which may hatch from any eggs laid above ground from reaching the roots beneath. The young plants penetrate through the thin crust of lime without difficulty.

Another method, which is even better, is the employment of a poisoned sweet bait to kill the flies before they lay their eggs. It is made by dissolving five grams of commercial sodium arsenite in a gallon of boiling water, and adding one pint of cheap molasses. The mixture should be applied along the rows in the form of a coarse spray of large drops once a week throughout the summer. A watering can with a finely perforated nozzle could be employed.

When hoeing, any plant that is not growing satisfactorily should be cut out and crushed underfoot so as to destroy the maggots. Furthermore, onions should not be grown a second time on, or close to, a bed which has been infested with these insects. Pyrethrum insect powder or white hellebore may be applied in the same manner as recommended for the Cabbage Maggot. Many other substances, such as salt, plaster, Paris green, etc., have been tried without any satisfactory results. When taking up the onions in the fall any bulbs infested by maggots should be carefully destroyed.

PARSNIP.

The Parsnip Webworm (*Depressaria heracliana*). When parsnips are left in the ground all winter and allowed to grow up for seed-bearing purposes during the following season, they are very liable to be attacked by this insect. Towards the end of June, when the stems are tall and bear fine umbels of flowers, it is often found that the bloom is disfigured with webs which draw the whole into an untidy mass, and on examination a colony of small caterpillars will be found at work within. When they have finished consuming the flowers, they burrow into the stem and feed upon the soft inner lining; here they change to the chrysalis stage during the latter part of July, and are often so numerous that the hollow stems will be found packed with larvæ or pupæ. The caterpillars are of a dirty green color and yellowish on the sides and beneath; most of the segments are furnished with shining black warts, each of which terminates in a fine bristle. The moths come out about the first of August and hibernate in any shelter that they can obtain, often coming into houses for the purpose; they are dusky gray in color, with no conspicuous markings, and with the body much flattened; the expanse of the wings is less than an inch, and the length of the body under half an inch. The insect is a European species.

These caterpillars may be found in abundance working in a similar manner on celery plants that have grown up for seed and on wild carrot and other umbelliferous plants. In the garden they should be treated with Paris green as soon as they are noticed; if the umbels are drawn into a web they should be cut off and burnt, and if the stalks are perforated the same operation should be performed on them. Wild carrots and parsnips should be cut down wherever they may be found in neighboring fields or waste places.

Parsnips are also attacked by the insects already mentioned in connection with carrots and celery.

PEAS.

The Pea-Weevil (*Bruchus pisorum*)—(Fig. 36). The life history of this insect resembles in many respects that of the Bean-weevil, already described. The beetle is about one-fifth of an inch in length, brownish-gray in color, with two conspicuous oval black spots on the end of the abdomen which is not concealed by the wing-covers. The head is bent under the front of the body and ends in a square-cut beak. When peas are in blossom these little beetles may be found upon them, waiting for the young pod to be disclosed; on it the minute eggs are laid, and the grubs, as soon as hatched, bore through and enter the small green peas, one beetle only infesting a single pea. Here the grub remains, feeding upon the substance of the pea, passing through the pupal stage, and only attaining maturity

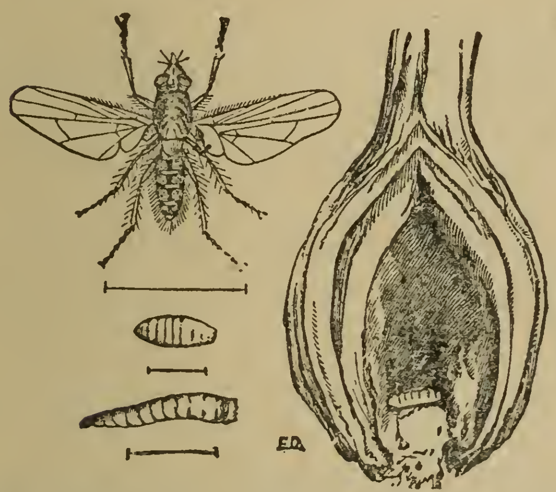


Fig. 35.—Onion maggot: puparium, fly and infested bulb.

Fig. 36.—Pea-weevil, natural size and much enlarged.

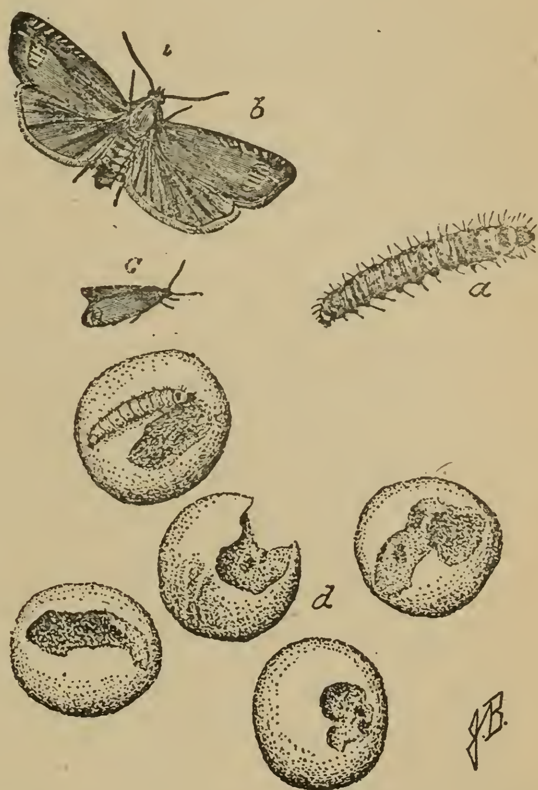


Fig. 37.—Pea-moth and caterpillar; moth greatly enlarged and natural size; infested peas.

when the peas are ripe and ready for harvesting. Most of the beetles remain inside the peas until they are sown the following spring, but some emerge when the peas become ripe, and remain in the field or in the barn all winter. Unlike the Bean-weevils, this species does not increase and multiply in the stored peas, but will die if they are kept over for another year.

Treatment. The pea crop should be harvested early, a little on the green side, so that the pods will not shell out before removal from the field; threshing should be done as soon as possible, and all refuse from the machine should be swept up and burnt. If any weevils are noticed in the peas, the crop should be put into bins or barrels and fumigated with carbon bisulphide in the manner recommended for the Bean-weevil. Peas that contain weevils, even though they are dead, should not be sown, as the plants grown from them will be stunted owing to the lack of food material in the pea; a considerable proportion would probably not grow at all, owing to the germ having been devoured by the beetle. The remains of the crop not taken from the field should be raked up and burnt. If every pea-grower would adopt these methods we should soon be rid of the pest, as the beetle does not attack any other plant.

The Pea Moth (*Semasia nigricans*)—(Fig. 37)—is not often found in Ontario, but is very common and at times extremely destructive in the Maritime Provinces; its occasional occurrence with us renders it necessary to be on our guard against it. The parent moth is small, less than half an inch in expanse of wings, and of a dull, slaty-gray color. It lays its eggs on the growing pods of peas; the caterpillars soon hatch out and bore their way into the pod, where they feed upon the young peas, consuming many of them and filling the space with a mass of excrement. When full grown the worms leave the pods and form their small oval cocoons below the surface of the ground.

Where there is reason to expect an attack, the pea vines should be sprayed, as soon as blossoming is over, with a liquid wash of one pound of soap in twenty-five gallons of water in which has been thoroughly mixed four ounces of Paris green; the spraying should be repeated a couple of times at intervals of a week or ten days. The object is to poison the young caterpillars when they are eating their way through the pod.

Sowing early varieties as early as possible in the season has been found useful, the pods being too far advanced to be injured when the worms appear. Very late sowing is also recommended in order that the blossoming may not take place till after the moths have ceased egg-laying.

An important point is to plow or dig deeply in the fall any piece of land where infested peas have been grown, in order to bury the cocoons and prevent the moths coming out in the spring. All unripe pods should be burnt, as they may contain worms, and peas should not be grown again upon or near the same piece of ground the next season.

The Pea Aphis (*Nectarophora destructor*). This large green plant-louse during recent years has become extremely destructive to the vines of peas. In some parts of the neighboring States, where large acreages were devoted to this crop for canning purposes, the annual loss was estimated at many millions of dollars, three-fourths of the crop being in some instances destroyed. The usual remedies for plant-lice have already been referred to under "Aphis," but they are of little value when contending with an attack on a very large scale. A method that has been found effective is to sow the peas with drills and wide enough apart for a cultivator to work between the rows, instead of the usual broadcast plan. As soon as the plants are seen to be infested, boys are employed to brush the insects off, and they are followed at once by the cultivator, which buries the lice and prevents their getting back on the vines. The operation has to be repeated a few times, but the results have proved entirely satisfactory and to warrant the labor and expense.

POTATO.

The Colorado Potato Beetle (*Leptinotarsa decemlineata*)—(Fig. 38)—is so familiar to everyone that it is hardly necessary to give any description of the destructive creature. The adult beetles come out of their winter hiding places about the end of May and feed at once upon the earliest appearing potato plants; soon after this the females lay their bright orange-colored eggs on the underside of the leaves in batches of various numbers up to fifty or more. The grubs hatch out in about a week and set to work to devour the foliage; their dark orange color renders them somewhat conspicuous, so that an attack can hardly fail to be noticed. When fully grown the insect changes to the pupal stage in a cell a few inches below the surface of the ground. A period of about eight weeks is required to complete a life cycle, and then a second brood of beetles appears, lays its eggs and starts new colonies of grubs; the third brood comes out in September and may be observed crawling or flying about in search of winter quarters. The broods are by no means distinct, as all the grubs do not mature at the same time, consequently the insect may usually be found in all its stages at any time during the summer.

The well-known and long-tried remedies are Paris green or arsenate of lead combined with Bordeaux mixture, the latter ingredient assisting in warding off the attacks of fungus diseases and also in destroying Flea-beetles, when they are

Fig. 38.—Colorado Potato-beetle.

present, as they commonly are. Spraying should be done early in June as soon as any grubs are to be seen, again a month later, and three times, at intervals of a fortnight, between the end of July and the first of September.

The Three-Lined Potato Beetle (*Lema trilineata*)—(Figs. 39 and 40)—looks very like the Striped Cucumber Beetle, but is larger and of a darker yellow color. Before the coming of the Colorado beetle this was the chief insect enemy of the potato, but now, though common, it is not usually particularly destructive; its life history is much the same, the adult beetle coming out in the spring and laying her eggs on the underside of the leaves of the young plants; these are yellow in color and are laid along the midrib of the leaf. The larvæ have the extraordinary habit of piling their excrement on top of their backs, possibly as a protection against their enemies, and thus present a disgusting appearance. The grubs appear in June and go through their transformation in time for another brood to come forth in August; the beetles from this later brood do not emerge till the following spring.

When this insect is at all abundant, it can be easily controlled by the application of Paris green; the measures everywhere taken to check the Colorado Beetle have no doubt prevented this species also from becoming numerous.

THE POTATO FLEA-BEETLE (*Epitrix cucumeris*) is one of the most serious pests of the potato plant. The tiny creature—it is less than one-twentieth of an inch long—eats small holes all over the surface of the leaves and causes much injury in this way; but a worse result is that the spores of a fungus disease called "Blight" find a suitable place in these holes for germination and the complete destruction of the leaf soon follows. Flea-beetles as a class have already been

Fig. 39.—Three-lined Potato-beetle.

Fig. 40.—Three-lined Potato-beetle; eggs, larva and pupa.

referred to; it is unnecessary, therefore, to do more than state that spraying with Bordeaux mixture is a satisfactory remedy for both the insect and the Blight.

BLISTER BEETLES are often reported from the northern parts of the Province as appearing suddenly in great swarms in the potato fields and greedily devouring the foliage. An account of them has already been given under insects attacking beets and spinach.

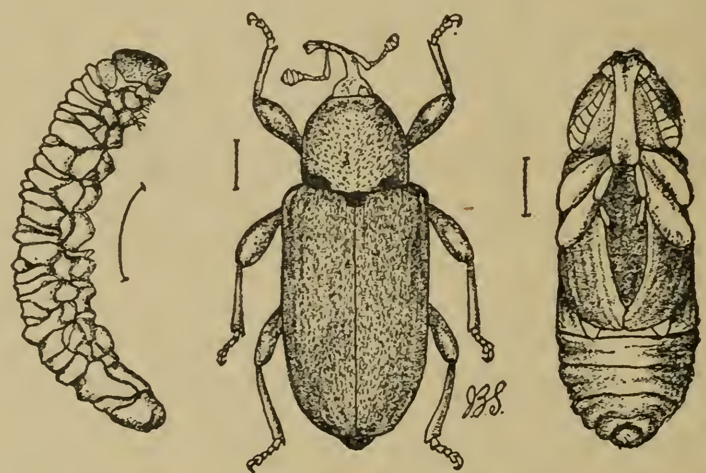


Fig. 41.—Potato-stalk Borer: beetle, grub and pupa.

THE POTATO STALK BORER (*Trichobaris trinotata*)—(Fig. 41)—is only an occasional cause of injury to the plant in this country, but in some of the States to the west and south it is considered almost as great a pest as the Colorado Beetle. As the name indicates, the attack is made by boring the stalk; this is done by the grubs, which are whitish in color and without legs. The small beetles, about a quarter of an inch long, are ashen-gray in color and belong to the family of weevils or snout beetles, having the head developed into a long beak; the base of the wing-covers is marked with three distinct black spots, which readily distinguish it from similar species. About the month of June the parent makes a hole in the stalk of the potato with its snout and deposits an egg and repeats the operation a number of times. The grubs which hatch from them burrow up and down in the stalks, devouring the interior, and when full-grown, about the beginning of September, form their chrysalis inside the stalk near the base of the plant; the beetles emerge later on, but remain in this retreat all winter.

No application of poison is of any avail, as the grubs are out of reach in the stalk, but much may be done to exterminate the insect by cleaning up and burning all the remains of the plants after the potatoes are dug in the fall; this is advisable also in order to destroy the germs of fungus diseases.

RADISH.

Radishes are very liable to attack and serious injury when they first come up in the seed beds by the minute Flea-beetles described among the insects that are general feeders; cheesecloth screens are found to be the best protection. The Radish Maggot (*Phorbia*) is the same or a very closely allied species to that which attacks the roots of cabbages, and may be treated in much the same way; protection with cheesecloth is by far the simplest and an entirely effective method of securing perfect radishes in the spring.

TOMATO AND TOBACCO.

These two plants may be associated together, as the same insects are liable to attack both; but it is highly probable that the growth of tobacco on a large scale

Fig. 42.—Tomato worm.

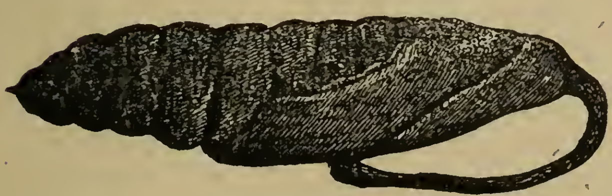


Fig. 43.—Chrysalis of Tomato worm.

Fig. 44.—The Turnip Flea-beetle and larva, greatly enlarged.

in the south-western counties of Ontario will cause other enemies of the latter plant to make their unwelcome appearance. Cutworms early in the season are very destructive to the young plants, but may be warded off by the use of the poisoned bran-mash. The leaves are liable to be attacked by Flea-beetles, the Tarnished Plant-bug and Grasshoppers. The most conspicuous enemy of both plants is:

The Five-Spotted Hawk Moth, or Tomato Worm (*Protoparce celeus*)—(Figs 42 and 43). This is a large caterpillar, attaining to a length of nearly four inches when fully grown and correspondingly thick. It has a series of oblique pale lines along the sides and a prominent tail; in color there are three varieties, pale green, dark green and almost black. They are very voracious feeders, and soon strip the foliage from a plant; but being so conspicuous they can be readily got rid of by hand picking. When growth is completed, the caterpillars burrow into the earth and form a cell in which they transform to a dark brown chrysalis, which has attached to the head and underside of the thorax a projection resembling the handle of a jug and containing the enormously long sucking tube with which the moth is provided. The moths come out in the autumn if the weather should be warm, otherwise they do not appear till the following summer. They are large, handsome, swiftly flying creatures, ashen-gray in color with a variety of paler and darker lines and markings; the abdomen is ornamented with five large orange spots on each side which give the insect a very characteristic appearance. These Tomato Worms have often been supposed to be poisonous, and many marvellous tales have been told of their deadly stings and bites; they are, however, quite incapable of either stinging or biting, and may be handled without the least danger.

The Corn Ear Worm (*Heliothis armiger*), which has been fully described above, frequently attacks green tomatoes before they are fully grown, and bores large holes which utterly destroy the fruit. It also feeds on tobacco, eating into the unripe seed capsules and devouring the contents. In the case of tomatoes the only plan seems to be to cut off and destroy all the infested green fruit. Where tobacco is extensively grown, if there should be an annual attack of these caterpillars, it would be advisable to grow a strip of corn as a "trap-crop" along the sides of the field; the moths would lay their eggs on the young ears of corn in preference to the tobacco plant, and these could be gathered and burnt or fed to pigs before the worms attain to maturity.

Turnips.

Turnips are attacked by several of the insects already described as enemies of the cabbage, viz., the Zebra Caterpillar, the Diamond-back Moth, the Cabbage Maggot, and the same species of Plant-louse (Aphis). The last mentioned insect has been more complained of recently by turnip growers than any other pest; its ravages in late summer and autumn are widespread over the Province, when there is prolonged dry, warm weather, which is favorable to their increase, and in many cases whole fields are rendered worthless. The usual remedies, kerosene emulsion and strong soapsuds, are found effective when applied in time; but in most cases the attack is not noticed till the damage is beyond repair. Much may be accomplished by keeping a sharp look-out for the colonies of plant-lice when hoeing is being done; an affected plant should be at once cut out and the lice crushed under foot; early measures of this kind will prevent a serious infestation later on.

The Turnip Flea-Beetle (*Phyllotreta vittata*)—(Fig. 44)—differs from our other species in having a wavy, yellowish stripe down each side of the wing-covers, but its habits are much the same as those of the rest of the family. Its attacks on the young plants when they first come up are often very serious and prevent the growth of a large proportion of the crop, necessitating a resowing. As the first brood of beetles disappears toward the end of June, it has been found that turnips sown during the third week of that month escape attack, and produce as good a crop as those sown earlier. When the beetles are observed to be attacking the young plants they may be got rid of by dusting with Paris green and land plaster, one pound of the poison to twenty of the plaster; this should be done when the plants are moist with dew in the early morning. A condition of the soil which induces rapid and vigorous growth is of great importance, as it enables the young plants to get beyond the danger point before much injury has been sustained.

INSECTICIDES.

Paris Green and Bordeaux Mixture.

Four pounds of fresh lime, 4 pounds of bluestone, and 4 ounces of Paris green, thoroughly mixed in 40 gallons of water. In all cases where spraying with Paris green is recommended in the foregoing pages it is advisable to add the bluestone (or Bordeaux mixture) in order to counteract fungus diseases at the same time as the insects are destroyed. The bluestone (copper sulphate) should be dissolved by suspending it in a wooden vessel containing 4 or 5 gallons of water, and the lime slaked in another vessel; if lumpy, the lime should be strained through coarse sacking. Pour the bluestone solution into a barrel and half fill with water; dilute the slaked lime to half a barrel and mix the two together. The Paris green should be made into a paste with warm water, poured into the barrel and stirred thoroughly. The mixture is then ready for use. The addition of the lime prevents the poison from scorching the foliage.

For garden purposes one teaspoonful each of Paris green and lime in a pail of water may be used.

Arsenate of Lead.

Arsenate of soda	10 ounces.
Acetate of lead	24 ounces.
Water	150-200 gallons.

"The arsenate of soda and the acetate of lead (sugar of lead) should be dissolved separately and then poured into a tank containing the required amount of water. A white precipitate of lead arsenate is immediately formed, and when thoroughly stirred is ready for spraying. Its finely divided condition keeps it in suspension for hours and thus simplifies the work of spraying. The preparation may be used several times stronger without the least danger of scorching the most delicate plants. When sprayed upon the foliage it forms a coating which adheres so firmly that it is but little affected by ordinary rains." (Bulletin 154, Harcourt and Fulmer). For use in small quantities, one tablespoonful of the paste arsenate is enough for one gallon of water.

Kerosene Emulsion.

The following is the formula recommended by Dr. Fletcher (Central Experimental Farm, Bulletin No. 52):

Kerosene (coal oil)	2 gallons.
Rain water	1 gallon.
Soap	½ pound.

Boil the soap in water till all is dissolved; then, while boiling hot, turn it into the kerosene and churn the mixture constantly and forcibly with a syringe or force pump for five minutes, when it will be of a smooth, creamy nature. If the emulsion is perfect, it will adhere to the surface of glass without oiliness. As it cools it thickens into a jelly-like mass. This gives the stock emulsion, which must be diluted with nine times its measure of warm water before using on vegetation. The above quantity of three gallons of emulsion will make 30 gallons of wash.

Kerosene emulsion may also be made conveniently by using an equal amount of sour milk instead of the soap and water in the above formula, and churning for the same time to get the stock emulsion.

Another method is to use lime, which will hold the kerosene in suspension, or the following, where lime cannot be obtained:

The requisite amount of kerosene is placed in a dry vessel and flour added in the proportion of 8 ounces to one quart of kerosene. It is then thoroughly stirred and two gallons of water added for every quart of kerosene. The whole is then vigorously churned for from two to four minutes, and the emulsion is ready for use. It has been found that by scalding the flour before adding the kerosene, an excellent emulsion, which does not separate in the least after standing for a week, can be prepared with 2 ounces of flour, by mixing the resulting paste with one quart of kerosene and emulsifying with two gallons of water.

TOBACCO WASH. (For destroying Aphids). Soak 4 pounds of tobacco waste in 9 gallons of hot water for four or five hours (in cold water for four or five days); dissolve one pound of whale-oil soap in one gallon of hot water; strain the decoction into the dissolved soap and apply with a spray pump as forcibly as possible. "Black Leaf 40" and "Nicotine" are very satisfactory commercial preparations, which can be obtained at the large seed-stores, with directions for use. When added to a soap-wash they are very effective.

SOAP WASHES.

Dissolve one pound of whale-oil soap in four gallons of warm water for black or brown Aphis, and one pound in six gallons for green Aphis.

Another remedy for Aphis is the following: Boil 8 pounds of quassia chips in 8 gallons of water for an hour, dissolve 7 pounds of whale-oil soap in hot water; strain the quassia decoction and mix with the soap solution; then dilute to make 100 gallons. Spray forcibly while hot; this will kill the plant-lice and not injure the plants.

COOK'S CARBOLIC SOAP WASH.

Hard soap, one pound, or soft soap	1 quart.
Crude carbolic acid	1 pint.
Water (boiling)	1 gallon.

Dissolve the soap in the boiling water; while still hot add the carbolic acid; emulsify thoroughly. This is the stock solution. For use, dilute with 30 to 50 times its bulk of water. Very effective against root-maggots of cabbage, radish and onion.

HELLEBORE.

White hellebore (fresh)	1 ounce.
Water	2 gallons.

PYRETHRUM OR INSECT POWDER.

Pyrethrum powder (fresh)	1 ounce.
Water	3 gallons.
Or,	
Pyrethrum powder	1 ounce.
Flour (cheap)	5 ounces.

Mix thoroughly, allow to stand over night in a closed tin box, then dust on plants through cheesecloth.

THE POISONED BRAN MASH.

For Cutworms and Grasshoppers.

Bran	20 pounds.
Paris Green	1 pound.
Molasses	½ gallon.
Water	About 2 gallons.
Lemons	2 or 3 fruits.

Mix thoroughly the bran and Paris Green dry in a tub or any large receptacle. This may be done the night before. On the morning of using squeeze the juice of the lemons into the water, run the pulp and rind through a meat chopper, and add this and also the molasses to the water. Stir well, and then pour the liquid upon the poisoned bran, and mix so thoroughly that every part is moist and will fall like sawdust through the fingers.

For cutworms in small gardens use one quart of bran, one teaspoonful of Paris green, one tablespoonful of molasses, with enough water to moisten the bran.

The mash should be applied in the evening for cutworms, and in the early morning for grasshoppers.

Ontario Department of Agriculture

WOMEN'S INSTITUTES

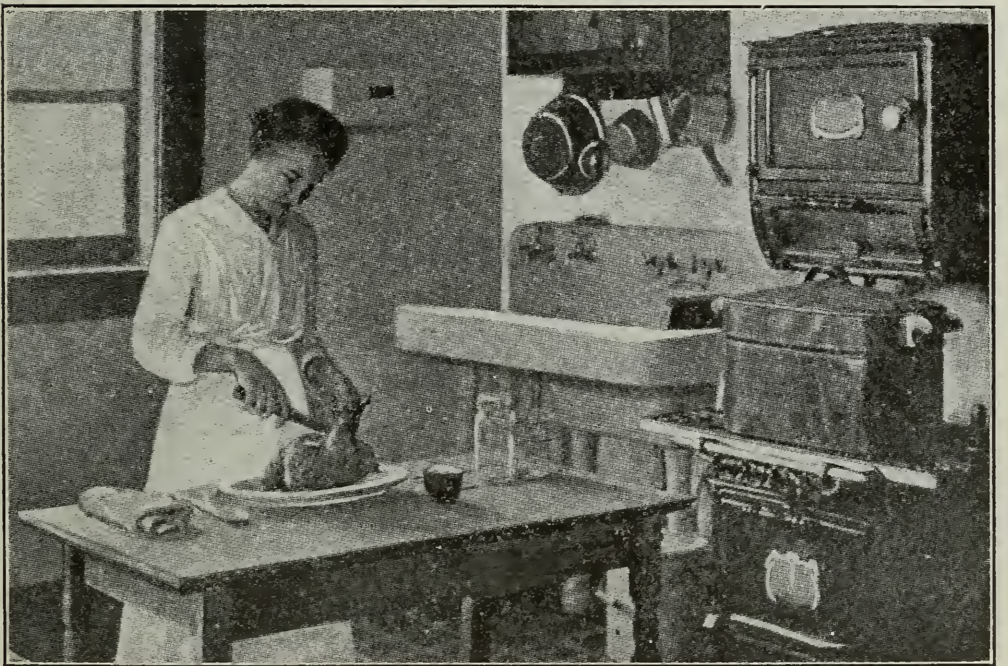
BULLETIN 252

THE PRESERVATION OF FOOD

Home Canning

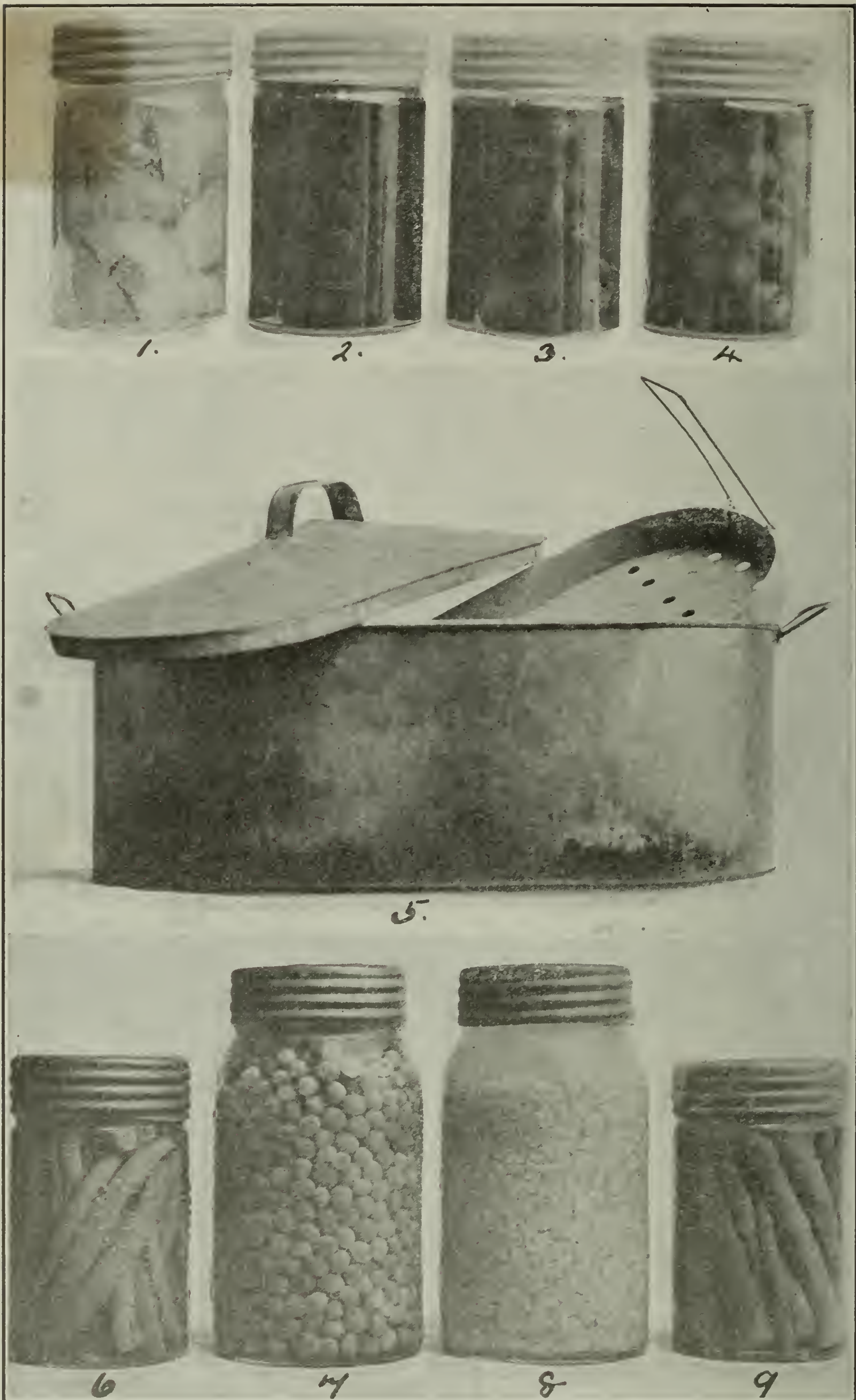
Compiled By
MISS ETHEL M. CHAPMAN

Canned vegetables in good types of jars.



Canning surplus chickens in the Fall.

TORONTO, ONTARIO, JULY, 1917



1. Pint jar of peaches. 2. Pint jar of raspberries. 3. Pint jar of strawberries. 4. Pint jar of cherries. 5. Wash boiler fitted with perforated false bottom, used for sterilizing jars of fruit and vegetables. 6. Pint jar of butter beans. 7. Quart jar of green peas. 8. Quart jar of young corn. 9. Pint jar of asparagus.

BULLETIN 252] [JULY, 1917

Ontario Department of Agriculture

WOMEN'S INSTITUTES

The Preservation of Food

HOME CANNING

IMPORTANCE OF PRESERVING FOOD IN THE HOME.

The urgent need of conserving every ounce of food produced this year makes the matter of preservation in the home of special importance. By the canning or drying of fruits and green vegetables and the proper storing of winter vegetables the waste common in ordinary years can be reduced to almost nothing.

The reason for having a supply of fruits and vegetables the year round, is not merely that they give variety to the diet. Besides the food value of the starch and sugar which they contain their mineral matter and fibrous material give them an important health value. In families where the diet is poor in vegetables and fruits, or where these are abundant for only three or four months of the year, recourse to medicinal help is more frequent.

A garden of from one-quarter to one-half acre will furnish sufficient fresh vegetables for the average family's use during the summer and also a surplus to store or can. The economy of home-gardening and canning of these vegetables is not fully appreciated. If the produce were purchased as required on the open market, the cost would be from \$100 to \$200, and if purchased as canned goods the cost would be considerably more.

Food is going to be scarce this winter. The woman who can find time to preserve food which would otherwise be wasted, and who will sell or give away the surplus above what is required for her own family, will be doing a real patriotic work. Canned fruits, jams and jellies are needed for soldiers in the hospitals and in the trenches. Through the income derived from selling canned products at home markets many women would find a practical way of raising Red Cross funds.

WHY CANNED FRUITS AND VEGETABLES SPOIL.

The two common agents that make fruit spoil are molds and yeasts, two forms of bacteria present in the air, which must be killed by heat in the cooking of the fruit, and from which the fruit after cooking must be protected by having the jars sealed or made air-tight. If a mold spore present in the fruit or jars has not been killed by heat, it will set up a growth of mold spoiling the flavor of the fruit. If a yeast plant remains unkilled by heat, it will produce other yeast plants which, in the process of growth, give off a gas and cause the fruit to ferment.

Occasionally mold appears on the top of fruit in a jar which is tightly sealed, and the housekeeper wonders how it ever got in. The mold didn't get in after the jar was sealed; it was in the jar all the time. It may be that the fruit was over-ripe, and mold plants had time to grow on it and ripen their spores; in the spore stage, these mold plants are not killed by ordinary cooking. It may be that jars had been used which had not been thoroughly cleaned when they were emptied of their former contents, or which had contained moldy fruit and had not been thoroughly washed and sterilised, and therefore contained numbers of resting spores. See that the jars are perfectly clean and thoroughly scalded with boiling water; a good method is to wash the jars and fill them with cold water, then set them on a rack or thickly folded towels in the wash boiler, surround with cold water, let the water come to a boil and boil five minutes.

See that the rubbers and glass tops are sound, without grooves or nicks, and let them stand in scalding water for a few minutes.

Another important point is to use only sound fruit or vegetables. It is false economy to put up over-ripe food which is very likely to ferment. Fruit may be canned without sugar, and it will keep just as well. A thick sugar syrup acts as an antiseptic and will preserve even raw fruit without any cooking, but sugar in the quantity used in ordinary canning takes no part in keeping the fruit from spoiling.

Canning compounds and other preservatives used to prevent fermentation in canned fruits and vegetables are all more or less injurious to the human system. Even the least objectionable of these, if it will prevent the fermentation of canned goods, will also prevent the action of the digestive juices in the stomach, which are simply other ferments.

METHODS OF CANNING.

1. *By cooking in hot water bath.*
   (1) For home canning, a wash-boiler can be made to take the place of the more elaborate commercial outfit. Prepare the fruit, and syrup, or if vegetables are to be canned, have boiling water and salt ready to fill the cans.
   (2) Pack the fruit into sterilized jars, fill with syrup, then put covers on loosely, and place on wooden rack in the boiler.
   (3) Pour warm water into the boiler, to come nearly to the top of the jars. Place the filled jars on the rack, far enough apart to not touch one another, and pack the spaces between with cotton to prevent the jars striking when the water boils.
   (4) Cover and cook until the fruit is cooked through. Ten minutes after the water boils will do for berries and some of the small fruits.
   (5) Remove cover from boiler to let steam escape, remove one jar at a time, fill to overflowing with boiling syrup and seal. The object of adding more syrup is simply to fill up the space after the fruit has settled down in cooking. (It is not necessary for the keeping of the fruit to add liquid to fill the jars after sterilizing. The air will have been exhausted in the cooking, and the glass tops will be sealed air-tight automatically.)
   (6) Set aside where there is no draught, and screw on tops as they cool and contract.

2. *Cooking or Stewing in a Preserving Kettle.*
   (1) Put fruit into a syrup and cook slowly until the fruit is cooked through. Fill sterilized jars to overflowing and seal.

(2) Jams or preserves are cooked by this method. (See recipes in this Bulletin.)

3. *Fruit Cooked in the Oven.*
   (1) Make syrup and prepare fruit.
   (2) Sterilize jars and set in a pan containing two inches of boiling water in the oven.
   (3) Fill jars with fruit, pour in syrup to cover, put on the tops without screwing down and cook about ten minutes.
   (4) Remove jars from the oven, fill with boiling syrup and seal.

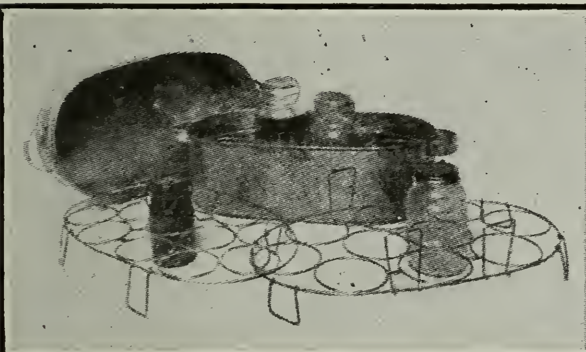
4. *"Raw Canning" of Small Fruits.*

Small fruits like raspberries, strawberries, or sliced peaches can be sterilized so as to retain their shape and color and natural flavor without actual cooking.

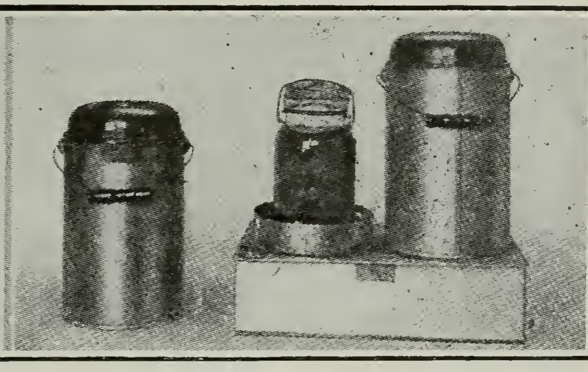
Pack fruit into sterilized jars. Make a syrup and while it is boiling, pour it over the fruit and seal tightly. Put the jars in a kettle or washtub, fill the vessel to the tops of the jars with boiling water, cover over with a blanket, and as the water cools tighten down the tops. Turn upside down to be sure they are air-tight.

5. *Cold-Pack Method of Canning Vegetables.*

The cold-pack method of canning does not mean that the canning is done without heat; it simply means that the final sterilization is done after the jar or



Wash boiler with wire rack for holding jars.



Small hot water bath outfit for sterilizing one jar at a time.

can has been completely filled. The vegetables are blanched in boiling water or live steam, then quickly dipped into cold water, the skins removed and the vegetables cut into sizes for jars or cans. They are then packed into jars or cans, hot water and salt are added, and the sterilizing is done in a hot water bath or steam-pressure cooker.

Scalding, Blanching, Cold-Dipping.

Scalding—The important reasons for scalding fruits and vegetables are:—
   (1) To loosen the skins.
   (2) To eliminate objectionable acids and acrid flavors.
   (3) To start the flow of the coloring matter which is later arrested or coagulated by the cold dip.

Blanching—The reasons for blanching are:—
   (1) To eliminate objectionable acids and acrid flavors.
   (2) To reduce the bulk of vegetable greens.

(3) To make it unnecessary to use the intermittent process of sterilization (or boiling on three successive days to insure the killing of bacteria spores).

Cold Dipping—Three reasons for using the cold dip in canning are:—

(1) To harden the pulp under the skin and permit removing the skin without injuring the pulp.
(2) To coagulate the coloring matter.
(3) To make it easier to handle the vegetables in packing.

GENERAL RULES AND RECIPES FOR CANNING FRUITS.

Proportions of Sugar and Water for Syrups:—

For strawberries and cherries, 2 cups of sugar to 1 cup of water.

For peaches and plums, 2 cups of sugar to 1½ cups water.

For pears, peaches, sweet plums, sweet cherries, raspberries, blueberries and blackberries, 2 cups sugar to 4 cups water.

To Can Soft Fruits, such as Strawberries, Blackberries, Dewberries, Blueberries, Sweet Cherries, Grapes, Peaches, Apricots, Plums:—

Can the same day fruit is picked, if possible. Wash the fruit by pouring cold water over it through a strainer. Pack immediately in jars or cans. Add boiling hot syrup. Place rubber and top in place and partially tighten. Sterilize in hot water bath twenty minutes. Remove and tighten covers. Invert to cool and test joints. Wrap glass jars in paper to prevent bleaching; then store.

Sour Berry Fruits, such as Currants, Gooseberries, Cranberries, and Sour Cherries:

Can fruit same day as picked. Blanch in hot water one minute. Remove and dip quickly in cold water. Pack berries closely in container. Add hot syrup. Place rubber and cap in place. Seal partially, not tight. Sterilize sixteen minutes in hot water bath. Remove jars. Tighten covers and invert to cool and test joints. Wrap in paper and store.

Hard Fruits, such as Apples, Pears, Quinces:—

Blanch one and a half minutes and plunge quickly in cold water. Core, pit and remove skins if necessary. Pack whole, quartered or sliced as desired. Add boiling syrup. Place rubbers and tops in position and partially tighten. Sterilize in hot-water bath twenty minutes or until fruit is soft. Remove jars. Tighten covers. Invert to test joints. Wrap glass jars with paper to prevent bleaching and store.

Rhubarb:—

Wash the stalks clean. Cut them into pieces three-fourths of an inch in length. (Do not remove the skin.) Blanch two minutes. Cold dip. Pack in jars. Pour on a thick syrup, using three pounds sugar to one quart water. Put the rubber and cap in position, not tight. Sterilize twenty minutes in hot water bath.

Raw Canning of Rhubarb and Green Gooseberries:—

Cut rhubarb when it is young and tender. Wash thoroughly; cut into pieces about two inches long. Pack in sterilized jars. Fill the jars to overflowing with cold water, and let them stand ten minutes. Drain off the water and fill again to overflowing with fresh cold water. Seal with sterilized covers. When required for use treat the same as fresh rhubarb. Green gooseberries may be preserved in the same way. (Although rhubarb canned in this way may keep satisfactorily, the flavor is not generally as good as when the rhubarb is sterilized and canned.)

Sugarless Canning.

The cost of sugar required to take care of the large quantities of fruit in the canning season need not prevent the preservation of the entire fruit supply available, when we know that fruit canned without sugar will keep just as well as when sugar is used. There might be some objection to this method with the large, thick-fleshed fruits, on the ground that unless sugar is added while cooking, the sweetness cannot penetrate the fruit. This objection would not hold with berries and the smaller fruits, and a minute or two of cooking with sugar when the fruit is opened for use, gives very good results even with the larger fruit.

FRUIT JAMS AND RELISHES.

In selecting berries or other fruits for jam, the ripe broken ones will give fine color and flavor, but at the same time there should always be about one-half the quantity which are slightly under-ripe. These contain the pectin which gives a jelly-like consistency to the product. Cooking in small quantities also helps to retain color and flavor as the fruit is cooked more quickly. Rapid cooking with constant care to prevent scorching is essential.

In common practice, equal weights of fruit and sugar are used. It has been found, however, that a better consistency and a more delicate and characteristic flavor is produced when less sugar is used. Three-fourths as much sugar by weight, as fruit, has been found sufficient to keep the fruit, when it is cooked to the proper concentration. The sugar acts as an antiseptic so that the fruit will keep without being sealed air-tight.

In stirring jam use a wooden spoon or paddle, moving it across the centre of the vessel first one way and then the opposite and next around the pan, gently moving the mixture from the bottom of the pan, being careful not to stir rapidly or beat. To test when the jam is cooked to the right consistency, cool a little in a spoon and allow it to drop. If it will not pour, but falls in a sheet or flake-like jelly, it is done. An easier way is to use a candy thermometer and cook the jam until it registers 220 degrees F.

Raspberry or Strawberry Jam.

4 pounds raspberries or strawberries. 2½ pounds sugar.

Mash berries; add sugar; cook thirty minutes or until the desired consistency is obtained, stirring very often. Pour into glasses or jars and cover.

Black, Red or White Currant Jam.

4 pounds currants. 4 pounds sugar.

Stem currants, crush slightly; add sugar, let stand over night. In the morning cook one half hour, stirring often. Turn into glasses and cover.

Green or Ripe Grape Jam.

Wash and stem grapes. Separate skins from pulp. Cook skins until tender and press through a sieve. Cook pulps ten minutes and press through a sieve. Combine the two. Add one pound of sugar to every quart of fruit. Boil one-half hour, stirring often. Pour into glasses and cover.

Peach Marmalade No. 1.

4 pounds peaches.
2 pounds sugar.
Juice 2 lemons.

Wipe and cut peaches in halves, remove stones, cut peaches in pieces; add sugar and cook slowly two hours; add lemon juice. Pour into glasses and cover.

Quince, apricot, plum and prune marmalade may be made in the same way.

Peach Marmalade No. 2.

5 pounds peaches cut into small pieces.
2 pounds sugar.
1 dozen whole allspice.
A few cracked peach pits.
2 inches ginger root.
1 teaspoon whole cloves.
2 teaspoons cinnamon bark.
2 teaspoons sprig mace.
1 cup peach juice.
(Tie spices in cheese-cloth bags.)

Cook all together until as thick as marmalade and clear, or until the mixture registers 220 degrees F. when tested with a candy thermometer. Pack hot in hot jars and seal at once.

Ginger Pears.

Use pears not quite ripe; peel, core, and cut into thin slices. To 8 pounds of pears allow 8 pounds of sugar, 1 cup of water, juice of 4 lemons. Cut the lemon rinds into thin strips and add them. Also add one-eighth pound of ginger root cut into pieces. Simmer until thick as marmalade. Pack.

Apple Ginger.

4 pounds sour apples.
4 lemons.
2 pounds sugar.
1 ounce ginger root.

Pare, core, and slice apples; wash, remove seeds, and slice lemons; add sugar and ginger root, and cook very slowly six hours. Pour into glasses and cover.

Apple Butter.

One bushel apples, eight quarts cider; cover and boil until tender. Rub the pulp through a strainer and cook thirty minutes longer, then measure. For each gallon add eight cupfuls sugar, eight teaspoons ground cloves, eight teaspoons ground cinnamon. Stir and boil twenty minutes longer; fill into jars and seal with paraffin.

Apple Butter without Sugar.

One bushel sweet apples, eight quarts cider. Cook until tender, put through a strainer, and cook until thick. Add 9 teaspoons ground cloves and 9 teaspoons cinnamon. Give three to four hours slow boiling, fill into jars and seal with paraffine.

Cider Apple Sauce.

Reduce four quarts of new cider to two, by boiling. Add enough pared, cored and quartered apples to fill a good-sized kettle. Cook slowly for four hours.

Apple Butter without Cider.

Pare and core the apples. Boil in water until fruit is soft. Mash to a fine pulp. To each 25 pounds of apples add 2 ounces cinnamon, 1 ounce ground cloves, 1 ounce nutmeg, 6 pounds sugar. Cook until thoroughly mixed and thickened.

Spiced Grapes.

1 peck grapes.
3 pounds sugar.
1 pint vinegar.
1 teaspoon cloves.
1 teaspoon cinnamon.
1 teaspoon allspice.

Pulp the grapes; boil for five minutes; strain to take out the seeds; put the skins and pulp together; add the other ingredients and cook until thick.

Spiced Currants.

4 pounds currants.
2 pounds brown sugar.
2 tablespoons cinnamon.
2 tablespoons cloves.
1 teaspoon salt.
1 cup vinegar.

Remove stems and wash currants. Add remaining ingredients and boil twenty minutes. Keep in stone jar or glasses.

Spiced Peaches.

4 pounds peaches.
3 pounds brown sugar.
1 cup vinegar.
1 tablespoon cloves.
1 tablespoon cinnamon.
1 teaspoon ginger.
1 teaspoon salt.
⅛ teaspoon cayenne pepper.

Boil sugar and vinegar. Scald peaches. Remove skins, and cook in syrup. Tie spices in bag and cook with peaches. When peaches are tender, pour into stone jars; re-heat syrup every day for a week, pouring, when boiling, over the peaches.

Spiced Gooseberries.

4 pints gooseberries.
3 pounds brown sugar.
1 cup vinegar.
1 teaspoon whole cloves.
Few sticks cinnamon.
1 teaspoon salt.
⅛ teaspoon cayenne.
1 tablespoon lemon juice.
½ ounce ginger root.

Tie spices in a bag. Cook vinegar and sugar five minutes. Add spice and remaining ingredients and cook slowly one hour.

Sun Preserved Strawberries.

Select ripe, firm strawberries. Pick and preserve them the same day. Hull and rinse them, and place a single layer on shallow platters. Pour over them a syrup made of six cups of sugar to one cup of water. Cover with a glass dish or pane of window glass and set in the sun eight hours. Pack in glasses, cover with paraffine or paper and keep in a cool, dry place.

PRESERVING.

Preserving fruit is cooking it with from three-fourths to its whole weight of sugar, without breaking it up like jam. The object is to have the fruit permeated with syrup. Care must be taken to do this gradually so as to prevent the shrinking and toughening which results when fruit is placed at once in very dense syrup. It is also important not to pack the finished preserves in syrup heavy enough to crystallize later.

Preserved Raspberries or Blackberries.

4 pounds berries.	3 pounds sugar.

Sort over berries and wash. Cover with sugar and let stand two hours. Simmer until boiling point is reached; boil one minute; cool; bring to boiling point again and boil one minute. Fill into jars and seal. Strawberries, thimbleberries, and gooseberries may be preserved in the same way.

Preserved Strawberries.

4 pounds strawberries.	3 pounds granulated sugar.

Cover berries with the sugar and let stand over night in a cool place. Drain off the juice, pour it into a granite sauce pan, and let it boil fifteen minutes, removing the scum. Add the berries, boil three minutes, pour into hot jars and seal immediately.

Preserved Cherries.

4 pounds cherries.	4 pounds sugar.

Wash cherries, remove stems and stones. Cover cherries with the sugar and let stand two hours. Set on stove and bring slowly to boiling point. Cook until cherries are tender. Fill hot jars and seal.

Currants and huckleberries may be preserved in the same way.

Preserved Crab Apples.

4 pounds crab apples.	4 cups water.
4 pounds sugar.	Juice of 4 lemons (optional).

Let the water and sugar come to a boil. Add the crab apples either whole or quartered and cored. Cook until apples are tender. Add lemon juice if desired, fill into hot jars and seal.

Preserved Citron.

4 pounds citron.	4 lemons, juice and rind.
4 pounds sugar.	Small piece of ginger root.
4 cups water.	

Wash citron, cut in halves, remove seeds; cut each half into eighths, sprinkle with salt and cover with water; let stand over night then drain. Cover with clear water, let stand four or five hours and drain. Remove skin, cut in cubes and cook until transparent in syrup to which ginger and lemon have been added. Fill into hot jars and seal.

Preserved Peaches.

4 pounds peaches. 3 pounds sugar.

Pare peaches, cut in halves and take out stones. Arrange peaches and sugar in layers in preserving kettle; let stand overnight. In the morning simmer until peaches are tender. Fill jars with fruit. Boil syrup five minutes, fill jars with syrup and seal.

Preserved Pears.

4 pounds pears. 2 cups water.
4 pounds sugar.

Wash, pare, core, and cut pears in quarters. Put into cold water to prevent discoloring. Make a syrup of the sugar and water. Cook only enough pears to fill a jar at a time. When tender fill jars with fruit, add syrup and seal.

Apricots are preserved in the same way.

Very hard pears may be simmered in water until tender before putting into syrup.

Preserved Plums.

4 pounds damsons, greengages or blue plums. 4 pounds sugar.

Pick over plums and prick the skins so they will not burst in cooking. Arrange alternate layers of plums and sugar in a granite dish and let stand over night. In the morning drain off syrup, boil and skim. Add plums and cook until tender. Fill into hot jars and seal.

Preserved Quinces.

4 pounds quinces. Boiling water.
4 pounds sugar.

Wash, pare, core and cut quinces in quarters. Put in preserving kettle, cover with boiling water and simmer until tender. Cool on platters. Mix sugar with one pint of water in which quinces have been cooked. Boil ten minutes. Add quinces a few at a time, cover kettle, and cook slowly until quinces are of a rich red color. Fill into hot jars and seal.

JELLY MAKING.

In order to make good jelly a fruit juice must contain two ingredients, acid and pectin. The pectin is generally known as the substance in fruits which makes jelly "jell"; it is found in the largest quantities in the cores and hard parts of the fruit, and is changed as the fruit ripens into a substance which has very little of the jellying property. It is, therefore, important to use some slightly underripe fruit, and to include cores, seeds and hard parts in the first boiling to extract the juice. To test fruit juice for pectin, to a small quantity of the cold juice add an equal measure of ordinary alcohol. If pectin is present a gelatinous mass will form. If there is no pectin, the solution should remain clear.

The changing of the juice from a liquid to a jelly, is brought about by the combined effect of sugar, acid and boiling upon the pectin of the fruit juice. Some fruits contain sufficient pectin, but are deficient in acid, such as peaches, quinces, pears and sweet apples. A fruit that jells with difficulty may be combined with one that jells readily; apples, though possessing little flavor, except a few varieties, have all the necessary jellying qualities. When any desired flavor is added, good jelly results. Fruits suitable for jelly-making are: Currants, ripe and partially ripe grapes, crabapples, sour apples, and plums. Raspberries may be used, though they jell less readily.

It is, of course, possible to supply the deficiency of either acid or pectin. In oranges and lemons, the white material between the pulp and yellow rind is very rich in pectin. This may be extracted by grinding or chopping fine the thick white part, soaking in cold water twelve to twenty-four hours, and then simmering an hour. Care should be taken to remove all the yellow portion before grinding. Equally good results may be obtained, however, by adding a generous supply of apple-cores and skins to the fruit before boiling to extract the juice. A deficiency of acid may be likewise overcome by adding some acid fruit. Rhubarb juice added to any fruit juice will bring out the flavor and add "snap" to the jelly. Tartaric or citric acid, which are perfectly safe fruit products, may be obtained in crystalline form. One level teaspoon to a quart of juice is usually sufficient; however, this depends on the acidity of the fruit. To test, stir the juice until all acid crystals are dissolved, then taste. It should be about as acid as good tart apples.

Extracting the Juice.

Heating is necessary to extract the pectin from the fruit. The amount of water depends on the juiciness of the fruit. The smallest possible amount of water should be used. After the fruit is thoroughly heated with the water, it should be crushed and cooked until all juice is extracted. It can then be strained through moistened double cheesecloth or flannel bags. As all of the juice is not extracted by the first cooking, a second and third extraction may be made by adding water to the pulp and further cooking.

Amount of Sugar.

The theory (which has been disproved) that sugar caused the juice to jell led many people to use too much sugar. Directions usually called for equal quantities of sugar and juice irrespective of the kind of juice. The amount of sugar should be based upon the amount of pectin in the juice. A large proportion of sugar may be used with those fruits which contain a large amount of pectin, and for those in which only a small amount of water is used to extract the juice. In such cases, the use of too small a quantity of sugar results in a tough jelly. When water has been used in extracting the juice, or when the pectin content is not especially high, as in some berries, the proportion of three-fourths as much sugar as juice gives good results.

If the proportion of sugar is correct, it will show in the character of the resulting jelly. Tough jelly indicates too little sugar, and a soft, sticky jelly (providing both pectin and acid are present) indicates too large a proportion of sugar. Imperfect jelly, due to a wrong proportion of sugar or juice, may be corrected by cooking a second time, adding more juice or more sugar as the case may require. Care should be taken to get the correct proportion in the first place, however, as cooking the pectin too long in the presence of acid may destroy its jellying properties.

Time of Cooking.

A definite concentration of juice and sugar is necessary before jelly will be formed. The cooking time necessary for such concentration ranges from eight to thirty minutes. The larger the proportion of sugar to juice, the sooner such concentration is reached. The most accurate test is to take the temperature with a candy thermometer in the boiling liquid. When it registers 217 degrees F. the jelly is done. Be careful not to let the bulb of the thermometer touch the bottom of the kettle, or the temperature taken will be that of the metal, not of the juice. Another good test is to cool a little in a spoon. If it will not pour, but falls in a sheet, the proper consistency has been reached.

Process of Making Jelly.

Wash and cut fruit into pieces, using all the skins and cores. Put into a granite or porcelain-lined kettle, add a very small amount of water, and cook slowly until juice is well drawn out. With very juicy fruits like grapes and currants, mash the fruit at the beginning and do not add any water. Crush fruit and strain through double thickness of cheesecloth or flannel jelly-bag. Add more water to the pulp, boil and strain again. The juice from the second boiling is apt to lack flavor. A juice may be added which, although possessing good flavor, will not jell, such as peach, cherry or strawberry. Boil the strained juice for twenty minutes, and add from three-fourths to an equal quantity of heated sugar. The advantage of using sugar which has been heated in the oven is that when cold sugar is added the boiling is temporarily stopped, thus increasing the cooking time, and the longer cooking period gives a darker colored jelly. Cook until it will jell. Skim and turn into sterilized glasses.

To Prepare Glasses for Jelly.

Wash glasses and put in a kettle of cold water; place on range and heat water gradually to boiling point. Remove glasses and drain. While filling glasses place them on a cloth wrung out of hot water.

To Heat Sugar for Jelly.

Put sugar in a granite dish, place in the oven, leaving the door open, and stir occasionally. A brown paper folded in the pan before the sugar is put in helps to prevent its melting or burning.

To Cover Jelly Glasses.

Jelly should be closely covered to protect from molds and dust as well as to prevent drying out or the absorption of moisture. Brush with alcohol or brandy and cover with melted paraffine just warm enough to pour, or cover with rounds of paper dipped in brandy. Put on tin covers or paste paper securely over the top.

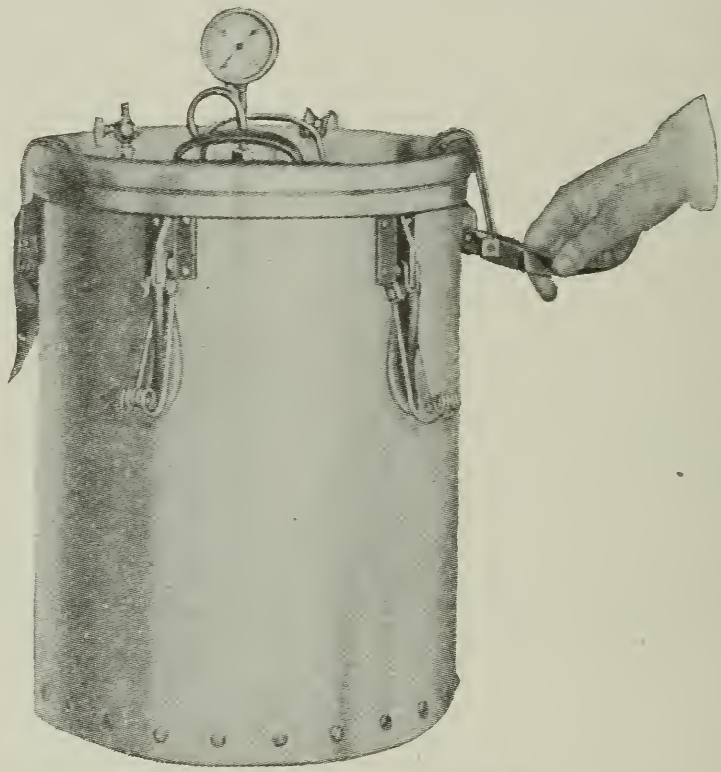
Combination of Fruits for Jelly-making.

The process of jelly-making does not vary; all kinds can be made in the same way. Numberless varieties may be made by blending flavors. Raspberries and currants, quinces and apples, elderberries and green grapes, and other combinations can be made up from supplies of fruit at hand, provided always the necessary pectin and acid are supplied by some fruit in the combination.

THE CANNING OF VEGETABLES.

Equipment for Home Canning.

When taking up the work on a small scale, it is quite possible to do successful home canning by using only such equipment as the farm and home may easily provide. A wash-boiler or other vessel with a close-fitting top can be easily transformed into a home canner by fitting with a rack for the bottom, with wire or wooden handles. These home-made outfits are classified in canning equipment as "hot water bath" outfits. A thermometer to test the concentration of jams and jellies, paring and coring knives, wiping cloths, a convenient table for work, plenty of fresh clean water near at hand, a watch or clock in a convenient place for use in checking the time according to schedule—these complete the equipment necessary for canning in glass jars. If you are using tin or aluminum cans, you will need soldering flux, lead, sal ammoniac, a soft brick, capping iron and tipping steel.



Small steam-pressure outfit for home canning.

For convenience in following recipes, and for those who are interested in canning on a larger scale, the following brief description of the three types of canning outfits will be of interest.

Hot Water Bath Canning Outfit.

These are manufactured commercially, but may be adapted from a new wash-boiler with a frame for holding the jars. A deep pail, a kettle, or any other container which is at least six inches deeper than a quart jar, and which has a close-fitting cover, makes an excellent home canner when equipped with some means of preventing the jars from resting directly on the bottom. Wire frames with bail handles can be obtained. After placing the jars in the canner, surround them with warm water, reaching to within one inch from the tops of the jars. Do not have the water hot enough to break the jars.

Water Seal Canning Outfit.—

This outfit looks like a large pail. It is fitted with a thermometer, a safety valve and a pet-cock, and is so constructed that steam is confined under pressure.

This raises the temperature in the canner above the boiling point, and reduces somewhat the length of time required to sterilize the contents of the jars.

Steam Pressure Outfits.—

This is similar in appearance to the water-seal outfit, but is much heavier to move about. Since it is stronger and heavier, more pressure is secured and the time of sterilization is cut down still further. Such outfits are extremely useful when vegetables are to be canned in large quantities. Directions which may be safely followed are sent out with all pressure-canner outfits.

Canning in Tin Cans.

The directions given in this bulletin refer more particularly to canning in glass jars, but with the following directions for capping and tipping, any of the recipes may be applied to canning in tin cans. Where new containers must be purchased, the tin cans are, of course, considerably cheaper than glass.

Capping.—

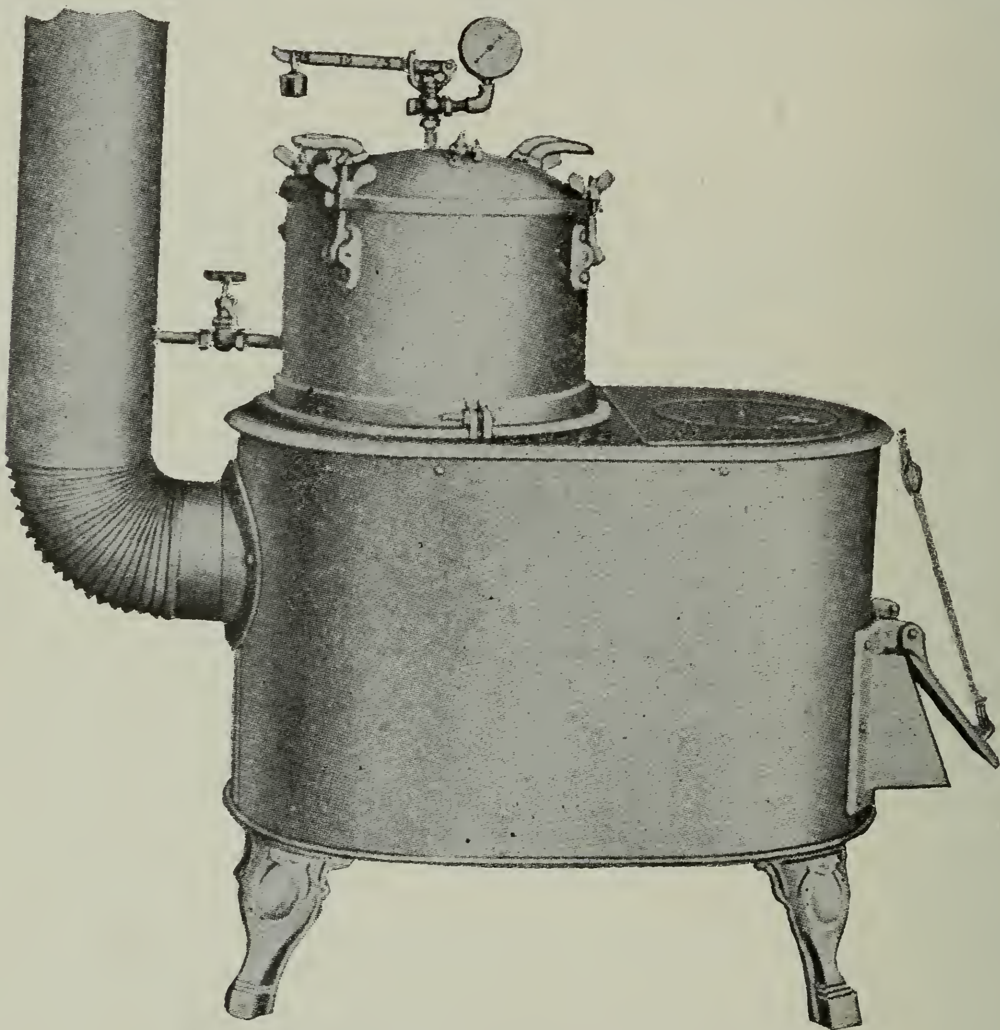
The most difficult and particular part of the work is the soldering on of the caps after the cans have been filled. This can be done in the fire box under the processing vat. It is, however, convenient to have a separate fire pot. A very cheap one can be made from half a length of stove pipe, cutting a hole two inches in diameter a couple of inches from one end of the pipe to put the iron through. Stand this end on a couple of bricks and build a fire within the pipe. Coal, charcoal or chips can be used as fuel. It is very important that the capping iron (as well as the tipping iron which is used later) should be well tinned and kept in a bright condition. Should the tinning wear or burn off the irons it is necessary to retin them. To do this, first smooth and brighten them by filing or using emery paper, after this heat them rather hot. Then dip them into soldering fluid or flux. Next rub them with sal ammoniac and stick solder. Continue this until the irons take on a smooth coating of tin. A very convenient plan for retinning the capping iron is to fill a No. 3 can a couple of inches deep with one part scrape solder or two parts sal ammoniac. After your iron has been heated and dipped in flux, revolve it in the above mixture until it is well tinned. Now dip it into the soldering fluid again and wipe off all adhering loose particles with a damp cloth. A low box or stool is most convenient to cap and tip on, having it placed between the fire pot and the processing vat. Have the tops of your cans wiped clean, especially in the grooves where the soldering has to be done. Place the cap on, holding it down with your left hand. Dampen the groove with a weak flux or soldering fluid applied with a small brush, being careful not to let any of the flux enter the cans. (The flux is acid and if more than necessary is used it will act upon the tin and cause oxide flakes to be formed. This is often found in factory goods, where a strong flux has been recklessly used or where a poor quality of tin has been used in the making of the cans.) Wipe your capping iron with a cloth moistened in flux. Hold the iron in your right hand and with a stick of solder in your left press the steel until sufficient solder has melted. Now revolve the iron several times or turn it from right to left until the solder is properly spread around the cap. Now press down on the central rod raise the iron and hold it a few seconds until the solder sets. It is a good plan to have a helper at this point to hold down the cap with a piece of stock so as not to detain the operator while his iron is hot. You cannot do a good job when your irons fail to melt the solder rapidly. When the iron becomes too cool to work with, dip it into a weak flux and place it in the fire to reheat. A separate tin of flux should be kept for this purpose as it soon becomes quite dirty.

Exhausting.—

The caps having been soldered on the cans are immersed three-quarters of their depth in a vat of boiling water. This expands the goods and causes the air to be forced out through the little vent left open in the centre of the cap. This process is called exhaustion. It prevents the cans from bursting during the processing or cooking.

Tipping.—

After most of the air is driven out, the cans are removed from the vat and "tipped." That is the little vent is soldered up. The same precautions have to be taken here as in the case of the capping. The top of the cap should be wiped clean and a little flux applied around the vent. Place the point of the hot iron in the vent; touch the iron with a bar of solder, melting off just sufficient to seal



Practical steam-pressure outfit, with fire-box.

over the hole, twisting the iron slightly as you lift it from the hole. A common pointed soldering iron should be used for this part.

Processing, or Sterilizing.—

The cans are now ready to be processed. This is the term applied to the sterilizing or cooking of the foods contained in the sealed cans. The processing should be done as soon as possible after they have been exhausted and tipped. Processing is the most critical point in the process of canning. Have a clock or watch hanging conveniently and a slate or tablet upon which to record the time. Lower the crate containing the cans into boiling water; watch here for bubbles which will indicate "leaks." Remove any such cans and repair by opening the vent with a hot iron. Mend the leak and retip. Observe the time the goods are put into the boiling water, add to this the time they have to be processed and you will have the time the goods have to come out. *N.B.* Have the water boiling before you count the time. It is not safe to leave the timing to memory, as the best of men are apt to make mistakes.

After the cans have been processed they should be put into cold water for a few minutes. This is to form the contents, which will add to the quality of the goods.

RULES AND RECIPES FOR CANNING VEGETABLES.

Methods of Sterilization.

One-Day Method.—

By the one-day method of sterilizing we mean placing the jars in the canner and heating them continuously at the boiling point or above it, for several hours. usually if this heating is continued long enough the vegetables will keep.

Intermittent or Three-Day Method.—

The jar is taken out of the canner at the end of an hour's boiling. The clamp or rim is tightened and the jar is set aside to cool until the following day. Do not let the vegetables cool off in the canner as this results in over-cooking. On the second day, the clamp is loosened or the rim unscrewed, the jars are placed in warm water deep enough to reach within an inch of the tops, and they are left until they have been boiled an hour, at the end of which time they are again removed. On the third day the hour's boiling is repeated in the same way.

There is reason for believing that the three-day method is advisable when peas, beans, corn and greens are canned. Sometimes certain organisms on these vegetables go into a restive or spore form in which they are not easily killed by boiling. If, for example, there are spores in a jar of peas, they will probably not be killed by one hour or even by three hours of sterilizing. So after an hour's cooking, we set the jar aside until the next day, and as it gradually cools, conditions become just right for these spores to germinate. Most of them quickly change to an active or vegetative form in which it is possible to kill them by boiling. The second day, these vegetative forms are killed. It is barely possible, however, that some of the spores may not have reached the vegetative stage during the first cooling, and so have not been killed by the second boiling. For this reason we take the added precaution of sterilizing the third day. A longer cooking period for a single day is less trouble and perhaps it requires less fuel than the three-day method, but the intermittent method is absolutely safe. It is for the housekeeper to decide which method she wishes to use and then to follow explicitly the directions for that method.

Note.—(1) The terms "blanching," "cold-dipping," "cold pack," used in the following recipes have already been explained in the section "Why Fruits and Vegetables Spoil" in this bulletin.

(2) The length of time allowed for sterilization in these recipes is required for cans not larger than two-quart size. Gallon cans require a longer period.

Vegetable Greens—Spanish, Beet-Tops, Asparagus, Swiss Chard, Etc.

Prepare and can the same day picked. Sort and clean. Blanch in a steamer for 15 or 20 minutes. Remove, Plunge quickly into cold water. Cut in pieces convenient for canning. Pack tightly in jars or cans. Add boiling water to fill crevices, and a teaspoonful of salt to each quart. If using glass jars, place rubber and tops in position, partially seal; (if using tin cans, tip and seal completely). Use the intermittent process of sterilization, or,

Sterilize 90 minutes in hot water bath outfit.
Sterilize 60 minutes in hot water seal.
Sterilize 50 minutes in steam pressure outfit under five pounds of steam.

Remove from canner. Tighten the covers. Invert to cool and test joints. Wrap in paper to prevent bleaching and store.

Root and Tuber Vegetables.—Carrots, Parsnips, Beets, Sweet Potatoes.

Wash thoroughly. Scald in boiling water sufficiently to loosen skin. Plunge quickly into cold water. Scrape or pare to remove skin. Pack into jars whole or cut in sections or cubes. Add boiling water and one level teaspoonful of salt to the quart. Place rubbers and tops in position. Partially seal, but not tight. (Cap and tip tin cans).

Sterilize 90 minutes in hot water bath.
Sterilize 75 minutes in water seal outfit.
Sterilize 60 minutes in steam pressure outfit under five pounds of steam.
Sterilize 35 minutes in pressure cooker under twenty pounds of steam.

Remove jars. Tighten covers. Invert to cool and test joints. Wrap jars in paper to prevent bleaching and store.

Note:—In canning beets, if vinegar is added to the water in the proportion of one part vinegar to four of water, the natural bright color will be preserved.

String Beans and Peas.

Can same day vegetables are picked. Blanch in boiling hot water from 2 to 5 minutes. Remove and plunge quickly into cold water. Pack in jars. Add boiling water to fill crevices. Add 1 level teaspoonful salt to each quart. Place rubbers and tops in position. Partially seal, but not tight. (Cap and tip tin cans.) Use the intermittent sterilization process, or

Sterilize 120 minutes in hot water bath.
Sterilize 90 minutes in water seal outfit.
Sterilize 60 minutes in steam pressure outfit under five pounds of steam.
Sterilize 40 minutes in pressure cooker under 20 pounds of steam.

Remove jars. Tighten covers. Invert to cool and test joints. Wrap in paper to prevent bleaching and store.

Tomatoes

Scald in hot water enough to loosen skins. Plunge quickly in cold water. Peel and remove hard cores. Pack whole in jars. Fill jars with tomatoes only. Add 1 level teaspoonful salt to each quart. Place rubber and cap in position. Partially seal but not tight. (Cap and tip tin cans.)

Sterilize 22 minutes in hot water bath outfit.
Sterilize 18 minutes in water seal outfit.
Sterilize 15 minutes in steam pressure outfit, under five pounds steam.
Sterilize 10 minutes in pressure cooker under twenty pounds steam.

Remove jars. Tighten covers. Invert to cool and test joints. Wrap jars in paper to prevent bleaching and store.

Sweet Corn.

Can the same day as picked. Remove husks and silk. Blanch on the cob in boiling water 15 minutes. Plunge quickly in cold water. Cut the corn from the cob. Pack solidly in jars. Add 1 level teaspoonful of salt to each quart, and sufficient hot water to fill the jars. Place rubber and top in position. (Cap and tip tin cans.) Use the intermittent process of sterilization described above, or

Sterilize 4 hours in hot water bath outfit.
Sterilize 90 minutes in water seal outfit.
Sterilize 60 minutes in steam pressure outfit under five pounds steam.

Remove jars. Tighten covers. Invert to cool and test joints. Wrap jars in paper and store.

Pumpkin and Squash.

Recipe for Canning Pie Filling.

Cut up into convenient sections. Core and remove skins. Cook for 30 minutes to reduce to pulp. Pack in glass jars or tin cans. Add ¾ cup of sugar and 1 teaspoonful salt to each quart of pulp. Place rubber and top in position. Partially seal but not tight.

Sterilize 60 minutes in hot water bath.
Sterilize 50 minutes in water seal outfit.
Sterilize 40 minutes in steam pressure outfit under five pounds steam.
Sterilize 30 minutes in pressure cooker under twenty pounds of steam.

Tighten covers, invert to cool, wrap in paper and store.

Recipe for Canning, for Special Dishes (*Fried, creamed, baked.*)

Cut pumpkin into small cubes. Blanch in boiling water for 10 minutes. Plunge quickly in cold water. Pack in jars. Add boiling water and 1 level teaspoonful salt to the quart. Place rubbers and caps in position.

Sterilize 60 minutes in hot water bath.
Sterilize 45 minutes in water seal outfit.
Sterilize 35 minutes in steam pressure outfit under five pounds steam.
Sterilize 25 minutes in pressure cooker under fifteen pounds of steam.

Seal as in preceding recipe.

Note.—Hubbard Squash is made much easier to prepare for canning if allowed to stand in scalding water for about five minutes. The skin can then be removed very easily.

Note No. 2.—As it takes pieces of squash some time to cook tender, it can be sterilized more quickly if first put through the food chopper, or it may be first cooked and mashed.

Cauliflower.

Separate the flowerets. Blanch 3 minutes. Plunge into cold brine (½ pound salt to 12 quarts water.) Let stand in brine for 12 hours. Pack in glass jars or enamelled tin cans. Fill with boiling water and add 1 level teaspoonful of salt per quart. Place rubber and cap in position. (Cap and tip tin cans).

Sterilize 45 minutes in hot water bath.
Sterilize 35 minutes in water seal outfit.
Sterilize 30 minutes in steam pressure outfit under five pounds of steam.
Sterilize 20 minutes in pressure cooker under fifteen pounds of steam.

Remove jars, tighten covers, and invert to test joints.

Mushrooms.

(Do not take any risks with wild mushrooms until you are absolutely sure they are mushrooms.)

Wash and trim the mushrooms. If small can them whole: if large cut into sections. Blanch 5 minutes. Plunge into cold water. Pack in glass jars. Fill with boiling water and add 1 level teaspoonful of salt to each quart. Place the rubber and cap in position.

Sterilize 90 minutes in hot water bath outfit.
Sterilize 60 minutes in water seal outfit.
Sterilize 50 minutes in steam pressure outfit, under five pounds of steam.
Sterilize 20 minutes in pressure cooker under fifteen pounds of steam.

Remove jars. Tighten covers and invert to test joints.

PRESERVING VEGETABLES IN BRINE.

String Beans, Cucumbers, Etc.

String beans, cucumbers, etc., may be kept for winter use by packing in a brine in stone crocks. The two common methods of doing this are:—

(1) To pack the vegetables in the crock and cover with a concentrated salt solution made by stirring salt in a pail of water, and continuing to add salt until the water will not dissolve any more. Pour off the clear brine; add more water to the salt in the pail and continue until the vegetables are completely covered. Place a weight on top to keep the vegetables under the brine, cover the crock and set in a cool place.

(2) Pack like sauer-kraut. This method would not do for larger vegetables like cucumbers which could not be packed tightly. Place a layer of vegetables in a crock, sprinkle with salt as in making sauer-kraut. Pack solidly, place under a weight and keep in a cool place.

Sauer-Kraut.

Cut the cabbage into shreds, do not chop. Put a layer of cabbage about three inches deep into tank or vessel having straight sides. Crockery ware, or cypress or white pine casks are good for the purpose. Sprinkle over the first layer of shredded cabbage the first grade of dairy salt. The proper proportion is 2½ pounds salt for each 100 pounds of cabbage. Repeat this until the cask is full and heaped up. Have a cover fitted to inside of cask. Put this over the cabbage and weight it down with rocks. In ordinary room temperature the kraut will cure in from 16 to 18 days.

Dried Sweet Corn.

Sweet corn may be preserved for winter use by drying in the oven, and this is an excellent method of saving any that is left over from a meal during the green corn season. The corn must first be cooked. Cut the corn from the cob and dry in a slow oven for fifteen minutes, being careful not to let it scorch or brown at all. Remove from the oven and allow it to stand in an airy place for a few hours. Put into cotton bags and hang in a dry place. When preparing for use, soak over night like white beans, and cook the same as canned corn.

PICKLES.

In pickles the preservation is effected by the use of vinegar and spice. This means that the strength of the vinegar must be sufficient to exert a preservative action, also that there must be enough of it to cover the material pickled. There are three main classes of pickles; sweet fruit or vegetable pickles; sour pickles which include mustard pickles; and that large variety of pickles in which the material is chopped finely. Although many varied recipes may be found for each class, one formula can be used to make a great variety.

Sweet Pickled Peaches, Pears, Sweet Apples, Crab Apples.

1 peck prepared fruit.
1 quart vinegar.
1 cup water.
2 ounces stick cinnamon.
1 ounce whole cloves.
4 pounds sugar.

Boil sugar, vinegar, and spices, twenty minutes. Dip peaches in boiling water, and rub off the fur but do not peel. Pare other fruits. Stick fruit with whole cloves. Put into syrup and cook until soft, using one-half the fruit at a time.

Sour Pickles: Onions, Cucumbers, Green Tomatoes.

The vegetables must first be soaked in brine. Allow 1½ cups salt to 2 quarts boiling water. Pour over the vegetables and let stand two days. Drain and cover with more brine. Let stand two days and drain again. Take fresh brine, and heat to boiling point; put in onions and boil three minutes. Drain and cover with a spiced vinegar made as follows:

1 gallon vinegar.
1 cup sugar (optional).
4 red peppers.
2 sticks of cinnamon.
2 tablespoons whole allspice.
2 tablespoons mace.

Tie spices in a cheesecloth bag and boil in vinegar ten minutes. Pour over vegetables and bottle.

Mustard Pickles for Mixed Vegetables: Onions, Cucumbers, Green Tomatoes.

Prepare the vegetables for pickling by giving them the brine treatment described in the recipe for Sour Pickles. Make a dressing from the following recipe:

¼ to ½ cup sugar.
1 ounce ground mustard.
2 tablespoons flour.
1 pint vinegar.

Mix the dry ingredients and stir into the hot vinegar. Cook until well thickened. Turmeric may be added to give color. Pour while hot over the vegetables and bottle.

Chili Sauce.

2 quarts ripe tomatoes.
4 large onions.
4 peppers.
3 tablespoons sugar.
2 tablespoons salt.
2 teaspoons cloves.
2 teaspoons cinnamon.
2 teaspoons ginger.
1 teaspoon ground allspice.
2 teaspoons nutmeg.

Boil together until quite thick, then bottle for use.

Tomato Catsup.

1 gallon tomatoes.
2 medium sized onions.
2 tablespoons salt.
4 tablespoons sugar.
1 tablespoon powdered mustard.
1 pint vinegar.
1 level tablespoon each whole allspice. cloves, cinnamon and pepper.
2 small red peppers sliced and seeds removed.

Tie the whole spices in a cheesecloth bag. Cook tomatoes, put through a colander, add ground spices and spice bag and cook for $1\frac{1}{2}$ hours, or until nearly thick enough. Add vinegar and cook until thick. Bottle and seal with paraffine, or cork tightly.

CANNED MEATS AND SOUPS.

Meat may be canned as successfully as fruits and vegetables. Besides giving a supply of fresh meat for emergency occasions; the canning of some of the meat butchered on the farm is a right step in the way of economy. Beef which might otherwise be used more freely than is necessary, at the time of killing, can be saved for use in seasons when fresh meat is difficult to obtain.

Canned Fresh Beef No. 1.

Cut the beef into pieces of about $\frac{3}{4}$ pounds in weight. Roast or boil slowly for one-half hour. Cut into small pieces, remove gristle, bone, and excessive fat and pack directly into glass jars. Fill with gravy from the roasting-pan, or pot liquid concentrated to one-half its volume. Add 1 teaspoonful salt for each quart of meat. Put rubber and cap in position, not tight.

Sterilize 5 hours in hot water bath.
Sterilize $4\frac{1}{2}$ hours in water seal outfit.
Sterilize $3\frac{1}{2}$ hours in steam pressure outfit at five pounds pressure.
Sterilize 2 hours in steam cooker at ten pounds pressure.

Remove jars, tighten covers, and invert to test joints.

Canned Beef No. 2.

Free the meat from the bone, and cut it in pieces of a size to go into jars easily. Pack the raw meat solidly into jars, filling the jars to within three-fourths inch from the top. Sprinkle over the meat one teaspoonful salt to each quart of meat. Add no water. Celery leaves, onion, pepper or other seasonings may be added if desired. Place rubbers and tops in position, not tight. Sterilize and seal as in Canned Beef No. 1.

Canned Chicken No. 1.

Kill the fowl and draw at once. Wash carefully and cool; Cut into sections and boil until meat can be removed from the bones. Pack meat in glass jars, fill jars with the liquid which has been boiled down to one-half its original volume. Add a level teaspoonful of salt per quart of meat. Place rubber and cap in position, not tight.

Sterilize $3\frac{1}{2}$ hours in hot water bath.
Sterilize 3 hours in water seal outfit.
Sterilize $2\frac{1}{2}$ hours in steam cooker at five pounds pressure.
Sterilize 2 hours in steam cooker at ten pounds pressure.

Seal the same as other canned meats.

Canned Chicken No. 2.

Kill the fowl and draw at once. Wash carefully and cool. Cut in convenient sections removing the bones, and pack in glass jars. Fill with boiling water. Add a level teaspoonful of salt per quart. Put rubber and cap in position and sterilize one half hour longer than time given in recipe for Canned Chicken No. 1.

Canned Chicken No. 3 (Macdonald Institute).

Clean and draw the chickens as usual. Peel all the raw meat off the bones. Pack the bones in a pot, cover with water, add a tiny bit of whole mace, 1 clove and 2 allspice berries for each chicken, and boil gently 5 or 6 hours. Wash and scald wide-mouth fruit jars. Spread the raw chicken out, sprinkle it lightly with salt and pepper, and pack it into the jars. Lay the covers on without rings or rubbers. Steam 2 hours and set aside till next day. When the bones-stock is cooked, strain it off. The following day, remove the fat from the top, melt the jellied stock and use it to fill up the jars. Put on the rubbers and tops, and screw the rings partly down.

Steam for one hour longer and screw the rings down tightly.

Pork Sealed in Dripping.

Pork may be canned in the same way as beef. A very easy and satisfactory way to preserve fresh frying pork for summer use is to slice and fry the meat, cooking it almost as much as you would for immediate use. Place the pieces in layers in a stone crock pouring hot fat over each layer making sure to have the top completely covered with fat. This makes a seal under which the meat will keep perfectly. Bind a cloth over the top of the jar, cover and keep in a cool place.

Chicken Stock Soup.

All bones and trimmings of the chicken should be covered with cold water, salted and slowly simmered until the flesh drops in shreds from the bones and the liquid is concentrated to about one-half its original volume. Remove meat and bones and strain the stock. Partially seal glass jars. (Cap and tip tin cans).

Sterilize 90 minutes in hot bath outfit.
Sterilize 75 minutes in water seal outfit.
Sterilize 60 minutes in steam cooker at five pounds pressure.
Sterilize 45 minutes in pressure cooker at ten pounds pressure.

Remove jars, tighten covers, and invert to test joints.

Chicken Broth With Rice.

For each gallon of soup stock use 12 ounces of rice. Boil the rice 20 minutes. Fill the jars or tin cans two-thirds full of rice and the remainder with soup-stock. Partially seal glass jars. (Cap and tip tin cans.)

Sterilize the same as Chicken Stock.

Vegetable Soup.

Soak ¼ pound lima beans and 1 pound rice for 12 hours. Cook ½ pound pearl barley for 2 hours. Blanch 1 pound carrots, 1 pound onions, 1 medium-sized potato, and 1 red pepper for 3 minutes and cold dip. Prepare the vegetables and cut into small cubes. Mix thoroughly lima beans, rice, barley, carrots, onions, potatoes, red pepper. Fill glass jars or the enameled tin cans three-fourths full of the above mixture of vegetables and cereals. Make a smooth paste of ½ pound of wheat flour and blend in 5 gallons of soup stock. Boil 3 minutes and add 4 ounces salt. Pour this stock over vegetables and fill cans. Partially seal glass jars. (Cap and tip tin cans.) Sterilize the same as Chicken Soup.

Additional Canning Notes.

1. In the case of vegetables, which do not require long or intermittent sterilization in canning, it is a good plan, when preparing them for dinner, to cook enough extra to fill a can or two. This method saves time and fuel.

2. Broken or poorly-shaped tomatoes are just as good for soup as the perfect ones. Tomatoes canned for soup may be strained to get rid of the seeds before canning.

3. To can tomatoes whole, to use for salad during the winter, select small tomatoes, scald to loosen the skins, peel and plunge into boiling water for a few minutes. Lift from the boiling water and pack in jars, adding a teaspoonful of salt for each quart of tomatoes. Add a little boiling water to fill the jars if there is not juice enough without crushing the tomatoes, and sterilize as explained under "Canning of Vegetables."

4. In making apple butter, where the recipe calls for cider, it has been found that grape juice may be substituted, and many people consider that this gives a more delicate product than where cider is used.

PRESERVATION OF EGGS.

Packing in Water-Glass.

Eggs should be preserved during March, April, May, and June, when the production is greatest and the price is lowest. Eggs preserved in water glass can be successfully kept for as long a time as one year. They are practically as good as fresh eggs for all cooking purposes. The commercial water-glass solution may be obtained from any drug store. Water glass in the form of a powder is now on the market. It can be dissolved in a definite quantity of water, as stated in the directions on the package, and for this reason is more reliable than the commercial solution, which varies in concentration.

Directions.

If the commercial water-glass solution is to be used, mix 1½ quarts with 18 quarts of pure water; water which has been boiled is preferable. Stir the mixture until the ingredients are thoroughly mixed. A stone jar is the most suitable vessel for the mixture. Two eight-gallon jars are sufficient for 30 dozen eggs, using the amount of solution prescribed. After the water glass is thoroughly mixed, pour it into the vessels to be used, being sure that the vessels are absolutely clean. Place the eggs in the water glass, see that those at the top are submerged under at least two inches of the liquid, and cover the jars in order to prevent evaporation. Put the jars in a cool place where they will be undisturbed during the year.

Suggestions.

Preserve only absolutely fresh eggs; stale eggs will not keep in any preservative. Have your preservative ready to receive the fresh eggs as you get them. If there is any doubt as to the freshness of the eggs, candle them, or see whether they sink when placed in a dish of water. If an egg sinks, it is reasonably fresh.

Do not preserve dirty eggs or eggs that have been washed. Washed eggs will not keep because the protective gelatinous coating has been removed by the washing; and dirty eggs will become tainted in flavor.

Do not use the same liquid preservative more than one year. Use spring eggs; they will keep better than summer or fall eggs. Use infertile eggs; rather than fertile eggs for preserving. Do not leave eggs in the preservative longer than one year. Rinse the eggs with water, after removing from water-glass solution.

Eggs that are in good condition when removed from water-glass solution will usually remain good for at least two weeks. If it is desired to boil eggs preserved in water glass, prick a small hole through the large end of the shell before placing them in the water. The pores of the shell have been sealed by the water-glass solution, and without the pinhole the expanding air within the shell would burst it.

Hot-Dipping Method.

Eggs may be preserved by putting a few at a time in a cheesecloth bag and lowering into boiling water for ten seconds. Remove, cool, wrap each in paper and pack away in a cool place.

DRYING FRUITS.

The necessity of saving every pound of produce grown this year, will, no doubt, revive the practice of drying fruit on many farms. While it is difficult to give any fast rules to follow with the equipment used in the average home, where the fruit is dried mostly on racks over the stove or in the oven with a slow fire, the following methods used in kiln evaporators give some idea of the temperature and time required for drying.

In the kiln evaporator, most operators maintain a temperature of 155 to 165 degrees for the first five or six hours. If the temperature is raised higher than this the cellular structure of the fruit is destroyed, and a great deal of sugar lost by bleeding. Unless the temperature is kept up to this level, the surfaces of the fruit become slimy and further drying is retarded. By these signs, the housekeeper can regulate the temperature even where her equipment does not permit the use of a thermometer. After the first five or six hours some operators allow the temperature to go down to 130 or 135 degrees, open the ventilators widely, and continue the drying by using large volumes of air at lower temperature for ten to twelve hours, after which the temperature is brought up to 175-180 degrees, and kept there until the drying is completed. Those who use this method claim that it is economical of fuel, and that it makes a more springy, "lively" product.

In drying prunes, and berries, cherries, currants, etc., the temperature at the outset should not be allowed to rise above 125 or 130 degrees until the fruits have lost a considerable part of their water, as otherwise there will be expansion and bursting with consequent dripping. If ample air can be obtained, or if a good draught can be had through the kitchen where the fruit is being dried, a higher temperature, from 185 to 180 degrees may be employed in the last half of the drying period. If there is not a free circulation of air, however, the temperature must be kept below this point or the fruit will be partially cooked or dried outside while the inside is still moist.

To Determine When Apples are Sufficiently Dried.

Apples should be removed from the drying trays while they still contain slightly more moisture than the finished product is to have. One can learn only by experience how to judge accurately when the fruit is ready to remove, but some general tests may be used. If the fruit is sufficiently dry to take from the dryer, it will be impossible to press water out of the freshly-cut ends of the pieces, but they will be sufficiently elastic not to break when the piece is rolled into a cylinder. When a mass of slices are pressed firmly into a ball in the hand, they should separate at once when released. When the fruit has reached this condition it should be spread out on the floor or on a table in a dry room, to a depth of a foot or more, and stirred thoroughly once a day.

Some idea as to whether apples have been sufficiently dried may be gained by weighing them before and after drying. An average yield of dry fruit from Baldwin, Spitzenburg, or Ben Davis will be 13 to 13½ pounds from 100 pounds of fresh fruit. Jonathan and Greenings will yield from 13½ to 14 pounds per hundred of fresh fruit, while varieties like Russet and Grimes Golden will give from $14\frac{1}{2}$ to 16 pounds. Windfalls and immature fruits will make a slightly lighter product as they must have the water content reduced to a lower percentage in order to prevent spoiling.

Sun-Dried Fruits.

Rules which apply to such fruits as cherries, plums, peaches, quinces, apples, pears, apricots, are as follows:—

All fruits must be perfect and ripe. Cherries should be stoned before drying. Plums are wiped clean and stoned. Firm, ripe peaches are better if dried with the skins on. They must be brushed with a small vegetable brush or wiped with coarse towels, cut into halves and the stones removed. Apricots are prepared the same as peaches, but apples, pears and quinces are pared and cut into quarters and eighths, depending on the size of the fruit.

All fruits are dried in the same way: Spread them in a single layer on a board; have small posts at each corner of the board; cover it with a piece of mosquito netting, and set the board in the hot sun. When the sun is down bring the fruit indoors. Next morning turn the fruit over, and set again in the hot sun. If there should be rain or damp weather, the drying will have to be finished in a very moderate oven. If dried in the oven, care must be taken not to scorch the fruit.

The fruit must be perfectly dry before putting it into flour bags or sugar bags. When filled, tie the bags and hang them in a cold, dry place.

For sun-drying, about three hot, sunny days will be required, and the fruit must be turned quite often.

CURING PORK AND BEEF ON THE FARM.

While beef-rings have simplified the meat problems for the farmer's family in many localities, there is still a popular demand for home-cured pork. We are beginning to realize that the sugar-cured hams and bacon considered almost a delicacy by townspeople, may be relished just as much at home, and can be prepared so as to be not at all inferior to the article selling in stores for twenty or twenty-five cents a pound.

Pork, unlike beef and mutton, should be cut as soon as it is cooled through, and many butchers prefer to split the carcass as soon as it is dressed, to hasten cooling. The method of cutting most commonly followed is to remove the head about an inch back of the ears, taking out the shoulders between the fourth and fifth ribs and cutting off the hams about two inches in front of the pelvic bones. The bits cut off in trimming the hams to a smooth rounded shape may be used in the sausage meat or if very fat, tried out for dripping with other waste pieces of fat. The feet may be removed at the hock joints, but sawing them off a couple of inches above is better as the hams will then pack much closer in the barrel. The leaf must be peeled out if it has not been done when the animal was dressed, and the tenderloin and spare rib can then be taken out. If the quality of the bacon is to be the best, it must be cut close to the ribs. The side may be cut, lengthwise into three evenly-sized strips, or if it is to be cured and smoked, into two pieces, the upper one-third, called the back strip, for salt pork or lard, and the lower two-thirds for bacon. The ribs and neck bones are generally taken from the shoulder and the bloody spots, and neck meat trimmed down to the shoulder blade, the foot being removed above the knee-joint.

Being so easily preserved without deterioration in quality, pork is a good staple for the country larder. It does not contain so much building material as beef, and for this reason as well as for variety should be supplemented by fresh meat. It is a fine fuel food, however, and good curing overcomes to a great extent the difficulty of digesting due to the large proportion of fat. When we speak of this it must not be overlooked that bacon does not come under this objection; on account of the granular nature of bacon fat it is one of the most readily digested of flesh foods. The hams, shoulders and bacon strip may be cured and smoked, the loin cut into chops and roasts, or sliced, partially "fried", and sealed in jars for summer use, and all lean trimmings made into sausage, and fat trimmings into lard. The feet may be pickled and the head boiled for head cheese.

Preservatives and Curing.

The only preservatives necessary for perfect curing and the finest quality of cured meats are salt and sugar or molasses. Salt is an astringent, and if used alone makes the meat hard; sugar or molasses used with it keeps the muscle fibre soft as well as improves the flavor. Saltpetre preserves the natural color of the meat, and if used in small quantities may be almost harmless; it must be remembered, though, that it is a poison. Spices may be used for flavor. They also have an antiseptic effect while baking soda may be used in small quantities to sweeten the brine if there seems to be danger of its spoiling in warm weather. In this case it would be better to boil the brine or make a fresh supply.

Brine for Salt Pork.

Although the plain salt pork is not used so much as the sugar cured, many farmers prefer to preserve the sides at least in this way. A brine of 10 pounds of salt and two ounces of saltpetre dissolved in four gallons of boiling water makes good pickle for one hundred pounds of pork. The meat is kept in this until it is used. A clean hard wood barrel makes a suitable vessel for this, but a large stone jar is the ideal, as it can be so thoroughly scalded out and retain no odors.

Sugar Cured Hams and Bacon.

In sugar curing hams and bacon rub each piece with salt and let it drain over night, then pack in a barrel, putting the hams and bacon in the bottom and filling in with bacon strips. For each one hundred pounds of meat weigh out eight pounds of salt, two pounds of sugar and two ounces of saltpetre. Dissolve in four gallons of water, heat to boiling, cool and pour over the meat. Bacon strips should remain in this brine from four to six weeks; hams and shoulders six to eight weeks before smoking.

Dry Curing.

While dry curing requires more work than pickling, it is generally thought to preserve the flavor better. A mixture of five pounds of salt, two pounds of sugar and two ounces of saltpetre will do for one hundred pounds of meat. Andrew Boss, of the University of Minnesota, says: "Rub the meat once every three days with a third of the mixture." This would mean that the meat gets only three "Rubbings," so possibly the farmer who treats his every day for a fortnight is doing a lot of unnecessary work. After the last rubbing the meat should lie in the barrel for a week or ten days, when it will be cured and ready to smoke. It should be cured in a cool moist place in order that the preservative may penetrate well and evenly.

After meat is smoked there is still the difficulty of protecting it from insects. A coat of ground pepper helps a great deal, but if it is to be kept for any length of time, the pieces should be wrapped in paper and put in cotton bags which are then washed outside with a mixture of whitewash and glue.

Trying Out Lard.

After the killing this is a job that the housewife wants to get through with as soon as possible. The fat should be divided into separate lots according to the quality of lard it makes. The leaf fat which makes the best lard should be rendered out first and kept for pastry. The back strip at the side and trimmings from the ham, shoulder and neck also make good lard, and the fat taken from about the intestines should not be mixed with these.

When preparing the fat for trying, cut it up into pieces about an inch square so that they will all be tried out in about the same time. Any lean pieces should be removed as they are likely to stick and scorch. Fill a kettle about three-fourths full and put in a quart of water or if convenient a quart of hot lard to prevent the fat from burning before the heat brings out the grease. (Of course any one knows the danger of letting water drop into fat after it is hot). When done, cool slightly and strain through a muslin cloth. Stirring the lard occasionally while cooling, tends to make it white and smooth or adding a little baking soda will have the same effect.

Pork Sausage.

As the pork usually used for sausage comes from the shoulder, neck and trimmings it is likely to be too fat unless part of the fat is removed and used for lard. There should be at least three times as much lean as fat. The seasoning will vary, of course, to suit the individual taste, but a very good combination consists of twenty pounds pork, eight ounces of salt, two ounces pepper, one ounce sage. After the meat is put through the chopper it may be spread out and the seasoning sprinkled over, then put through the chopper again. This gives a more even mixing than working with the hands. Sausage meat will keep well in a jar with a thin coat of lard over the top, but if you want to case it it hardly pays to bother cleaning casings at home. Strong uniform casings cost very little or long muslin bags two or three inches in diameter may be used. If the meat is to be kept in these for some time they should be rubbed over the outside with melted lard.

Many people prefer sausage made of a mixture of pork and beef. In this case a good proportion to use would be two pounds lean pork, one pound fat pork, and one pound lean beef, seasoning the same as pork sausage.

Any tenderloin that is not used for roasts may be "fried" and put away in jars with dripping poured over it. The fat congealing over the top makes a seal under which the meat keeps well. When this is wanted for use it needs only to be heated in the oven, and it is just like freshly cooked meat. Some housekeepers prefer to keep part of the cured of the ham for summer use in this way.

We are all familiar with the process of making headcheese, the importance of soaking the heads over night and getting rid of the gristle and fat before pressing the cooked meat. A few beef bones boiled with the head meat gives a more jelly like consistency to the liquor.

Pickled Pigs' Feet.

Soak the pigs' feet for twelve hours in cold water. Scrape them clean and remove the toes. Boil until soft; four or five hours will usually be required. Salt them when partially done. Pack in a stone jar and cover with hot spiced vinegar. They are served cold, or split, dipped in beaten egg and bread crumbs and fried.

Corned Beef.

The pieces commonly used for corning are the plate, rump, cross ribs, and brisket, or, in other words, the cheaper cuts of meat. The loin, ribs, and other fancy cuts are more often used fresh, and since there is more or less waste of nutrients in corning, this is well. The pieces for corning should be cut into convenient sized joints, say 5 to 6 inches square. It should be the aim to cut them all about the same thickness, so that they will make an even layer in the barrel.

Meat from fat animals makes choicer corned beef than from poor animals. When the meat is thoroughly cooled it should be corned as soon as possible, as any decay in the meat is likely to spoil the brine during the corning process. Under no circumstances should the meat be brined while it is frozen. Weigh out the meat and allow 8 pounds of salt to each 100 pounds; sprinkle a layer of salt one-quarter of an inch in depth over the bottom of the barrel; pack in as closely as possible the cuts of meat, making a layer 5 or 6 inches in thickness; then put on a layer of salt, following that with another layer of meat; repeat until the meat and salt have all been packed in the barrel care being taken to reserve salt enough for a good layer over the top. After the package has stood over night add, for every 100 pounds of meat, 4 pounds of sugar, 2 ounces baking soda, and 4 ounces of saltpetre dissolved in a gallon of tepid water. Three gallons more of water should be sufficient to cover this quantity. In case more or less than 100 pounds of meat is to be corned, make the brine in the proportion given. A loose board cover, weighted down with a heavy stone or piece of iron should be put on the meat to keep all of it under brine. In case any should project, rust would start and the brine would spoil in a short time.

It is not necessary to boil the brine except in warm weather. If the meat has been corned during the winter and must be kept into the summer season, it would be well to watch the brine closely during the spring, as it is more likely to spoil at that time than at any other season. If all the brine appears to be ropy or does not drip freely from the finger when immersed and lifted, it should be turned off and new brine added, after carefully washing the meat. The sugar or molasses in the brine has a tendency to ferment, and, unless brine is kept in a cool place, there is sometimes trouble from this source. The meat should be kept in the brine 28 to 40 days to secure thorough corning.

Dried Beef.

The round is commonly used for dried beef, the inside of the thigh being considered the choicest piece, as it is slightly more tender than the outside of the round. The round should be cut lengthwise of the grain of the meat in preparing for dried beef, so that the muscle fibres may be cut crosswise when the dried beef is sliced for table use. A tight jar or cask is necessary for curing. The process is as follows; To each 100 pounds of meat weigh out five pounds of salt, 3 pounds of granulated sugar, and 2 ounces of saltpetre; mix thoroughly together. Rub the meat on all surfaces with a third of the mixture and pack it in the jar as tightly as possible. Allow it to remain three days, when it should be removed and rubbed again with another third of the mixture. In repacking put at the bottom the pieces that were on top the first time.

STORING VEGETABLES FOR WINTER USE.

S. C. Johnston, Toronto.

Vegetables which have been grown to perfection during the summer months with great diligence and care, and gathered while in a prime condition, may be stored for winter use. They will, however, deteriorate rapidly in flavor, and in some cases decompose so much that they are not useable, if proper care has not been exercised in placing them away for winter keeping. Unfortunately, many of the common methods employed on farms and commercial vegetable gardens do not apply to the average backyard garden, in that conditions are very different, and the quantities of vegetables stored are not nearly so abundant as in the former case. The following general information is given in the hope that many of the dwellers in the cities, towns and villages will have more success in keeping some crops which they have grown or purchased in the fall for winter use:—

In all cases it must be remembered that vegetables should receive careful handling. They should not be thrown from one part of the garden to another nor bounced down cellar steps or thrown in cellar windows. Unfortunately, many people have the idea that because a cabbage is only a large vegetable it can with impunity be treated much more carelessly than were it a piece of firewood. The vegetables should be the very best specimens grown in the garden, not too large, but firm and solid, and free from disease or other blemish. Poor, stunted plants should be consumed in the early fall, and the best ones placed away for winter purposes.

Quite possibly the cellar of the home is one of the best places to store the winter's supply of vegetables if it is properly handled. It must be dry, frost proof, and have abundant facilities for easy airing of the vegetable compartment. The most common mistake made by many city dwellers lies in the fact that they keep their cellars too warm, and do not provide for the circulation of fresh air. It is nearly always quite unnecessary to close the cellar windows before well on into December, and further, just because the window has been closed once it does not necessarily need to remain closed until April. The vegetable room should be thoroughly aired often, so that the atmosphere does not become stagnant. Care must, however, be exercised that the vegetables are not allowed to freeze. Where the heating appliances of the house are in the cellar it is almost essential and advisable that that portion of the cellar farthest from these appliances be used for storing the vegetables. A portion may be partitioned off and rough boards only need be used for this purpose. Such a room should, for best results, include at least one window on the sunny side of the house. This compartment may be arranged in a series of shelves and nails may be driven into the joints from which some vegetables may be suspended.

Potatoes.—In the city home there is no better arrangement for storing potatoes than building bins which hold two to three bushels of tubers. While it is not absolutely necessary to keep the potatoes from direct contact with the floor, it is better if this is followed out. Narrow strips of board a couple of inches wide may be laid on the floor and the potatoes placed on these. The potatoes in these bins should not receive any light, and to prevent this they may be covered with pieces of canvas or carpet. By the middle of winter it will be necessary to carefully sort over the tubers and remove any which have commenced to decay. One tuber which has developed a rot will spread the disease to all those close to it. Possibly in the month of March, the potatoes will have commenced to sprout, and they must be again sorted over and all the sprouts removed. It is advisable that these sprouts be removed before they are any length, as they can then be easily broken off by a gentle pressure of the thumb.

Onions.—Onions should be thoroughly dry and well cured before being taken into the cellar in the fall. Dampness in onions especially causes decay. The bulbs should be placed in slat boxes which allow a free circulation of air through the whole box. These too should be sorted over and any spoiled ones removed, and also any which have started to grow, placed by themselves.

Squash.—This vegetable seems to be the most difficult one to keep, as they are very susceptible to cold and moisture and must be kept warm and dry. They will possibly keep in a better condition for a longer period if they are kept in a room just a little warmer than the compartment in which other vegetables are kept. A room through which a chimney passes is in many cases recommended. Some recommend that they be kept on shelves and others that they be kept in barrels packed in excelsior or straw. If, however, only a few are to be kept they can be covered with rugs or bags and will come through the winter all right.

Beets, Carrots, Parsnips, Salsify and Turnips.—These are handled somewhat differently from other vegetables. They require more moisture than others for best results and should be immersed or covered with moist sand. Packing boxes are sometimes used for this purpose. An inch of slightly moistened sand is placed in the bottom of the box and then a layer of vegetables, and so on until the box is filled. If this seems too elaborate a plan for handling these roots they may simply be piled on the floor and covered with earth.

Celery.—This plant may be stored during the early winter months with fair success. Before any severe frost in the fall the plants with roots on should be taken up and placed in a box containing a couple of inches of moist sand. The roots should be placed as close together as possible. The room should be kept practically dark and a free circulation of air should be allowed. Toward Christmas the heads should be taken out and used.

Cabbage.—In the late fall before permanent freezing up the cabbage should be pulled up and stored for winter use. A few of the outside leaves may be taken off. They may be piled on shelves so arranged that the air will circulate freely around them or they may be tied up in bunches of three and suspended from the ceiling. A pit may be made in the dryest part of the garden and the cabbages piled in the form of a pyramid. They should be piled heads down and the succeeding layers bringing the pit to a peak at the top. Earth should be thrown over them as the season advances. If the pit is at all large an air vent should be left. This may be a piece of stone, pipe or a piece of tile set in the peak of the pit. In severe weather this ventilator should be filled with straw or excelsior.

Tomatoes.—Sometimes in the fall one sees a tomato vine covered with fruits which under ordinary circumstances would be of little use through freezing. If the whole vine is pulled up and taken to the cellar before it has been frosted the fruits will ripen and may be used up until Christmas in many cases. The vine should be suspended from the ceiling and the windows should be practically darkened.

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Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

DAIRY CATTLE

A. Leitch, H. M. King, and J. P. Sackville.

THE ECONOMY OF DAIRY FARMING.

The dairy cow is the most economical producer of human food of all our farm animals. No other animal can turn into so much money the great range of animal foods, roughage and concentrates, grown on the average farm. The product of no other farm animal, when sold off the farm, removes so little of the fertilizing constituents or plant food from the soil. She is the only farm animal that every day yields a marketable product within twenty-four hours of the time her food is fed. It has been proven by careful experiments that a cow yielding thirty lbs. of average milk per day will in one week produce 26¼ lbs. of dry matter, all of which is edible and immediately available for human consumption. In the same time a fattening steer gaining two pounds per day, on approximately the same feed, will produce only 10½ lbs. of edible dry matter. It has also been shown that from 100 lbs. of digestible matter in the food, that the dairy cow produces 18 lbs. of digestible solids suitable for man; the pig, 15.8 lbs.; poultry, as eggs, 5.1 lbs., as meat, 4.2; lambs, 3.2 lbs.; steer, 2.8 lbs., and sheep, 2.6 lbs., clearly demonstrating that the dairy cow easily leads all farm animals in economy of feeding operations.

With this great advantage in economy of production, it is quite easy to discern why the dairy cow tends to supplant the meat-bearing animals in regions where land is high priced and population dense. She gives the greatest financial returns from the feeds grown on the farm, and therefore enables the owner to get the necessary added returns from his high-priced land. Still easier is it to see why the dairy cow has supplanted the meat-bearing animals where land has become impoverished. Here she enables the farmer to get the greatest financial return from what little his land does produce and at the same time returns to the soil practically all the plant food taken out by the feed she eats.

In spite of her great superiority over other animals, in the use she makes of her food, there are some factors in the dairy industry that restrain or limit the spread or increase of dairying to the greater exclusion of other lines of live stock production. First in importance is the greater amount of labour entailed. Roughly speaking, it takes seventy-five hours to milk a cow for an ordinary lactation period. This amount of labour has no counterpart in other branches of farming. It is extra work above feeding and other care. It must be done twice a day every day she milks, no matter what conditions of weather, what rush of work, or what social duties prevail. Therefore, as a business, dairying does not appeal to the farmer who can make a reasonable living or income otherwise. Again, there is an enormous bulk of dairy products derived from cows that are not strictly dairy cows.

This butter and milk comes from a large number of small herds at the time of the year when cows are fed the cheapest, in spring and summer. These herds are cheaply wintered on the roughest and most unmarketable foods grown and, more important, are milked with the least expensive labour, the farmer's own family, at those times of the year when labour is at its greatest demand. These herds are the beef herds or general farming herds of the country, and although the contribution of each to the butter market is small the sum total is a very large amount of butter that has an appreciable effect in keeping down the market price of butter fat, which is in the final analysis the controlling factor in the price of all dairy products.

In the course of history of a new country, such as ours, the growth of dairying is obviously slow. But steady growth is inevitable as according as populations increase, lands become more valuable through proximity to great markets or

Holstein Cow—Young Springwood.

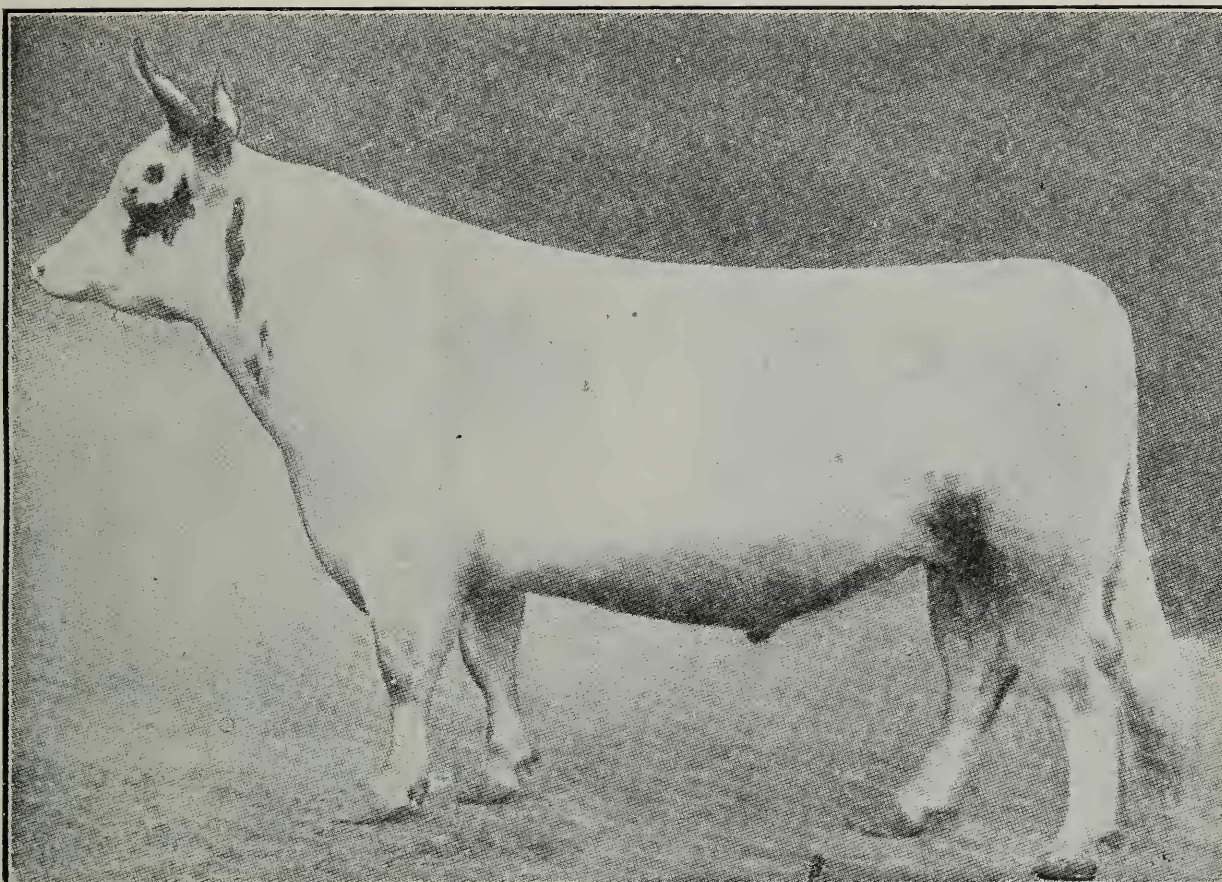
Bred and owned by Ontario Agricultural College. Record at five years old: 20,110 lbs. milk; 819 lbs. butter fat; 1,024 lbs. butter. The highest known record on twice-a-day milking.

become impoverished through bad cropping systems, and the dairy cow introduces herself as the great stabilizer of lands and peoples, the one animal without whose help the human race could not exist.

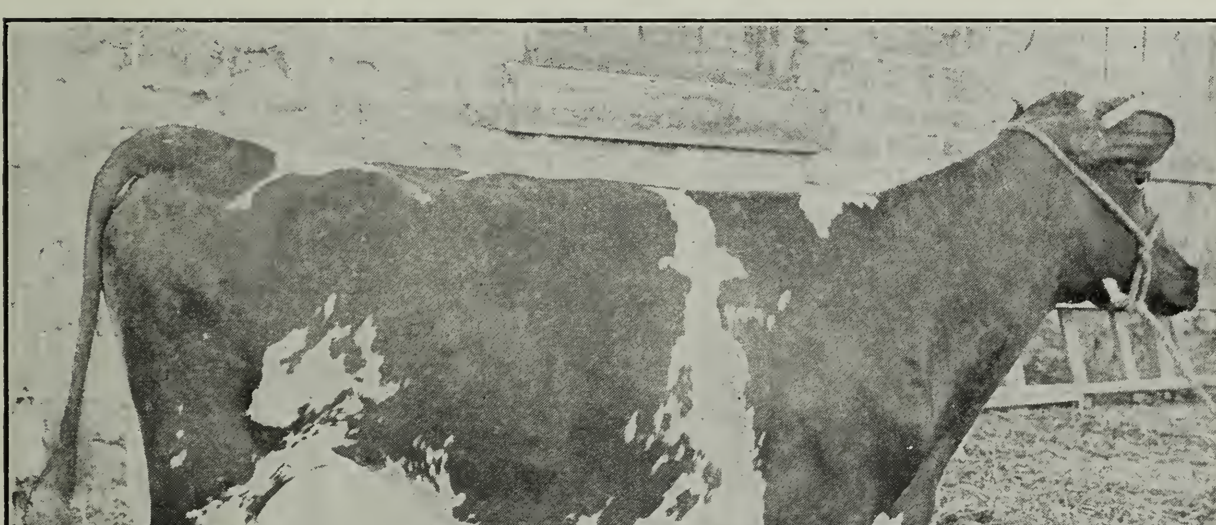
BREEDS OF ONTARIO DAIRY CATTLE.

Ayrshire.

The Ayrshire breed of cattle originated in the County of Ayr, which is in Southwestern Scotland. The early history of Ayrshires reveals the fact that they were developed under adverse conditions. Much of this district is rough and hilly, feed was scarce, pastures scant, and little care was given to live stock. These conditions resulted in the development of a hardy, thrifty type of cattle, as only the more vigorous animals were able to exist. The native stock was improved by crossing with other breeds, and by the selection of the best of these. It is claimed that Dutch cattle were first used with a view of increasing the milk



Ayrshire Bull—Hobsland Sunrise (Imp.)—39427—(10687).
First in class and Junior Champion, Toronto, 1913. First in class at Ormstown and Ottawa. First and Champion at local shows, 1914. Owned by the Ontario Agricultural College, Guelph, Ont.



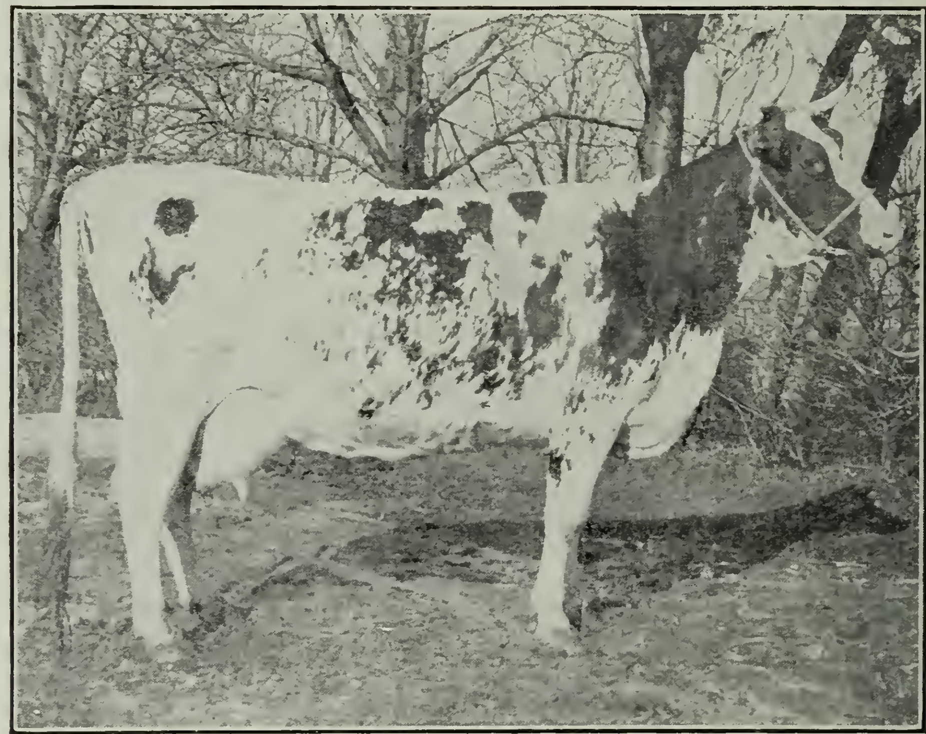
Ayrshire Cow—Milkmaid of Orkney, 59834.
Canadian 4-year-old Butter Fat Champion. 14,883 lbs. milk; 596 lbs. butter fat. Bred

flow, later Shorthorn and Alderney blood was infused which improved the breed in respect to smoothness of form and quality of milk.

The color and general characteristics of this breed are quite distinct. Red and white, or brown and white, is the prevailing color, the two colors are distinct and do not blend to form a roan. The very striking feature of the Ayrshire is the rather long, large horns which, as a rule, curve outwards and upwards and, in most cases, slightly backwards.

The size of the Ayrshire is medium, ranking between the Jersey and Holstein-Friesian. Mature cows will weigh about 1,000 lbs. and upwards, and bulls approximately 1,500 lbs.

Cows of this breed have produced very good yields of milk, but as a breed



Ayrshire Cow—Lady Jane, 30886.
Silver Cup Winner in Mature Class, 1916. 19,405 lbs. milk; 786 lbs. butter fat. Bred and owned by A. S. Turner & Son, Ryckman's Corners, Ont.

they are noted for a good uniform production of fairly good quality of milk, rather than for remarkable records. Coupled with this, they are economical producers, responding well to good feeding and management and, even under conditions that are not the most favorable, they will make a reasonably good showing.

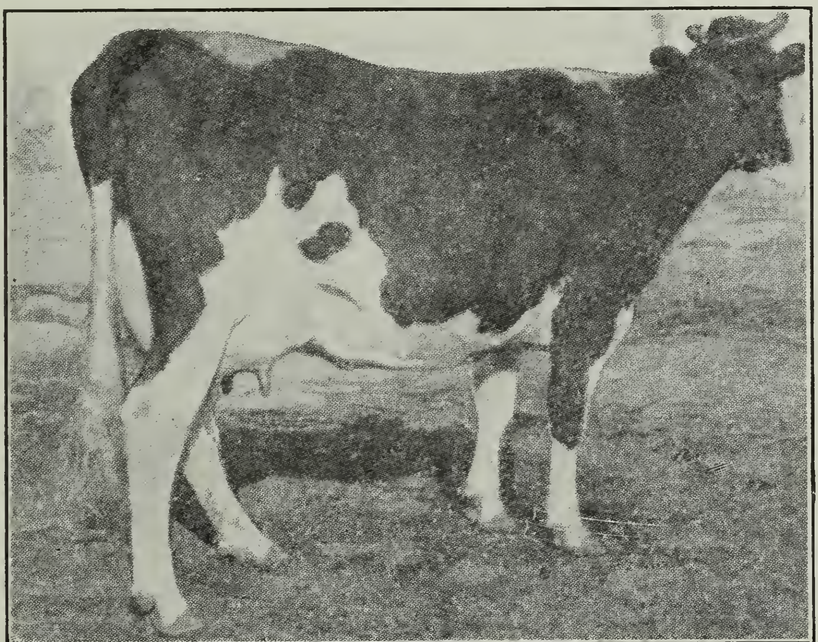
Ayrshires were brought into Canada early in the 19th century by the Scotch settlers. Since that time numerous importations have been made, and we find the Ayrshire distributed fairly well over the Dominion, more particularly in Eastern Ontario and Quebec.

Holstein-Friesian.

This breed is said to be one of the oldest in existence. Originating in North Holland and Friesland, they can be traced back for over two thousand years, continuously occupying this territory and always famous for dairy purposes. Very little, if any, foreign blood was introduced in the development of this breed, improvement being brought about by good care in feeding and management and careful selection.

These cattle have been known both in Europe and America by several different names—" Holland Cattle," " Dutch Cattle," " Holsteins," " Dutch Friesian," " Netherland Cattle," and " Holstein-Friesian." These are all the same breed. The names " Dutch," " Holland," and " Friesland " refer to cattle from Holland,

Holstein Bull—Hill Crest Ormsby De Kol.
Sire, Sir Admiral Ormsby; Dam, Rauwerd Countess De Kol Lady Pauline, whose A.R.O. record is over 29,000 lbs. milk in one year. Bred and owned by G. A. Brethen, Norwood, Ont.



Holstein Cow—Toitilla of Riverside, 12254.
Canadian Champion Mature Cow in R.O.P. 24,094 lbs. milk, 1,058 lbs. butter in one year. Owned and developed by Jos. O'Reilly, R. R. No. 9, Peterborough, Ont.

and " Holstein " is the name given to cattle of practically the same breeding and type from the Province of Holstein in Germany. Considerable confusion was caused by this diversity of names, during the time of the early importations to America, and to overcome this the breeders and importers decided upon the name " Holstein-Friesian."

Characteristics.—In size the Holstein-Friesians are the largest of the dairy breeds. Full grown cows will weigh from 1,100 to 1,400 lbs. The bulls at maturity are very large and heavy, often attaining a weight of 2,500 lbs.

The accepted color of this breed is black and white, in any proportion. These two colors are seldom mixed, the outlines of the markings being usually fairly distinct.

The introduction of the Holstein-Friesian into America dates back to late in the seventeenth century. These were brought over by the early Dutch settlers into New York. About one hundred years later more importations were made from Holland. Since then they have increased rapidly by importations and by breeding, and are now pretty well distributed over United States and Canada.

Having been bred for so many years especially for dairy purposes, it is only natural to expect large development in all those parts that relate to milk production. Speaking generally, they are noted for their large flow of milk, not a few very high milk records have been made by members of this breed. During the past few years more attention has been given to weighing the fat content of the milk, with the result that Holstein milk from the standpoint of quality is now looked upon more favorably than it was some time ago.

Jerseys.

The native home of the Jersey is on the Island of Jersey, being one of the Channel Islands owned by Great Britain. The origin of this breed is more or less speculative. It is believed, however, that they are descended from the cattle of Normandy and Brittany in France. The cattle from these countries were supposed to have some characteristics in common with the Jerseys as we know them to-day, this is particularly true of the fawn and dark color.

The Island of Jersey, being small in area, containing less than 30,000 acres, lends itself to keeping the herds pure, and the Islanders have taken advantage of this. As early as 1763 laws were enacted prohibiting the importation of any other breed of cattle, except for slaughtering purposes. With a view of further improving and protecting the breed, the Royal Jersey Agricultural Society was organized early in the nineteenth century and, by means of careful selection, the breed rapidly improved in quality and uniformity of type.

The Jerseys have been referred to as the aristocrats among dairy cattle. The foundation for this may probably have its origin in the fact that we have records of cattle resembling Jerseys being brought from France and the Channel Islands into England to decorate and add dignity to the estates and parks of the nobility. The establishing of these herds in England has had much to do with the development and improvement of the Jerseys.

Jerseys were introduced into the United States, notably Connecticut, new York and Pennsylvania, about the middle of the nineteenth century, and into Canada a few years later. Since that time numerous importations have been made, and these form the basis for the herds now in existence in Canada and in the United States.

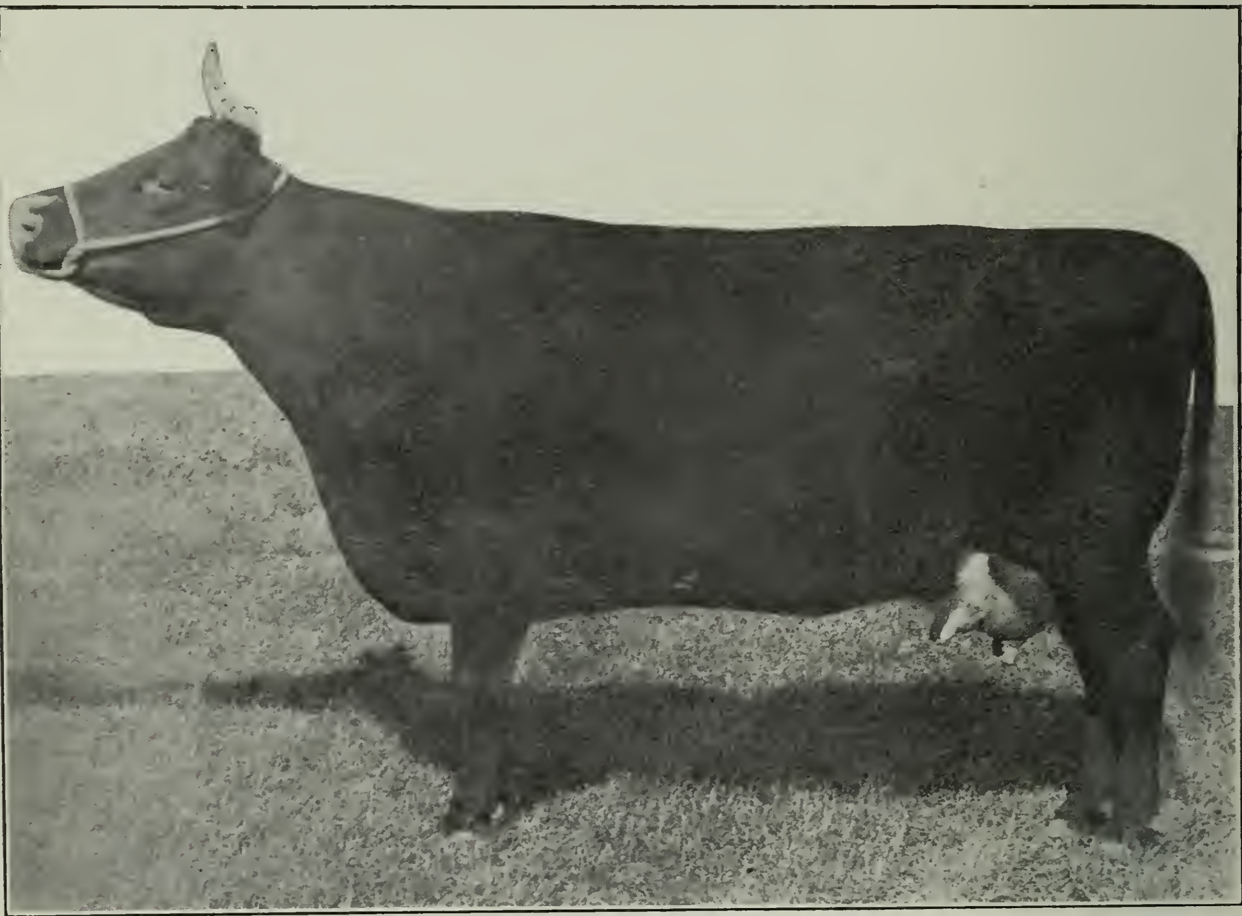
Characteristics.—The color of the Jersey is variable, running from a light fawn to a brown, gray, or red fawn. In some individuals the body may be nearly black. However, the fawn color over the entire body is preferred. In recent years, however, probably less importance has been attached to the color of the Jerseys than formerly.

Jersey Bull—Sultanne's Raleigh.
One of the best examples of Jersey type ever produced in Canada. Owned by B. H. Bull & Sons, Brampton, Ont.

Jersey Cow—Sunbeam of Edgeley.
Canada's Official Butter Fat Champion over all breeds. R.O.P. record: 18,153 lbs. milk, 926 lbs. butter fat. Bred and owned by James Bagg & Sons, Edgeley, Ont.

The Jersey is essentially a dairy animal, and in conformation represents the lean, muscular appearance characteristic of this type. Withal there is a blending of all parts which gives the breed a general appearance of smoothness. In size they are the smallest of the dairy breeds, the mature cows ranging from 700 lbs. upward to 1,000 lbs. The average weight of one large American herd was slightly over 1,000 lbs. The mature bull should weigh at least 1,300 lbs. The general tendency with this breed is to reach maturity at rather an earlier age than some of the other dairy breeds.

The Jerseys have long been recognized as producers of milk rich in butter fat, the fat globules are comparatively large and the cream easily separated. Thus this breed has been, and will continue to be, well adapted for those dairymen wishing to produce butter of good quality. Although there are individuals of



Shorthorn Cow—Iford Waterloo Baroness (Imp.), 104584.
R.O.P. record at five years: 13,440 lbs. milk, 500 lbs. butter fat. Average production for four years at 2, 3, 4 and 5 years old: 11,000 lbs. milk, 397 lbs. butter fat.
Owned by Ontario Agricultural College, Guelph, Ont.

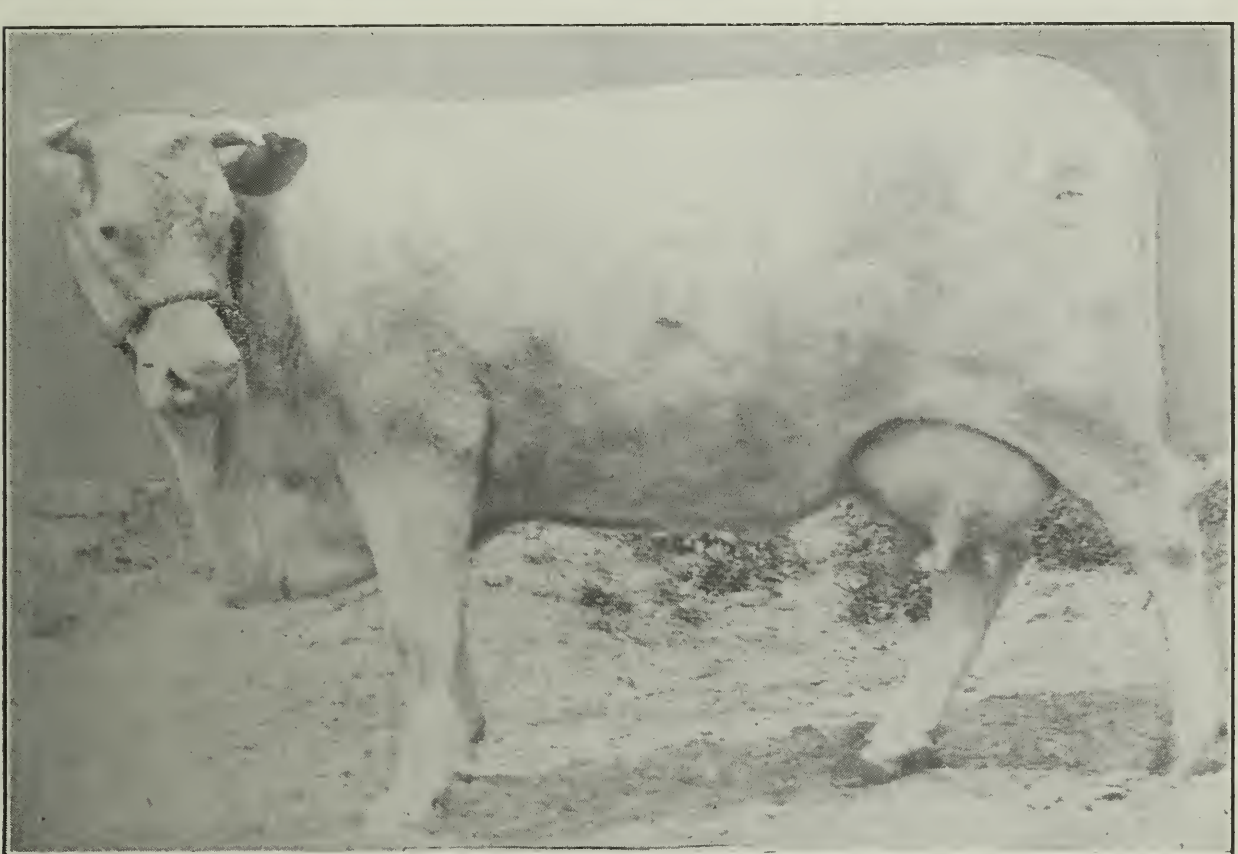
this breed that have ranked high for quantity of milk, at the same time they are not characterized by large flow, quality of milk rather than quantity are the merits of this particular breed.

Dual-Purpose.

The dual-purpose type of cattle is understood to represent one midway between the two special-purpose breeds, *e.g.*, dairy and beef. What is looked for is an animal that will give a reasonable flow of milk and, at the same time, in form and general characteristics, resemble in a general way what is expected in the beef breeds.

Considerable interest has centred around this particular kind of cattle within the past few years, notwithstanding the fact that there is a tendency on the part of not a few breeders of live stock to produce animals for a special purpose. Conditions prevailing in some parts of the Province, coupled with the favorable attitude of some men relative to mixed farming, do not always make it profitable or desirable to keep cattle of the special-purpose breeds, and in such cases the dual-purpose cow seems to fit in very well.

It is rather difficult to say just where the line should be drawn between dual-purpose and special-purpose cattle, or, in other words, to definitely state what really constitutes a dual-purpose animal. Some breeders have emphasized milking qualities and have in their herds individuals that for yield of milk would compare favorably with some strictly dairy-bred animals. Others working with this type



Shorthorn Cow—Golden Rose (Imp.), 104582.
R.O.P. record at seven years: 12,395 lbs. milk, 560 lbs. butter fat. Owned by Ontario Agricultural College, Guelph, Ont.

have sacrificed something in the way of milk and selected animals that conform pretty well to the beef breeds.

The ideal dual purpose cow in type and general conformation is a combination of the beef and dairy animal, not possessing the blockiness and smoothness of form and lacking the wealth of fleshing of the beef animal, and yet showing these characteristics to a reasonable extent. Something of the angular, wedge-shaped form which is accompanied with milking qualities of the dairy cow must be expected. In development of udder and milk vessels, the dual-purpose cow should give evidence of one that will perform fairly well at the pail.

Shorthorns.—So far as Ontario is concerned, the Shorthorn breed represents the only dual-purpose animal, very few of the other recognized dual-purpose breeds, as, for example, Brown Swiss, Devons and Red Polls, being bred to any extent.

The development of the dairy Shorthorn which took place in England goes back to about the beginning of the nineteenth century. During this time much valuable work was accomplished in improving the Shorthorn breed. One of the prominent men connected with this work was Thomas Bates, who in his breeding operations not only sought to improve the beef qualities of his herd, but also kept careful records of milk yields, and, in this way, developed a strain of cattle that have ever since been recognized as dual-purpose animals. Such Shorthorn families as "Duchess," "Waterloo," "Wild Eyes," and "Oxford," still famous for their dairy as well as beef qualities, were founded by Bates. From these noted strains or families have sprung many of the present day dual-purpose Shorthorns found in Ontario. In justice to the Shorthorn as a breed, it should be mentioned that even among the Scotch bred Shorthorns are to be found cows that are no mean performers at the pail.

Dairy Shorthorn herds have also been developed in this country that may have no connection with Bates-bred cattle. Careful breeding, the selection of animals noted for a good yield of milk, together with hand milking of cows, have resulted in building up some very creditable herds of dual-purpose cattle in different parts of Canada.

SOME PRINCIPLES OF BREEDING.

Modern science and recent discoveries of certain laws of inheritance have not revolutionized live stock breeding operations of to-day. They have, however, done a great service in freeing breeding of the detrimental influence of certain time-honoured beliefs which, in the light of present knowledge, appear as absolute falseness.

Variation is universal. No two are exactly alike. No matter how closely two animals may resemble one another, there always exist certain minute differences. Experience has shown that within a particular breed, or tribe, or strain, we are likely to have exhibited certain variations which seem to be peculiar to it. Hence, it is essential that in order to gain the greatest success with the breed that is our favorite, we must be well informed as to its history. Then, knowing the history and variations most likely to occur, sound judgment must be used in departing from any of the definite principles of live stock breeding.

It is interesting to note that within comparatively few years a special kind of animal has been produced for practically every utilitarian purpose. This rapid progress has largely come about by breeders keeping always in mind two things—utility, and beauty of form. If the breed we are using is not especially pleasing to our sight, failure is sure to follow. The same thing is true if the breed is lacking in utility. We have no place for the faddist stock breeder.

Observation was the chief asset of early breeders, and from their observations they came to conclusions which, in a measure, were correct. They observed that in ordinary breeding operations, like tends to produce like; also that pedigree counts. It was realized that a certain dependence could be placed on an animal's pedigree, but of the value of this working of heredity they were not sure. It was also considered that in a general sense, in-breeding brings uniformity of type but with it a loss of vigor. Likewise, cross-breeding increases vigor, but destroys uniformity in the herd or flock. With these principles well in mind, it is not surprising that much advancement has been made.

Grading.—This implies the mating of a common or relatively unimproved parent with one that is more highly improved, meaning a pure bred. This is usually accomplished by using a pure-bred male, because in this way one animal's influence is distributed over the entire herd. Grading is the economical method of improving live stock, and consequently is the method in most general use. The reputation of any breed is made more on the grades of that breed than on its pure-bred representatives. It is somewhat surprising to note the percentage of purity in animals with a few top crosses. The progeny of a grade dam from a pure-bred sire is known as a half breed or 50 per cent. pure blood. The progeny of a half breed from a pure-bred sire is ¾ or 75 per cent. pure blood. In this way we arrive at ⅞, or 87.5 per cent. pure blood; 15/16, or 93.75 per cent. pure blood; 31/32, or 96.87 pure blood; 63/64, or 98.44 pure blood, and so on. Since pure-bred animals are more prepotent than grades, these percentages are no doubt higher than can be shown mathematically.

Crossing.—Means the mating of animals belonging to different breeds, and implies that each is pure bred. Although this system of breeding has produced some wonderfully good animals, yet it is generally not a wise course to follow. The great danger lies in the fact that there is always a tendency to keep the cross-bred progeny for breeding purposes and seldom, if ever, do they breed as well as their individual merit woul lead us to expect.

In-Breeding.—Three forms of in-breeding are recognized: Mating the sire with his daughter, the son with his dam, and brother and sister matings. With the first two methods we have some idea what the combination will result in, because we get in the offspring a preponderance of the blood of one individual. In the first-mentioned case, there would be a concentration of three-quarters of the sire's blood lines, and in the second three-quarters of the dam's blood lines. Although brother and sister matings have in some instances given good results, the chances for inferiority are greater than with the other methods. It must be borne in mind at all times that we can intensify both the good and the bad by in-breeding. There is ground for the popular objection that in-breeding impairs vigor and fertility, and these factors are sure to be intensified if they were lacking in the original animals. Neither in-breeding nor the reverse will be a success unless the animals are suited to each other, unless we select strictly and rigidly for vigor and high fertility, and are careful to note that there are no weaknesses in common, and as much good as possible. The practice of in-breeding should never be adopted by the novice and seldom by the skilful breeder.

Line Breeding.—Line breeding differs from in-breeding merely in degree. The number of ancestors of a line-bred animal in some particular generation, or generations, is fewer than the maximum possible number. It is a mild form of in-breeding, and has been productive of much good when judiciously practiced by experienced breeders. Many of the most noted sires of all classes of live stock have been line-bred individuals. Like in-breeding, however, it is not a safe practice for the average breeder.

Vigor and Fertility.—Successful live stock production depends a great deal on a proper degree of constitutional vigor in breeding animals. It is essential to long life and heavy production. Together with lack of vigor, imperfect sexual development is one of the most common defects in animals. Fertility is an unseen quality, and one that is most often neglected, yet there is no doubt but that it is a heritable character. It is a relative quality. All, as a rule, produce some offspring. Note the final results as shown in the table below, where the progeny of three cows, each possessing a different degree of fertility, is studied. "A" produces two calves, one of each sex, then becomes infertile. "B" produces four calves, and "C" six calves before losing their powers of reproduction.

Cow	Total Number of Calves	Females			
		1st Generation	2nd Generation	3rd Generation	4th Generation
A	2	1	1	1	1
B	4	2	4	8	16
C	6	3	9	27	81

It is assumed that the female offspring of the original cows were prolific to the same degree as their dams, and the likelihood is that they would be. The progeny of "A" would never build up a herd, and "C's" progeny would soon dominate. It is true that we can hardly over-estimate the value of the old and tried females in our herds. It is history that the reputations of many of our prominent stock breeders have been made largely on the merit of some few exceptional individuals, either male or female, in their herds which possessed a high degree of constitutional vigor and sexual fertility, and were propotent for these qualities. When our standards are against the highest fertility they are dangerous, if not fatal, to the breed.

NUTRITION.

The process of nutrition, or the use which the animal makes of its food, has long been a matter of careful study and experiment among scientists all over the civilized world. In general the animal body requires food for the following purposes:—

(1) To maintain the bodily functions of the animal—respiration, blood circulation, digestion, etc., and restore waste.
(2) To provide body heat, and keep it at normal temperature.
(3) To provide energy for natural movements of the body, and for external work.
(4) To provide, in the immature animal, material for growth in all parts.
(5) To provide, in the female, material for the production of milk.

Investigation has found that there are different elements or substances which are necessary in foods to supply the above requirements in the animal body. These nutrients, as they are called, are all found in varying proportions in the different fodders and grains grown on farms. They may be divided roughly into classes:—

(1) Proteids or albumens.
(2) Carbohydrates.
(3) Fats.
(4) Ash or mineral matter.

These substances make up the dry matter in the feed.

The proteids or protein compounds are those containing nitrogen. They enter largely into the formation of lean flesh, or muscle, hide, hair, blood and all the tissues of the internal organs, and also into the composition of milk. Protein matter in the food is absolutely essential to life itself in the animal, and no other nutrient in the food can take its place in the formation of the above parts of the animal body. It is known, however, that proteins can take the place of the other nutrients in the work which they do in nutrition. There appears to be a great necessity for protein in stimulating the various functions of the different organs of the body, and as there is a constant breaking down in the tissues of these organs while they are at work, a constant supply of protein is necessary to supply this waste. In the production of milk, protein plays an important part. About 25 per cent. of the total dry matter in milk is protein in its nature, and in addition to supplying this the protein in the food must supply enough to stimulate the milk-making machinery of the cow's body, as protein is the cell stimulating nutrient of the food. Protein is found in greatest proportion in such feeds as alfalfa hay, and clover hay, wheat bran, cotton seed meal, oil cake, and gluten meal.

Carbohydrates are the starches, sugars, fibres and such allied constituents of the food. Their chief function in the body is to supply heat and energy, and they are also the source of much of the fat stored up in the body by fattening animals. They are divided roughly into two classes, nitrogen free extract, such as starch, sugar and gums, and crude fibre, or cellulose, the more indigestible woody part of the plant or grain. The carbohydrates form the largest proportion of all the nutrients in farm grown cattle foods. Grains like corn, barley and oats, have from 50 per cent. to 70 per cent. of nitrogen free extract, and 10 to 13 per cent. crude fibre, while rough feeds like hay, straw and corn fodder have 35 to 40 per cent. nitrogen free extract, and 30 to 40 per cent. of the more indigestible crude fibre. In addition to supplying heat and energy to the body, the carbohydrates provide much of the energy for manufacturing milk, and also the material necessary for the milk sugar, and also much of the butter fat in the milk.

The fats in the food play the same part in the process of nutrition as do the carbohydrates. They also are the source of heat and energy in the body and supply to some extent the fat laid on by the animal when gaining in weight. In the case of dairy cows, fat in the food is also the source of part of the fat found in the milk. While fats have the same function in animal nutrition as carbohydrates, it is stated that one pound of fat is equivalent to about two and one-quarter pounds of carbohydrates for the production of heat and energy.

The ash in the food is the mineral matter that is found in all parts of every plant that is grown. Its use in the animal body is to form bone and to assist in the manufacture of the juices and fluids of the digestive tract of the animal. In the production of milk it also supplies the small percentage of ash found therein.

In addition to the above nutrients all feeding stuffs contain greater or lesser amounts of water, ranging from about 10 per cent. in the case of grains and cured hay, to 90 per cent. in the case of roots and green soiling and pasture crops. This water is of no greater feeding value than that from a well or stream, but the degree in which it is present determines largely the succulence and palatability of the feed, as is seen most easily in roots and green crops of all kinds. In the animal body water is found in every tissue, organ and fluid, and, as is well known, is absolutely essential to life itself, while best results from feeding of any animal depends upon a plentiful supply every day. Water forms about 87 per cent. of the total bulk of milk, and its use is therefore of prime importance in dairy cattle feeding.

To determine the proper amount of each of the different nutrients that should be fed for the profitable production of milk, has been a profound study by many live stock investigators and scientists for the past fifty years. To such a success has this been carried that it is now pretty well determined just what amounts of the various nutrients are necessary for the animal under nearly all conditions. Moreover, the analysis of rations fed by successful feeders, who feed from experience and judgment only, show that their rations correspond very closely with those advised by investigators, as the result of experimental work. It is true there is considerable variation in the digestive and productive ability of individual cows of the same breed, size and bodily condition, so that it is impossible to lay down exact amounts to be fed of the various nutrients in the feeds. It is true also that exact figures cannot be given of the amounts and digestibility of the various nutrients in all classes of feed stuffs at all times. These vary considerably with weather at harvesting, stage of maturity, and storage conditions of the farm crops and feed stuffs being fed. These factors must be taken into consideration by the feeder himself, who must, in addition, study the likes and capacity of his individual animals if he is to make the best use of the results of the work of investigators along feeding lines.

Feeding Standards.

The investigation work mentioned above has culminated in what are commonly called Feeding Standards. In milk production a feeding standard is a table showing the approximate amount of the various nutrients a cow of 1,000 pounds live weight should receive in her feed, to produce varying amounts of milk daily, to give best results. All kinds of feeding stuffs have been analyzed so that the proportions therein of the various nutrients, protein, carbohydrates, fats, ash and water are pretty well established. At the same time the animal cannot digest or assimilate all of those various constituents of the different food stuffs. But it has been established by much experimenting about what percentage of the various nutrients, in each of the different feeds, is digestible. For instance, it is known that oats contain about 11.4 per cent. of protein, or 11.4 pounds protein in 100 pounds of oats. It is also known that about 77 per cent. of this protein, or 8.8 pounds is digestible, so that oats are said to contain 8.8 pounds digestible protein. Red Clover, on the other hand, contains 12.3 pounds protein in 100 pounds; just 50 per cent. of this, or 7.1 pounds, is digestible. So it is seen that though 100 pounds oats contain less protein than 100 pounds of red clover hay, the oats have actually more protein that is available because it is more digestible. In contemplating feeding standards it is necessary, therefore, to take into account only the digestible portion of the nutrients of the different feeds. When applying feeding standards, to milk production, in addition to the nutrients mentioned, the total amount of dry matter in the ration is the important factor. All ruminant animals (those that chew the cud) require a bulky ration in order to keep their large digestive organs properly distended. The dry matter in a ration for dairy cows (that part which gives bulk) must always be considered when discussing rations.

Feeding standards have been propounded by various live stock investigators in Europe and America. The earliest and most simple and complete standard to be presented is called the "Wolf-Lehman Standard," that portion of which, dealing with milk production, is herewith given:—

TABLE I.—DIGESTIBLE NUTRIENTS REQUIRED DAILY BY MILKING COWS PER 1,000 LBS. LIVE WEIGHT.

Dairy Cow Yielding.	Dry Matter.	Digestible Nutrients.			Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	
11 lbs. Milk daily	25	1.6	10.0	0.3	1:6.7
16.6 " "	27	2.0	11.0	0.4	1:6.0
22.0 " "	29	2.5	13.0	0.5	1:5.7
27.5 " "	32	3.3	13.0	0.8	1:4.5

NOTE.—Nutritive ratio is a term used to describe the proportion of digestible protein to digestible carbohydrates and fat in a ration. In making the calculation the fat is multiplied by 2¼ before adding to the carbohydrates.

This Wolf-Lehman feeding standard was for the period of thirty-five years previous to 1907 recognized as the most useful and accurate so far propounded. It was largely used by investigators and practical feeders because of its great simplicity. With tables containing the amount of various digestible nutrients in the feeds at hand, it was a comparatively simple calculation to figure out a ration that would be complete, economical and closely conform to the requirements of the animal.

About ten years ago, however, it was discovered by American investigators that in some respects, and in relation to some classes of live stock, the Wolf-Lehman standards were inaccurate. Some of the recommendations were not properly applicable to American conditions. This was especially true with dairy cattle. It was found that the amounts of dry matter and protein recommended by this standard were too high for economical feeding under American conditions. To determine the true values for such conditions much work has been done by animal nutrition experts on this continent during the last ten years. As a result, valuable information along this line of work has been submitted by Professor Haecker of Minnesota, Profs. Woll and Humphrey of Wisconsin, Prof. Savage of New York, and Prof. Eckles of Missouri. The recommendations of these men, which are much in agreement though stated in different terms, have been drawn upon largely by the writer in submitting herein the following tables showing the approximate requirements for economical rations for cows giving the various quantities and qualities of milk, that are representative of Ontario conditions. On account of the simplicity and ease of application of the Wolf-Lehman standard, the amounts of the different nutrients are stated in that form, except that the fat is reduced to its equivalent in carbohydrates and included in the same column as digestible carbohydrates and fat.

TABLE II.—MODIFIED WOLF-LEHMAN STANDARD.

	Dry Matter	Digestible Protein	Dig. Carbohydrates & fat x $2\frac{1}{4}$
1000 lb. cow giving 3.5% milk—	Lbs.	Lbs.	Lbs.
Cow dry	14.	.70	7.22
Cow giving 10 lbs. milk	16.5	1.25	9.83
" " 15 " "	19.	1.55	11.13
" " 20 " "	21.5	1.83	12.44
" " 25 " "	24.	2.12	13.75
" " 30 " "	26.	2.39	15.05
" " 35 " "	28.	2.67	16.36
" " 40 " "	30.	2.95	17.66
1000 lb. cow giving 4% milk—			
Cow dry	14.	.70	7.23
Cow giving 10 lbs. milk	16.5	1.30	10.09
" " 15 " "	19.	1.60	11.52
" " 20 " "	21.5	1.94	12.91
" " 25 " "	24.	2.28	14.30
" " 30 " "	26.5	2.59	15.72
" " 35 " "	29.	2.91	17.13
" " 40 " "	31.	3.16	18.60
1000 lb. cow giving 4.5% milk—			
Cow dry	14.	.70	7.23
Cow giving 10 lbs. milk	17.	1.33	10.36
" " 15 " "	19.5	1.65	11.92
" " 20 " "	22.	2.00	13.45
" " 25 " "	25.	2.36	15.00
" " 30 " "	27.5	2.66	16.55
" " 35 " "	30.	2.99	18.10
For each 100 lb. increase in weight of cow add	1.4	.07	.72

FORMULATING RATIONS.

In using these tables for computing rations, the following suggestions may be useful:—

(1) That a deficiency of two or three pounds of dry matter in a ration where over 20 lbs. is recommended, is not a serious mistake provided the feeder knows that the whole ration is bulky enough to satisfy the craving of the cow for a full stomach. This lack of dry matter in the ration will often occur where a high grade roughage like alfalfa hay or good silage is being fed, in which case the proper amount of digestible protein or carbohydrates is reached before the quantity of dry matter is high enough.

(2) As a basis of computing a trial ration it is well known that a cow should have approximately one pound of dry roughage (hay, straw, etc.) and three pounds silage (or four to five pounds silage and roots) for each hundred pounds of live weight. If no silage or roots is available, she should have two pounds dry roughage for each one hundred pounds of live weight.

(3) To bring the ration up to the standard, the concentrates or grain feed should be fed at the rate of about one pound of grain for each three to five pounds milk produced, depending on the quality of the milk—the richer the milk the more grain.

Keeping in mind the above recommendations we will proceed to formulate a ration. We will suppose that the feeder has at hand, at a reasonable price, the following feeds: Corn silage, clover hay, oat straw, bran, oats and oil meal. He wishes to feed a standard ration to a 1,100 lbs. cow giving 25 lbs. of 4 per cent. milk per day. According to our standard in Table II the requirements are:—

	Dry Matter.	Protein lbs.	Carbohydrates and Fat lbs.
	24.	2.28	14.30
Add for 100 lbs. extra weight of cow.	1.4	.07	.72
	25.4	2.35	15.00

Turning to the table of digestible nutrients of the different feeds on Table V, we find the feeds of this ration to be composed as follows:—

TABLE III.

In 100 lbs. of	Lbs. Dry Matter	Lbs. Digestible Protein	Digestible Carbohydrates and fat x 2¼
Bran	89.9	12.5	48.4
Oats	90.8	9.7	60.7
Oil Meal	90.9	30.2	47.7
Silage	26.3	1.1	16.6
Clover Hay	87.1	7.6	43.4
Oat Straw	88.5	1.0	44.6

FIRST TRIAL RATION FOR 1,100 LB. COW GIVING 25 LBS. 4 PER CENT. MILK PER DAY.

Feed		Lbs. Dry Matter	Dig. Protein	Dig. Fat and Carbohydrates	Nutritive Ratio
Silage	35 lbs.	9.21	.39	5.81	
Clover Hay	7 lbs.	6.10	.53	3.04	
Oat Straw	4 lbs.	3.54	.04	1.78	
Bran	3 lbs.	2.70	.38	1.45	
Oats	2 lbs.	1.82	.19	1.21	
		23.37	1.53	13.29	1: 8.8
Standard		25.40	2.35	15.00	1: 6.3
Additional requirements		2.03	.82	1.71	

The dry matter in this trial ration is nearly up to the standard, but the protein is more than 25 per cent. too low, while the digestible carbohydrates and fat are about 10 per cent. too low. To make this ration more balanced it is therefore necessary to add a protein rich food and, to keep the dry matter and the amount of grain within reasonable bounds, it is necessary to use more protein-rich roughage like clover hay instead of so much poor roughage as oat straw.

Second Trial Ration.

Feed		Lbs. Dry Matter	Dig. Protein	Dig. Fat and Carbohydrates	Nutritive Ratio
Silage	35 lbs.	9 21	.39	5.81	
Clover Hay	12 lbs.	10.45	91	5.21	
Bran	3 lbs.	2.70	.38	1.45	
Oats	3 lbs.	2.72	.28	1.82	
Oil Meal	1½ lbs.	1.36	.45	.72	
		26.44	2.41	15.01	1: 6.2
Standard		25.40	2.35	15.00	1: 6.3
Difference		1.04	.06	.01	

This ration approximates the standard so closely that it may be considered well balanced, but since all the nutrients are a trifle high, experience would suggest that about a pound of the grain mixture be taken away and that for a couple of pounds of clover hay there be substituted as much straw as the animal would eat.

Factors Limiting the use of Feeding Standards.

Individuality of Cows.—The application of feeding standards to actual practice must be done with considerable judgment and feeding standards can not be slavishly followed. It is possible to figure rations that are mathematically correct, but the ability of individual cows to make the best use of their feed cannot be mathematically figured. This must be determined by the observation and judgment of the feeder. It is, also, not practicable to figure out rations for each individual cow in a herd, according to standards. The proper way to use the standard is to make up mixtures of the different concentrates (grains, etc.) according to standard for an average cow of the herd, and feed this mixture in proportion to the daily milk yield of the individual cows, then to give each cow all she will eat of the different roughages in about the proportions the standards recommend. If it is found that a cow is not producing up to expectation by this method, it is sometimes wise to reduce somewhat the amount of roughage, still feeding the grain in proportion to milk yield. This also applies to a cow that is getting too fat. Sometimes it is better to reduce the grain and by this method get as large or at any rate a more profitable return.

Palatability and Digestibility of Feeds.—A table of digestible nutrients of different feeds is not an entirely accurate account of the true values of the nutrients for use in the animal's body, for retaining life or producing milk. For instance, an examination of Table III shows that oat straw has about as much digestible carbohydrates and fat as bran, oats or clover hay, in the same dry matter. Now this is perfectly true so far as it goes, but it takes a great deal more of the animal's energy to digest and work up these nutrients in straw, than in the better feeds. This energy must come from the food, so that a pound of carbohydrates in straw is not nearly so valuable as a pound of the same nutrient in clover hay or bran. As a matter of fact, clover hay has nearly twice as much actual net digestible carbohydrates as oat straw, and wheat bran has two and one-half times as much net digestible carbohydrates as oat straw. These factors must be taken into consideration, and care must be exercised that rations be not composed of too much hard-to-digest feeds like the different straws, even though the tables show them to have a large percentage of digestible nutrients. In general, it is safe to say, that the nutrients of the straw are only about half as valuable as equal amounts of the same nutrients in hay (clover or alfalfa) and only one-third to one-quarter as valuable as the same nutrients in the grains and concentrated feeds. This is due to the excess amount of woody matter, or fibre, in the straws. This fibre is a carbohydrate and is digestible but takes much more energy to digest it than do the other carbohydrates, the starches and sugars, that are present in large quantities in the grains and concentrates. In feeds that are not so mature, and that contain more water, such as silage and mangels there is not so much of this woody fibre and, as they are not so dry, they are more acceptable to the cow, hence called more palatable. The addition of these succulent feeds to rations containing all dry feeds make the whole ration more palatable, and therefore more digestible and, as a rule, are the means of causing a larger increase in milk flow than their composition would seem to warrant. The milch cow always responds to feeds that she can eat with more pleasure. For this reason, the feeder should aim at providing a ration that answers this requirement even at the expense of deviating somewhat from the feeding standard.

Variety.—Like the human being, the cow likes and will respond to variety in feeds; that is she likes a number of different kinds of feeds rather than too much of one feed, no matter how perfect that may be for the purpose, from its composition. Variety does not mean changing the feeds from one day to another. It means that in a whole day's ration a cow should have some succulent feed (mangels or silage) some dry fodder (hay and straw) and a mixture of two or more kinds of concentrates. Such variety will give cheaper and better returns than too much of any one kind of feed, even the best alfalfa or clover hay.

Characteristic Qualities of Different Feeds.—In addition to having a fairly uniform composition, many feeds have characteristic effect on the health and well being of the animal. These must be known and taken into account in making up rations and feeding same to milk cows. Such feeds as bran and oil cake have a beneficial laxative effect on the digestive system and can always be fed with safety and either one should be found in a heavy daily grain ration on this account. Cotton seed meal, on the other hand, has a tendency to constipate, and must, on this account, be fed with care that there is enough succulent food such as roots and silage, or a goodly share of some other laxative food such as bran or oil cake, to counteract this condition caused by cotton seed meal.

Armsby Feeding Standard Investigations.

As has been pointed out, the feeding standards just dealt with have some weaknesses which prevent their precise application to all feeding problems. The outstanding weakness is the difference in the digestibility of the different nutrients in the various classes of feeding stuffs. For example, the total quantity of digestible nutrients in oat straw is not equal in feeding value to the same quantity of like nutrients in wheat bran, because there is much more energy used up by the digestive system in working up and assimilating the nutrients of the former. To find, therefore, the actual net value of a feeding stuff it is necessary to deduct the amount of energy required in digestion from the total energy or food value supplied by the digestible nutrients.

Investigations along this line are being carried out by Armsby, of the Pennsylvania Experiment Station. As this class of investigations is very, very slow, on account of its technical difficulties, only some of the various food stuffs have been analyzed. As will be shown by the following table of foods analyzed, total dry matter and digestible protein are listed just as in the previous tables. But, as shown in the last column, foods are compared on the basis of their net energy, which is the energy available after the work of digestion and assimilation is provided for. This net energy is expressed "therms", a term used by chemists to describe a certain unit of fuel or energy value in nutrition experiments.

TABLE IV.—ARMSBY TABLE OF DRY MATTER, DIGESTIBLE PROTEIN AND NET ENERGY VALUES IN 100 LBS. OF VARIOUS FEEDING STUFFS.

Feeding Stuffs.	Total Dry Matter	Digestible Protein	Net Energy Value
Green fodder and silage:	lbs.	lbs.	Therms
Alfalfa	28.2	2.50	12.45
Clover, crimson	19.1	2.19	11.30
Clover, red	29.2	2.21	16.17
Corn fodder, green	20.7	.41	12.44
Corn silage	25.6	1.21	16.56
Hungarian grass	28.9	1.33	14.76
Rape	14.3	2.16	11.43
Timothy	38.4	1.04	19.08
Hay and dry coarse fodder:			
Alfalfa hay	91.6	6.93	34.41
Clover hay, red	84.7	5.41	34.74
Cowpea hay	89.3	8.57	42.76
Corn forage, field-cured	57.8	2.13	30.53
Corn stover	59.5	1.80	26.53
Hungarian hay	92.3	3.00	44.03
Oat hay	84.0	2.59	36.97
Timothy hay	86.8	2.05	33.56
Straws:			
Oat straw	90.8	1.09	21.21
Rye straw	92.9	.63	20.87
Wheat straw	90.4	.37	16.56
Roots and Tubers:			
Carrots	11.4	.37	7.82
Mangels	9.1	.14	4.62
Potatoes	21.1	.45	18.05
Turnips	9.4	.22	5.74
Grains:			
Barley	89.1	8.37	80.75
Corn	89.1	6.79	88.84
Corn-and-cob meal	84.9	4.53	72.05
Oats	89.0	8.36	66.27
Pea meal	89.5	16.77	71.75
Rye	88.4	8.12	81.72
Wheat	89.5	8.90	82.63
By-products:			
Brewers' grains, dried	92.0	19.04	60.01
Brewers' grains, wet	24.3	3.81	14.82
Buckwheat middlings	88.2	22.34	75.92
Cottonseed meal	91.8	35.15	84.20
Distillers' grains—dried—			
Principally corn	93.0	21.93	79.23
Principally rye	93.2	10.38	60.93
Gluten feed	91.9	19.95	79.32
Gluten meal—Chicago	90.5	33.09	78.49
Linseed meal, old process	90.8	27.54	78.92
Linseed meal, new process	90.1	29.26	74.67
Malt sprouts	89.8	12.36	46.33
Rye bran	88.2	11.35	56.65
Sugar-beet pulp, fresh	10.1	.63	7.77
Sugar-beet pulp, dried	93.6	6.80	60.10
Wheat bran	88.1	10.21	48.23
Wheat middlings	84.0	12.79	77.65

Armsby Standard for Growing Cattle.

Age.	Live Weight.	Digestible Protein.	Net Energy Value.
Months.	Lbs.	Lbs.	Therms.
3	275	1.10	5.0
6	425	1.30	6.0
12	650	1.65	7.0
18	850	1.70	7.5
24	1,000	1.75	8.0
30	1,100	1.65	8.0

As the animal approaches maturity it does not require proportionately as much digestible nutrients as it did in the earlier stages of growth. It will be noticed that, though the animal has quadrupled in weight between the ages of three months and thirty months, it requires only 50 per cent. more digestible protein and 60 per cent. more therms of net energy value in food, partially due to the ever-increasing power of the digestive system to assimilate more bulky and coarser foods.

Armsby Standard for Milk Cows.

Live Weight.	For Maintenance.		For each lb. of 4% milk add.	
	Digestible Protein.	Net Energy Value.	Digestible Protein.	Net Energy Value.
Lbs.	Lbs.	Therms.	Lbs.	Therms.
750	.40	4.95	.05	.30
1,000	.50	6.00	.05	.30
1,250	.60	7.00	.05	.30
1,500	.65	7.90	.05	.30

In addition to the above requirements, Armsby recommends that a 1000 lb. cow should receive from 20 to 30 lbs. of total dry matter per day, the amount depending on the amount of milk being produced. For this purpose the writer would advise consulting the modified Wolf-Lehman Standards on a previous page, Table II.

THE USE OF FEEDS.

With the object in view of acquainting the feeder with the peculiarities and values of different feeding stuffs for milk production there is next offered a table showing the composition of those feeds, followed by notes on the individual feeds based on experience and the work of Experiment Stations on feeds for dairy cattle.

TABLE V.—AVERAGE DIGESTIBLE NUTRIENTS IN 100 LBS. OF FEEDING STUFFS.

Name of Feeds.	Total Dry Matter. lbs.	Digestible Protein. lbs.	Digestible Carbohydrates Fat x 2¼. lbs.	Nutritive Ratio.
Corn	89.4	7.8	76.5	1–9.8
Corn-and-cob meal	89.6	6.1	71.5	1–11.7
Wheat	89.5	8.8	70.8	1–8.0
Barley	89.2	8.4	68.9	1–8.2
Oats	90.8	9.7	60.7	1–6.7
Peas	85.0	19.7	50.2	1–2.54
Beans	87.2	18.3	56.1	1–3.1
Buckwheat	86.6	8.1	53.6	1–6.6
Gluten meal	90.5	29.7	56.2	1–1.9
Gluten feed	90.8	21.3	59.3	1–2.78
Linseed meal, old process	90.9	30.2	47.7	1–1.57
Cottonseed meal	93.0	37.6	43.0	1–1.14
Dried Brewers' grains	91.3	20.0	45.7	1–2.28
Wet Brewers' grains	23.0	4.9	13.22	1–2.7
Dried Distillers' grains	92.4	22.8	65.8	1–2.88
Malt sprouts	90.5	20.3	49.1	1–2.4
Buckwheat middlings	87.2	22.7	51.22	1–2.25
Wheat middlings	88.8	13.0	55.82	1–4.29
Bran	89.9	12.5	48.4	1–4.0
Clover hay	87.1	7.6	43.4	1–5.9
Timothy hay	86.8	2.8	45.3	1–16.2
Alfalfa hay	91.9	10.5	42.52	1–4.05
Millet hay	86.0	5.2	40.4	1–7.7
Clover (green)	29.2	2.9	15.16	1–5.23
Timothy (green)	38.4	1.5	21.25	1–14.1
Alfalfa (green)	28.2	3.6	13.0	1–3.6
Millet (green)	25.0	1.6	15.07	1–9.4
Oat straw	88.5	1.0	44.6	1–31.8
Rye straw	92.9	0.7	40.5	1–58.0
Wheat straw	90.4	0.8	36.1	1–45.0
Barley straw	85.8	0.9	41.45	1–46.0
Oat hay	86.0	4.7	40.5	1–8.62
Oat forage (green)	25.0	2.6	12.35	1–4.75
Blue grass (Kentucky)	34.9	2.8	21.5	1–7.7
Pasture grass	20.0	2.5	11.2	1–4.5
Corn stover	59.5	1.4	32.77	1–23.4
Corn fodder	81.7	3.0	50.67	1–16.7
Corn silage (well matured)	26.3	1.1	16.6	1–15.0
Corn silage (immature)	21.0	1.0	12.3	1–12.3
Turnips	9.5	1.0	64.5	1–6.4
Mangels	9.4	0.8	6.62	1–8.2
Sorgum (green)	24.9	0.7	15.4	1–22.1
Whole milk	13.6	3.3	14.57	1–4.4
Skim milk	9.9	3.6	5.55	1–1.5
Buttermilk	9.4	3.4	5.12	1–1.5
Whey	6.6	0.8	5.37	1–6.8
Beet pulp (dry)	91.8	4.6	67.	1–14.6
Beet pulp (wet)	9.3	.5	6.9	1–13.8

CHARACTERISTICS OF FEEDS.

It is impossible within the scope of a work of this size to give in detail all the investigation work with the different feeds for dairy cattle, but an endeavour will be made to summarize the experiments in conjunction with facts gleaned from the experience of feeders so that the average dairyman may be assisted to feed his cattle to best advantage, knowing the qualities and costs of the feeds at hand.

Farm Grown Grains.

Corn.—This grain, though comparatively low in protein, is extremely rich in easily digestible carbohydrates and fat. It is palatable and easily masticated, but, on account of its low protein content and heavy nature, it should not form more than half of the grain ration. It is valuable in a ration if mixed with bran, oats, or brewer's grains, all of which tend to lighten up the ration and give more bulk for the same weight. The Maryland Experiment Station finds that cows gave, in a year, 33 per cent. more milk and 45 per cent. more butter on a ration consisting of wheat, bran, gluten feed and corn than on the same quantity of cornmeal, the rough feeds being the same in both cases. Where the roughage contains plenty of clover or alfalfa hay, corn may be fed in larger quantities than in a ration with timothy or other low protein hay. The Illinois Experiment Station found that a ration consisting of eight pounds of gluten feed and cornmeal, with clover hay and silage, produced 40 per cent. more milk and butter fat than eight pounds of cornmeal alone with timothy hay, a little clover and silage. Corn, on account of its palatability and high digestibility, is valuable as a part of the grain ration when fed with bulky high protein concentrates and clover or alfalfa roughage. If fed in the shape of corn and cob meal, corn gives better results if other bulky concentrates are not available, as the cob tends to lighten up the heavy cornmeal. On account of the high percentage of easily digested carbohydrates and fat, corn is a valuable supplement for feeding with skim milk to growing calves. The Iowa Experiment Station found that 1.3 pounds corn meal with 1-10 pound of flaxseed gave better gains on calves fed skim milk than 1.2 pounds of linseed, and equally as good gains as 1.5 pounds of oats fed with skim milk.

Barley.—This grain, found on nearly every Ontario farm, can be fed to advantage, within certain limits, for milk production. The Ontario Agricultural College found that barley gives almost equally good results as oats when fed as half the grain ration, with bran. Like corn, barley contains a large proportion of easily digestible carbohydrates, but contains 10 per cent. more protein and about half as much fat. It is also of a heavy nature when ground, and is better made lighter by the addition of bran, oats or brewer's grains. On account of its tendency to heat the animal, it is usually not wise to feed just previous to freshening or immediately after, especially if the cow's udder is swollen or inflamed.

Wheat.—Wheat is usually of too high a price to feed in any quantity for the production of milk. If of poor quality to sell, however, it may be fed to advantage. The Maine Experiment Station found that wheat was of equal value with corn, pound for pound, for the production of both milk and fat, while Danish experiments show that wheat is nearly equal to a mixture of equal parts oats and barley, for the same purpose. Elevator screenings, containing more or less wheat, some other grains, and black seeds, were experimented with by the Experimental Farm at Ottawa in 1914. It was found that screenings containing 65 per cent. wheat and 25 per cent. other grains, balance weed seeds and chaff, was equal to a mixture of bran 4 parts, gluten feed 2 parts, oil cake 1 part, cottonseed 1 part, when fed as one-third of the daily grain ration, the other two-thirds of which was the mixture mentioned above. Where the screenings consisted largely of black seeds and other offal it was found that, owing to the unpalatability and bitter taste, many cows would not eat their grain even though the screenings were only one-third of the grain ration. The value of wheat screenings depends on the proportion of weed seeds therein.

Oats.—Owing to the large quantity of oats grown on Ontario farms, this grain occupies a commanding position as a feed for dairy cattle of all ages. It contains a larger proportion of protein than any other farm grown grain except peas; it has a larger proportion of hull than other grains which, when ground, adds the lightness and bulk so desirable in rations for producing milk, and they have a flavour and palatability that makes it peculiarly acceptable to all classes of live stock. No other single grain is so satisfactory and safe for feeding purposes. Experiments of the Wisconsin Station show that oats produced 10 per cent. more milk and fat than an equal weight of bran when fed with clover hay and corn fodder as roughage. With a roughage ration consisting of timothy hay and corn fodder, which contains less protein than the above, the bran would be more valuable, as it contains a larger amount of digestible protein than oats. The Massachusetts Station reports that fed with 3.2 pounds of bran and 14.5 pounds of mixed hay, 4.5 pounds of oats was equal to the same weight of corn meal for milk production.

Oats have always been found a very valuable feed in the rearing of calves. The high protein content accompanied by a large proportion of ash, makes this grain eminently suitable for the growth of bone and muscle necessary in the raising of young animals, while the lightness of the grain aids in avoiding digestive troubles. The Iowa Experiment Station found that with skim milk, 1½ pounds of oat meal made as large, and cheaper gains, than 1.2 pounds of linseed meal, or 1.3 pounds of corn meal, and 1-10 of a pound of flaxseed, when fed to calves over two months old. In a census of breeders of Guernsey cattle, conducted by the American Guernsey Cattle Club, it was found that 60 per cent. used oats as half or more of their rations for raising calves. While the calf is under seven or eight months of age, whole oats give equal satisfaction as ground oats. After that age mastication is not so perfect and ground or rolled grain is preferable.

Although this grain is so satisfactory in milk production, it often happens that the price is too high, caused by the demand for horse feed, and human consumption. In this case, some of the more concentrated feeds, such as oil meal and cottonseed meal, are cheaper sources of protein, while bulk and lightness, combined with high protein content, may be more cheaply procured by using brewer's grains or gluten feed. At the same time, the feed value of oats in this connection usually warrant using at a fairly high price, especially for calves and growing stock and cows being fed on long-time tests.

Peas.—The price of this grain for the past ten years has prohibited their use as a general feed for milk production. Peas, however, are one of the best stimulants of the milk producing faculty, and in spite of the high price are used in feeding cows for high milk and butter fat records. This grain contains a very high percentage of protein and is rich in fat, carbohydrates and ash. They are easily digested but on account of their heavy nature when ground, they must be lightened up with some fibrous grain, such as bran or oats.

Buckwheat.—This grain is not fed to any great extent in Ontario. It is more suitable for fattening purposes than for milk production. At the same time, where this grain is available it may be fed to advantage as part of the grain ration, taking the place of part of the corn, barley or oats. When fed in large quantities it is supposed to injure the quality of the butter. Buckwheat bran, the hull of the grain, is practically worthless for feeding cows, but the buckwheat middlings, or that portion immediately within the hull, has been found to be equal to a mixture of equal parts corn and bran, when fed as part of a balanced ration. The middlings, however, are not particularly relished by cattle, and if fed in too large quantities have the same effect on the butter as the buckwheat itself.

Rye.—This is probably the most unsatisfactory of all farm-grown grains for milk production. It is not much relished by cattle; it tends to produce a hard, dry butter, and is a more frequent cause of digestive troubles than any other of the cereals. Neither has it the feeding value of the other grains. However, if available at a low price, it might help to cheapen the ration, by partially replacing some of the other grains.

Emmer.—The South Dakota Experiment Station reports that emmer is 12 to 15 per cent. less efficient for the production of milk than either barley or corn meal. This grain appears to have no injurious effect on the product of the dairy or the health of the animals, and as it is bulky in nature can be fed with safety as part of a ration.

Various By-products and Concentrates.

Bran.—This is the best-known and most widely used of all by-products, for milk production. In addition to supplying a large amount of protein and ash, it is mildly laxative in its nature, it is light and open in character, and may be fed in any amount with safety, either alone or in combination with other grains, to dairy cattle of any age and condition. Bran is about equal in value for milk production to a like weight of oats and barley, and is only slightly behind oats alone. It is especially valuable to feed with rich heavy carbohydrate grains, such as corn, rye, and barley. On account of its beneficial effect on the digestive system, it is particularly valuable for cows just before and after calving, as part of the heavy grain ration necessary to heavy milking cows on test, and to growing animals. Although becoming high in price, this feed will occupy first place for some time to come as the most important concentrate in milk production and in rearing dairy animals.

Middlings or Shorts.—This feed is a little richer than bran in most of the valuable nutrients, but its heavy, sticky texture, detracts considerably from its value as a feed, when fed in large quantities. It is not so valuable, therefore, for giving bulk and openness to a grain ration. However, when it can be purchased at about the price of bran it will yield good returns when fed as part of the meal, with oats or barley. There is quite a variation in the various grades of middlings, some of them being principally finely-ground bran adulterated with mill sweepings and dust. This is of less value than bran for feeding purposes. Good wheat middlings, or shorts, are fine and flour-like in texture and lighter colored than bran. They are not so suitable for feeding calves as bran, on account of their sticky nature.

Dried Brewers' Grains.—These grains are largely the residue from barley, after the removal of the soluble sugars and starch, for the manufacture of malt liquors. They contain nearly twice as much protein as wheat bran, but are lacking in the valuable carbohydrates, such as sugars and starch. The carbohydrates found in this feed are of the more indigestible kind, such as woody fibre, etc. On account of their high protein content, the grains are especially valuable for milk production. The Ontario Agricultural College found dried brewers' grains slightly superior to an equal weight of bran, for milk production. The Vermont Experiment Station reports that dried brewers' grains and bran are equal to a mixture of cottonseed meal, linseed meal and wheat bran. On account of the great amount of fibre, however, they are not quite as satisfactory as bran, when fed as the larger part, or the whole, of the grain ration. They are, however, very palatable and much liked by cows and, on account of their dryness and bulky nature, are valuable to lighten up a heavy meal ration. They may also be stored for a long period, in large quantities, without spoiling.

Wet Brewers' Grains.—These grains have a high value for milk production, if fed when fresh. On account of the great amount of water contained, they must of necessity be used almost entirely within easy hauling distance of breweries. About 25 pounds per day, per cow, can be fed if the animals have a good supply of dry hay, little other grain being necessary. They decay and become so foul, however, in a few days that feeding should be done only in concrete or other water-tight mangers, and should never be stored for more than a week at the very most. The odours arising from spoiling grains are the frequent cause of bad flavours in milk and butter.

Distillers' Grains.—In this country this feed is largely derived from rye. They are as bulky as wheat bran, contain about as much fibre, but are richer in digestible protein and in fat. They are not as palatable, and on account of a sour taste and smell it is difficult to get cows accustomed to eat them in large quantities. Both the Massachusetts and Vermont Stations report that when mixed with equal amounts of bran they produce about six per cent. more milk than an equal amount of gluten feed, and that when fed alone they produced 12 per cent. more milk and fat than an equal amount of corn meal and bran, and nearly as much milk as a mixture of cottonseed meal and bran. They are worth slightly more than dried brewers' grains, but not being acceptable to many cows, detracts considerably from their feeding value. They are largely used in the make up of many of the patent dairy feeds, and also to some extent by the feeders of high record cows, as a cheap source of protein and to add variety to the rations, a valuable consideration in such a line of work.

Malt Sprouts.—Though not commonly used, malt sprouts may be fed in limited amounts, if purchased at a reasonable price. The Massachusetts Station reports that they are equal to about 75 per cent. the same weight of gluten feed, when fed to milk cows as part of their grain ration. Great difficulty is often experienced in getting cows to eat them, on account of a bitter taste, and when fed in large quantities they impart a bitter flavour to the milk. As they absorb a large amount of water they should always be soaked before feeding. As a rule, the dairyman would not be justified in feeding them unless they could be procured at less than three-quarters the price of bran and oats.

Buckwheat Middlings.—If of good quality and containing very little buckwheat bran or hulls, these middlings are a valuable milk producer. The Vermont Station finds that they produce 8 to 11 per cent. more milk than an equal weight of cornmeal and bran. As cows do not relish them when fed in large allowances, they should form only part of the grain ration, with bran, oats or brewers' grains to lighten them up. Fed in this way they have no injurious effect on the quality of the milk or butter. In purchasing this feed care must be exercised to procure bright, floury quality, as they are commonly adulterated with buckwheat bran or hulls which, on account of their woody nature, have practically no feeding value.

Gluten Feed.—The best known by-product of corn in this country is gluten feed, which is a by-product from the manufacture of starch from corn. It contains all that is left of the corn after the starch is removed, except the germ. High-grade gluten feed is a very valuable product, containing a high percentage of protein and only a moderate amount of fibre. The low grade gluten feed is not worth so much by a good deal, and buyers should be on the watch in this connection, and should see to it that a satisfactory guarantee as to composition accompanies the feed. Gluten feed is especially valuable for dairy cows in milk, being usually a cheap source of protein and reasonably light and bulky. The Vermont Station finds that gluten feed produced 15 per cent. more milk and butter fat than an equal weight of cornmeal and bran. As a source of protein, the high grade feed is worth 20 per cent. more per ton than bran, but as it is not so laxative in its nature, it is most valuable in forming part of the ration mixed with bran. There is occasionally sold, in this country, Continental gluten feed which is a by-product in the distillation of alcohol from corn. This feed has nearly the same feeding value as gluten feed, but is not quite so well relished by cows, so it cannot be so profitably fed in large quantities.

Gluten Meal.—This feed is seldom sold in this country. It consists entirely of the gluten of corn without the admixture of the corn bran, as is found in gluten feed. This meal is heavy in its nature, but as part of the grain ration it is almost equal to oil cake in its ability to produce milk.

Cottonseed Meal.—Of all concentrates high grade cottonseed meal is the cheapest source of highly digestible protein, and is therefore one of the best stimulants of milk production yet known. Regarding cottonseed meal it must be remembered that it is valuable for a specific purpose, and that is for increasing the protein content of a ration. Cottonseed meal is not suitable for all classes of stock, and for any class of stock it should be used in moderation. Dairy cows or fattening cattle will take two pounds per day, per head, without any injury. It is true this quantity is frequently exceeded, but when a person is feeding three pounds or more of cottonseed meal to a cow per day he is venturing upon dangerous ground. For calves and pigs cottonseed meal had better not be used at all. It is true these animals may be fed very small amounts in their ration, but in this country we do not need to use it, and hence it is not worth while running risks. The danger in cottonseed meal lies in its highly constipating nature. For this reason it is usually unwise to feed it except where considerable quantities of silage or roots are found in the ration, or in combination with some other laxative concentrate such as oil-cake or wheat bran. With feeds of this kind it has been fully demonstrated by experience and feeding trials, that good cottonseed meal will displace twice its weight in wheat bran, or dried brewers' grains, with equally good returns in the pail. In general, to form part of a ration, the farmer is justified in paying from 60 to 75 per cent. more per ton for cottonseed meal than for bran, oats, or dried brewers' grains. Cottonseed meal is not, by any means, a constant term. That is to say, there are numerous grades of cottonseed meal on the market. In cold pressed cottonseed cake and in cottonseed feed the per cent. of fibre is nearly as high as the percentage of protein. A good brand of cottonseed meal, containing 40 per cent. or more of protein, is worth nearly twice as much per ton as cold pressed cottonseed cake or cottonseed feed. In fact, the two last-mentioned grades of feed are not worth a great deal more per ton than wheat bran. It is true they contain much more protein and fat, but their percentage of fibre is so high that it cuts down their value very materially. Those who are buying cottonseed meal should pay careful attention to the percentage of protein and of fibre, and not be misled into thinking that because the feed in question has a fairly high percentage of protein it is necessarily a valuable feed. It may have so much fibre that its feeding value is seriously reduced. Cottonseed hulls are but little better than worthless as a concentrate feeding stuff.

Flaxseed.—Flaxseed, at present, is so high in price that it is not used to any extent for feeding purposes. In some cases where it is grown at home, small amounts are used. It will be noted that flaxseed is extremely high in fat as well as fairly high in protein. The fat is extracted, giving us linseed oil, and the residue is known as linseed meal or oil cake. On account of the high percentage of fat, flaxseed is most commonly used in feeding skim-milk calves, as a substitute for the butter fat. For this purpose it is better boiled to a jelly-like consistency and mixed with skim-milk for young calves. When calves are eating grain, the flaxseed may be fed dry, either whole or ground, in a tight manger.

Oil Cake, Oil Meal, or Linseed Meal.—These three names apply to the same product. This by-product of flaxseed contains a high percentage of protein and a fair amount of fat. It does not contain so much protein as high grade cottonseed meal, but it does not possess any of the dangerous properties of cottonseed meal, and when fed to stock it tends to bring about a general thrifty condition in the animal. Owing to this fact most feeders prefer linseed meal to cottonseed meal, though it is lower in protein. As a source of protein for dairy cows cottonseed meal is more economical, and it is only on the ground that linseed meal can be fed to any class of animals, and tends to promote thrift, that we can justify paying quite as much per ton for this product as for high-class cottonseed meal. It is useful for increasing the protein in the ration of young pigs, calves, dairy cows, and practically every class of stock. This feed is especially valuable for cattle low in condition, and for cows just previous to and immediately after calving. It is also extensively used in fitting animals for show and for the sale ring, as its use tends to produce mellowness of hair and hide and general evidence of thrift. For feeding to young growing animals in small quantities, with oats, corn, or bran, it is unsurpassed. As a stimulator of milk flow it is not quite equal to cottonseed meal, but on account of its wide use as much can be paid for it as for cottonseed meal.

Dried Beet Pulp.—This feed is a by-product in the manufacture of sugar from beets. It is rather high in fibre, though containing a fair amount of protein. When thoroughly soaked with water they provide a succulent food, when roots or silage are lacking. They are worth about two-thirds as much per ton as wheat bran.

Molasses Feeds.—There are a wide range of these sold, both as to name and as to quality. They consist of various products, some high-class, such as cottonseed meal, many others of very low grade, such as oat hulls, cottonseed hulls, and mill screenings, combined with molasses. Many of them contain a very large amount of foul weed seeds, and most of them are sold at prices away above their actual value for feeding purposes. Some of the better quality brands have a useful tonic value if fed in small quantities, and they are often used for this purpose in feeding for high records. In general, the average dairyman is wise in leaving these feeds entirely alone unless he is in a position to judge of the merits of the different kinds.

Dry Roughages.

Red Clover Hay.—On account of its general use, this forage can be considered the most important of the crops fed in the dry rough state, for milk production. For a bulky feed it contains a high percentage of digestible protein. It can be profitably fed to dairy stock of all ages, from calves to cows in full flow of milk. Liberal feeding of red clover hay will enable the reduction in the amount of the concentrated feed in providing a well-balanced ration. The substitution of clover hay for timothy, bluegrass hay, or other grasses, will effect a saving in the amount of meal fed to produce a given amount of fat. For raising young stock, red clover hay provides a well-balanced ration by itself. The quality of clover hay depends largely on the condition in which it is stored. If cut in full bloom, and well saved without being rained on, or bleached from over-exposure to the sun, it is twice as valuable as that cut when ripe and dry, or unduly exposed to rain and sun. The thicker the stand of clover on the ground the finer will be the growth and also the feeding quality.

Alsike Clover.—Of much the same composition as red clover, it would be of equal value for milk production except that it is not so palatable and acceptable to the cows. As it does well on damp soil and lasts longer on the ground than red clover, it is usually wise to include a couple of pounds of alsike in the grass seed mixture of all Ontario farms. Threshed clover hay of both kinds have very little more feeding value than barley or wheat straw, for milk cows.

Crimson Clover.—This plant is grown very little as a hay crop in this country. Where grown, care must be taken to cut it before any of the blooms commence to die, because the small barbed hairs on the blossoms and stems become very hard and wiry when ripe and are liable to mat together in the stomach and cause serious digestive troubles. Crimson clover has a very early spring growth and is valuable as a pasture or soiling crop at this period.

Mammoth Clover.—On account of its rank, coarse growth and late maturing, this feed has by no means as high value as red or alsike clover. It thrives well on poor and light soils but yields only one cutting per year.

Alfalfa Hay.—Good alfalfa hay is beyond doubt the best roughage for milk production. It is very rich in available protein and of high palatability. In composition it compares very favorably with bran, but having a higher percentage of fibre, which affects the digestibility of the other constituents, one is hardly justified in saying that it is equal to bran in producing milk. It has been thoroughly proven that good alfalfa hay can replace with profit a considerable part of the concentrate or grain allowance in any ration not containing alfalfa. The Ohio Station found that twelve pounds of alfalfa, when fed with corn silage and six lbs. of corn meal, per day, produced as much milk as six pounds of corn stover and nine and a half pounds of a rich mixture of cottonseed meal, bran, and corn meal. The New Jersey Station found that 14 lbs. of alfalfa replaced 8½ lbs. of wheat bran, dried brewers' grains and cottonseed meal, 7 lbs. of corn stover and 5 lbs. of corn silage, with almost equally good results in milk and fat. In experiments made in the feeding of alfalfa hay in place of grain or concentrates it has been generally found that with cows of only moderate production, milk can be produced very cheaply where alfalfa hay is plentiful. It was noted, however, that the animals did not maintain the highest degree of health, due possibly to the non-supply of high digestible carbohydrates and the high percentage of fibre. With heavy milking herds it has been proved that larger and cheaper production and better health is maintained by the feeding of some concentrates in addition to the alfalfa. In deciding just how far to go along the line of alfalfa feeding, the farmer must take into account the productivity of his cows and the price of alfalfa hay as compared with protein-rich concentrates. Alfalfa is also especially valuable for young dairy stock and dry cows. It should, however, be harvested just as it is commencing to bloom, to produce the best quality of hay. The second cutting in this country is usually of a little better quality than the first, most likely on account of generally better weather for curing at that time, and also to some extent on account of the more fine and leafy nature of its growth. Although alfalfa has not all the magic properties sometimes ascribed to it, the dairyman who can grow it successfully, or buy it cheaply, has at his command the best roughage for his purpose.

Sweet Clover.—White sweet clover when cut early is a valuable roughage for milk production, and, to some extent, as a pasture crop. It is not quite so palatable as alfalfa or red clover, on account of a slight bitter taste, but cattle can be easily accustomed to its use. This crop will usually thrive well on poor soils. The yellow variety is neither as prolific nor as acceptable to animals as the white, and its growth is not to be strongly advised.

Pea and Oat Hay.—This is a variety of hay whose high standard of value is not generally recognized. It is rich in protein and very much relished by stock. Where clover meadows have failed to come through the winter safely, the growing of this hay is strongly to be advised, as it will greatly assist in providing a large amount of cheap succulent roughage for winter feeding. It should be cut when the peas are in full bloom and the oats in the milk stage.

Timothy.—This widely known hay has not equal value with the clovers for the feeding of cows in milk. However, on account of its palatability, the relish with which all stock consume it and its prevalence, it is valuable for calves and young stock generally. It is rather low in protein to stimulate milk flow, but it contains a large proportion of digestible carbohydrates. Its use, therefore, in a ration entails the addition of some protein-rich concentrate, such as oil meal, to balance it properly.

Canadian Blue Grass.—The hay is plentiful in some parts of Ontario, and is a valuable feed for growing and fattening stock and, as a milk producer, is somewhat superior to timothy. It is valuable as a nutritious early pasture that stands drought reasonably well, but as a hay crop it does not yield heavily and there is usually no aftermath.

Kentucky Blue Grass.—As a hay crop, Kentucky blue is about equal to Canadian blue, for feeding purposes. As a pasture grass it is one of the very best, especially early in the season. It should be included in every permanent pasture mixture on account of its dense early growth.

Millet.—The different varieties of millet and Hungarian grass are grown usually as catch crops where, on account of adverse conditions, it is impracticable to grow other crops. When sown thickly so that the growth is not too coarse, and cut a little on the green side, millet makes a valuable hay that ranks just a little better than timothy for milk production and for young and dry stock. Millet, on account of its rapid growth, is a valuable soiling crop to cut green for supplementing dry pastures, as it can be sown late enough to reach its greatest growth during the month of August, when pastures are poorest, when clover, peas, and oats have become too mature, and corn has not yet reached sufficient maturity to be profitably fed.

Straw and Chaff.—The noticeable feature of the composition of straw is the extremely high percentage of fibre. As a result, when we feed animals largely upon straw they have to handle a very large amount of what may be called inert or comparatively useless material. While this is true, it is also true that straw may be used as part of the bulky ration to good advantage, when other bulky fodders are scarce or very high in price. It must be remembered that if straw is used in the ration of dairy cows in milk it will be necessary to feed a good deal more meal than when hay is fed, so that sometimes what we may gain in saving hay may be more than lost through the extra amount of concentrates used. For store cattle or dry cows straw can be used to much better advantage than for cows which are milking or cattle which are being fattened.

Of the different kinds of straw buckwheat supplies the most protein, but it is so extremely high in fibre that it is seldom regarded as a satisfactory feed for stock, except in extreme cases. Everything considered, oat straw is the most satisfactory for all classes of stock.

Barley straw is practically equal to oat straw so far as composition is concerned, but barley straw is not so palatable as oat straw and the awns or beards of the barley render it objectionable.

Wheat straw and rye straw are both rather low in feeding value and should not be used for feed if oat straw is available. The chaff of oat and wheat straw have a much higher value for feed than the straw itself and if at hand in any quantity can be fed with a considerable saving in hay or other high class roughage. Pea straw has a high feeding value, but coming from the modern thresher it is usually very dusty, which detracts from its palatability.

Corn Fodder.—Because of the large tonnage that can be harvested from an acre, and the comparative ease with which it can be cured, corn fodder is one of the most valuable roughages at the command of the Ontario farmer. When well matured, and cut and cured with the ears on the stalks, corn fodder has a value, in the late fall and early winter, equal to timothy hay for milk production, and the profitable growth of young stock. As it becomes dried out in winter it is much improved by cutting a few days supply into a large heap, which, on account of the heat generated, spreads the moisture through the dry butts, leaves and cobs, and softens up those parts so they are more readily eaten and digested than if fed whole. In the feeding of uncut fodder, the butts of the stalks which contain valuable material are usually left uneaten. While for practically all purposes the same corn put in the silo would give better results, where corn is grown for fodder it is advisable to plant thicker than where grown for silage. The thicker sowing will produce a smaller growth of stalk and more leaves and a slightly higher tonnage per acre.

The Pennsylvania Station reports that corn fodder is nearly equal, pound for pound, with timothy hay for the production of milk and fat when both were fed with a grain ration of equal parts oats and bran. The Utah Station found that corn fodder would replace nearly half the alfalfa in a ration of 21 pounds of alfalfa hay, with bran and wheat or corn meal, producing practically as much milk and butter fat.

The main value of fodder corn lies in its ability to cheapen a ration by replacing part of the more high priced hay with equal results in milk production and growth. It must not be forgotten that corn fodder or silage, no matter how good, will not economically replace in a ration the entire amount of hay or other high class roughage.

Corn Stover.—Corn stover consists of the cured corn stalks after the removal of the ears. As might be expected, this feed has not as high a value as good corn fodder which contains the ears. The fact that this crop is usually allowed to mature to a greater extent than fodder corn, often being frozen before cutting detracts also from its feeding value. In spite of these conditions, corn stover has a feeding value much greater than straw. Henry of Wisconsin, found that one ton of uncut corn stover was slightly superior to one-third of a ton of mixed clover and timothy hay, and nearly equal to one-third of a ton of clover hay. He also found that cutting the stover increased its value, as less of the coarse parts of the stalks was wasted.

Corn Silage.—This feed occupies a high place in the feeding of dairy cattle in Ontario conditions. To such an extent is this so, that the writer feels confident in asserting that without corn silage dairying, as generally conducted in Ontario, could not, at present prices for dairy products, be profitably conducted. The great amount of actual feeding material that can be raised per acre, the efficient manner in which the silo stores and cures the feed, the convenience of the silo for feeding at all times of the year, give silage its great economic value. In addition it is important to know that silage, being a succulent food, is cooling and laxative in its action, helping greatly to keep the digestive system of the cow in good condition, and being an appetiser it helps the animal to consume larger quantities of food than she otherwise would. These are important considerations, especially in milk production.

Experiments conducted in most experiment stations in Northern United States and Canada, confirm the finding that for milk production corn silage is worth from 8 to 12 per cent. more than an equal amount of dry matter in good corn fodder. The Maine and Vermont Stations both reported that from three to three and a half pounds of silage is equal to a pound of mixed hay in replacing part of the hay in a ration. The Utah Station found that where cows were getting alfalfa hay and grain that one-third of the alfalfa hay could be replaced by silage at the rate of about three pounds of silage to one pound of alfalfa, and equal production of milk could be maintained. This also gives corn silage a value per ton about one-third of that of alfalfa hay, in replacing part of the more high-priced roughage. Owing to its rather low protein content, and high water content, corn silage is not a perfect ration by itself, its main usefulness being in its efficiency in providing a bulky succulent, appetizing roughage that will take the place, at a lower cost, of part of the more costly roughages, such as clover, timothy, and alfalfa.

It is now known definitely that silage from well matured corn has a much higher feeding value than silage from green immature corn. The writer found, at the Ontario Agricultural College, that, for milk production, silage from White Cap Dent corn, in the firm dough stage, was worth nearly $1.20 per ton more than corn from Southern Sweet on which the ears were just forming. As there was a difference of only one-half ton per acre, in the yield of silage, this was a clear demonstration of the value of the well matured varieties of corn. It is also pretty well established that reasonably thick planting of corn for ensilage, say up to one-third bushel per acre, will produce much more feed of nearly equal value, than will the thin planting such as is practised where corn is grown for grain.

Oats, Peas and Vetches Silage.—Silage from a mixture of oats, peas and vetches has proven of very high value, in those localities where corn cannot be successfully matured for silage. This applies particularly to the New Ontario district. The Nova Scotia Agricultural College reports very highly on this feed and considers it equal in value to corn silage for milk production. Although the yield per acre is large, it does not quite equal corn in this respect, and on that account can scarcely be recommended for general use in older Ontario.

Silage From Other Crops.—The ensiling of other crops, such as rye, clover or alfalfa, has been attempted with varying degrees of success. It has been found that clover and alfalfa deteriorate greatly in feeding value during the ensiling process, particularly in their protein constituent, nor has the ensilage from these crops been found always palatable and acceptable to cattle. It is fair to assume that these crops are more useful when harvested and cured in the usual way.

Rye silage has been tested with no great degree of success, both at the Guelph College and at the Vermont Experimental Station.

The refuse from canning factories, such as corn husks and cobs, and the green straw from peas, can be ensiled with success, and have been proven most satisfactory for dairy cows, but on account of their bulky character their use is limited to the districts immediately surrounding the factories.

Roots.—These foods belong to what are known as succulent foods; that is to say, all the members of the group of roots contain a very high percentage of water. The high percentage of water reduces the value of one hundred pounds of any of these foods, but the solid material which they furnish is usually very digestible and very palatable. In addition, these succulent foods tend to keep the digestive organs of the animal in better condition and consequently they have a value outside of their actual feeding value. All practical feeders recognize the importance of succulent foods as a means of keeping animals in healthy, thrifty condition. While the dry matter in roots is somewhat more valuable than in corn silage, on account of the greater amount of the latter that can be raised from the same land, with less labor, the production of milk generally speaking is not so profitable from roots as from silage. However, it is safe to say that the addition of some roots to a ration for cows adds much to its palatability and succulence, and allows the cutting down of the concentrate allowance to some extent. Generally speaking, mangels are the most satisfactory for feeding cows in milk. Their actual feeding value is no greater than turnips, but they have not the same bad influence on the taste of the milk that is attributed to turnips. When hay is scarce, or high priced, mangels or turnips are useful for mixing with cut straw, to add palatability and to increase the consumption of the straw. In this way the amount of dry matter needed in the ration can be provided at a smaller cost than if necessary to feed large quantities of hay.

For feeding cows on official test, roots have an especially beneficial action. Their laxative, succulent nature, and their ability to whet the appetite to the consumption of heavy rations, lend them a very high value for this purpose. The red beet that is closely allied to the table beet is preferred for this purpose.

Potatoes.—This crop is nearly always too high priced for feeding cattle. In addition, when fed in large quantity, they have an injurious effect on the flavor of milk and texture of butter. They are occasionally useful in feeding to sick cows, as they are sometimes readily eaten when everything else is refused.

Preparation of Foods.

It is often interesting to know to what extent such preparation of feeds as grinding or rolling grain, cutting hay or straw, cutting or pulping roots, soaking or cooking the various feed stuffs, can be profitably carried on. In the first place these operations demand the expenditure of labour and power, and the use of increased equipment. All of these commodities are expensive now-a-days, so that there is required a much increased feeding value in food being so prepared to justify the increased expenditure. For feeding cows, the hard brittle nature of most of our farm grains, and the tough leathery hulls on the others, practically demand the grinding or chopping of such to increase palatability and ease of digestion, and also to reduce to a minimum the amount that is liable to pass through the system undigested. The only noteworthy exception to the above is the feeding of oats to calves. The calf has a wonderfully efficient system of mastication that can quite readily handle the tough oat hull and hard oat kernel.

The practice of cutting hay has very little justification, unless it be of poor quality and it is desired to mix it with silage or roots to increase its consumption. The cutting of hay makes it dusty and therefore less acceptable to the cows, which fact is quite evident to all who have seen the enjoyment with which the cow always consumes good long clover or alfalfa hay. Cutting hay detracts from its feeding value, and adds to the cost of feeding operations.

Where only a limited amount of straw is being fed, there is little necessity of incurring the expense of cutting, but where it is necessary to feed a large amount, greater consumption of this roughage can be accomplished by cutting and mixing with roots or silage, or both. If this mixture be allowed to stand in the pile to heat for a few days, the straw portion is made more palatable.

The cutting of dry corn fodder, as has been previously mentioned, has much to commend it, in increasing the succulence of the harder drier parts of the leaf and stalk.

The mixing of the various feeds that make up the concentrate mixture is a valuable labor and time saving operation, and enables the feeder to serve out rations that are uniform in composition from day to day.

The soaking or slopping of feeds adds usually no value to the digestibility or feeding value thereof. In the case of dried beet pulp, or malt sprouts, which swell enormously with the addition of water, soaking before feeding will help to avoid digestive troubles. In the case of a sick cow, a bran mash or warm slop is often of value, but beyond these instances the soaking of feed is a waste of time.

The cooking of feed, likewise, has no value in a dairy stable, unless it be the boiling of flaxseed for calf feeding.

GENERAL PROBLEMS IN DAIRYING.

Some of the problems that confront the Ontario dairyman, in addition to those intimately connected with the actual handling of his cattle, are,—the proper system of crops for best results, the comparative advantages of winter and summer dairying, and the extent to which the farmer shall specialize in dairying to the exclusion of other branches of farm production.

Cropping Systems.—One of the first principles that should actuate the dairyman is that of growing all his own roughages, silage, roots and hay. For one reason, these feeds are bulky, and to purchase them would mean large expense in hauling to his farm. The more important reason is that under our conditions these crops can be grown much more cheaply than they can be purchased, while grain crops, or their equivalent in other concentrated feeding stuffs, can be purchased at little more than it costs to produce them in Ontario. This is due to the ability of the Western farmer to produce grain, from his large fields of new and fertile soil, much cheaper than we can here. Accurate farm cost accounts on the College farms during the past two years demonstrated that a crop of clover or alfalfa hay, of less than two tons per acre, could be grown and stored in the barn at about $7 per ton, which same hay would have cost $12 to $14 per ton to purchase. The same land and the same labor produced 60 bushels of oats at about 34c. per bushel, which same oats could have been purchased and stored at threshing time for 37c. per bushel, very little more than the cost of growing them. It is true, however, that the dairy farmer must raise some grain to produce straw, to enable him to seed down to hay and to make better use of the man and horse labour on his farm, than he could make if he were growing roughages only. But, the point is that he should not have his cropping system contain too much grain at the expense of a liberal supply of hay and other roughages. If he keeps in mind that his machine, the large capacity dairy cow, returns her largest profits from the intelligent use of roughages, he will see the necessity of giving attention to his cropping system.

Summer or Winter Dairying.—The solution of this question depends a great deal on the method of marketing the milk, by the individual dairyman. The cheapness with which milk is produced in spring and summer, of course, causes the greatest production during these seasons in all parts of the Province. In districts where the cheese factory absorbs the milk, the farmer will of necessity be compelled to have most of his cows calve in spring, because the nature of the cheese trade of Ontario demands an article produced from grass milk.

In those sections where milk is used for butter making, or for the manufacture of condensed milk, a wider variation of method occurs, though greatest production is even here obtained in spring and summer on account of low cost. It is well worth knowing, however, that cows that calve in the fall will usually produce more in a year than if they freshened in spring. If well fed and cared for in the stable, they will hold out well during the period of high prices for fat, as they are not subject to the same adverse weather conditions, and shortage of feed that usually occurs in summer. In spring, when turned out to grass, they freshen up again with an increased flow, and are dried off for the period of dry weather and labour shortage of the summer. These facts are well worth bearing in mind by those so situated as to be able to conduct their business in this way, and these conditions help to counteract the cheapness of summer dairying. Moreover fall calves can be very successfully raised in winter, when there is more time to devote to them and they will be old enough by spring to turn out to pasture to take care of themselves during the busy season. Those dairymen who are supplying the city milk trade, naturally find it most profitable to have as uniform an output as possible during the whole year, and therefore they have cows freshen at all times. However, the middle of the summer is not a good time to have cows freshen, as pasture and weather conditions are not the best to give the cow a good start in her lactation period. Should a cow not get away to a good start, she will not do her maximum production, even if conditions improve later in the milking period.

Specialized or General Dairy Farming.—This is often called the age of specialization. In most lines of endeavor the advantages of specialization, and the favourable results derived therefrom, are too obvious to admit of criticism. In the business of farming, however, there are so many interesting features over which the farmer has little or no control, such as temperature and moisture conditions, a fluctuating labour supply, uncertainties in the rearing of living animals, inability to create any stable situation in the law of supply and demand, and a characteristic independence in thought and action of his fellow farmers, that extreme specialization in this calling will permit of some argument. To illustrate some of the features of this problem, the writer takes the liberty of presenting a table compiled from the results of an analysis of the business of a large number of farms in a dairy district in a section of New York State where most conditions were like those in many of the dairy sections of Ontario. The table shows the labour income derived from specialized farms where only milk was sold, compared with that derived from farms on which varying proportions of revenue were derived from other sources as well.

Receipts from Crops for each $1.00 received from Stock (Milk).	Average % of receipts from Crops.	Receipts from Stock (Milk).	Receipts from Crops.	Receipts per Cow.	Total Cost of Labor.	Labor Income.
No. Crops Sold—	0	$1,288 00	....	$79 00	$726 00	$251 00
10 cents to 20 cents	14	1,136 00	$178 00	69 00	606 00	476 00
20 cents to 50 cents	23	1,282 00	387 00	82 00	584 00	766 00
50 cents to $1.00	39	1,093 00	707 00	75 00	675 00	725 00
1.00 and over	54	911 00	1,085 00	63 00	753 00	768 00

NOTE:—Labour income is the amount of money the farmer has for his own labour, after paying all running expenses of the farm, and allowing 5 per cent. interest on the capital invested.

This above table indicates the possibilities for greater profit from growing some cash crops in addition to the feeds usually grown for producing milk. Although it is quite evident that many of the farmers in the third and fourth classes used the money received from the sale of cash crops for purchasing other feed, it is evident it was more profitable to use some of land of the farm in growing the suitable cash crop for the locality, than to use it for growing feed for producing milk. It is well to notice also that the growing of cash crops added nothing to the cost of labour for the year. Wise policy would be to grow the cash crop that is peculiar to the neighbourhood, whether it be clover seed, potatoes, fall wheat, alfalfa hay, or sugar beets, etc., rather than devote all the energies of the farm and operator to growing feed for the production of milk. It is of course quite evident that part, at least, of the money from the sale of cash crops must be reinvested in feed if the fertility of the land is to be maintained or improved.

CARE AND MANAGEMENT.

THE MILKING HERD.

IN SUMMER.—Climatic conditions in Ontario cause a sharp division in method between the summer and the winter management of our live stock. Our seasons are such that there are, roughly speaking, five months in which it is possible for animals to gather their own food and seven months in which it is necessary to supply them with sustenance from storage and provide them with a reasonable amount of shelter. Generally speaking, the farms of Ontario have sufficient land to enable the live stock to sustain themselves during the five months of pasturage, but the season during this whole period is not by any means ideal to provide sufficient high quality pasturage, for the fullest returns from the milking herd. Taking into consideration the great efficiency of the dairy cows, in turning rough farm products into a highly palatable human food, and the serious break in the pasturage season, caused by the drought of July and August, the question of the economy of feeding productive dairy cows the year around is sometimes asked. Without doubt such method would economize on land, and would enable the highest standard of production of milk. In this connection experimental work done by the Guelph College, in 1915 and 1916, is illuminating. Fifteen high producing cows were fed in the stable during June, July, August, and September, under the same conditions as obtained in winter. During the same months, thirty-two cows of only average ability were pastured, with some grain in addition. In the case of the stabled cows, the feed was charged at slightly less than the market price for that grown on the farm and actual market price for that purchased. In the case of the pastured cows, the actual cost of pasture, which included rent of land, seed, temporary fencing, and labour of man, horse and machinery in seeding pasture, which was partly spring sown and annual pasture, was charged. It is worthy of note that both groups of cows averaged the same number of days from freshening time to the beginning of the test, and the same percentage of cows in each group calved during the test, so that the factor of length of lactation periods was eliminated. The returns from each group are seen in the following table:

Group.	Lbs. milk in 4 months.	Daily average per cow.	Lbs. fat in 4 months.	Daily average per cow.	Value of grain.	Value of roughage.	Value of pasture.	Total cost of feed.	Cost of 100 lbs. milk.	Cost of 1 lb. fat.
15 Cows Stabled.......	56296	30.8	2193	1.2	187.85	298.36	......	486.21	.86c.	.22c.
32 Cows Pastured	81650	20.9	3372	.86	178.11	......	190.17	368.28	.45c.	.11c.

It is therefore quite apparent that from the standpoint of feed costs alone, it is more economical to pasture cows in summer than to feed in the stable. If labour had been also taken into account, the results would have been much more marked in favor of the pastured cows.

During the past two decades the best principles of winter stock feeding have become well recognized, and the practices thereof have undergone great improvement. Such is not the case with the summer feeding which is, in general, in about the same situation as it was twenty-five years ago. This condition is due first to the general lack of available labour at this season, and second, to lack of realization of the importance of the two scanty months of July and August in their relation to the more plenteous pasture periods, both before and after, and in their relation to the economy of the whole season's feeding operations. Any solution, therefore, leading to the betterment of summer feeding conditions must take cognizance of those two most important factors, and also, to a limited extent, the value and necessity of economizing in tillable land in some instances where high priced land is being farmed.

To dwell at length on the lack of available labour for live stock purposes during the harvesting season is unnecessary here. This fact is painfully evident, especially during the present crisis in agricultural production. Sufficient is it to say that during July and August farm labour is worth, on its production basis, from two to four times as much as at any other time of the year. At ordinary values for labour the direct profits on live stock products are small enough now. A solution of the question, therefore, demands the conservation of manual labor at this time, even at the expense of some other commodity. This means that the animal must gather most of its own feed and scatter its own manure, though it may use a little more land, a commodity still comparatively cheap and plentiful in most Ontario communities.

It is in consideration of the second factor that the weakness of ordinary pasture system is disclosed. Most farms have a plentiful supply of pasture for the period ending the 25th of June, and again during the period beginning August 20th, and extending until the end of the pasture season. Particularly is this so, as the usual practice is to pasture the second growth of meadows and the fall rains regenerate the natural pasture. Between the two periods of plenty is the critical time of the year in live stock production. The natural pastures inevitably dry up, even good clover pastures do likewise, because the red clover plant is the first of all our cultivated plants to feel the effects of heat and drought. This is plainly seen in those years where there is a wet month of May followed by a dry June when, in spite of the good start, the clover crop is light in the fields to be cut for hay. In clover pasture the effect is worse, because the clover is not sufficiently fine in its growth to form a mat to shade the ground. At the beginning of July and August the milk flow and the growth of animals are usually at their highest point. If they are allowed to fall off abnormally, as they usually do under ordinary pasture conditions, a direct heavy loss is occasioned at once, and worse still, no matter how abundant feed may later become the normal production is never again attained that year, so the loss is really a cumulative one. The writer feels confident in the assertion that the usual falling off in milk flow alone, during the one month of July of dry, unsupplemented ordinary pastures, causes, on the average, a loss of 30 per cent. in the year's milk yield.

For those farmers so situated that their land is expensive and farms are small, carrying a large stock, a system of summer feeding that economizes on land is to be recommended. For such, a system of soiling is useful. This consists of sowing a number of crops that will provide a succession of green fodder to be cut and fed to the cattle during the dry season. The best crops for this purpose are one and a half bushels oats, one-half bushel peas, to the acre, sown in two or three patches about two weeks apart, then a patch of millet or Hungarian grass, or on good warm soil a patch of sorghum or sugar cane, and some early maturing flint corn for early fall feed. The total acreage devoted to these crops should provide at least one-half acre to each head of stock to be fed and of this acreage half could be devoted to the peas and oats. To supplement this green feed, red clover can be used before the first cutting of peas and oats, and the second crop of clover will also be found to fill in a week or two in August. This method will be found to provide enough feed to supplement the pasture and keep up the milk flow, but, as is quite evident, will require much labor to cut and haul this feed, which makes the system inapplicable to most farms. A more economical method, as far as labour is concerned, is the feeding of silage in summer, which has the advantage of convenience in feeding as compared with soiling. When it is borne in mind that a ton of silage will give a cow thirty pounds a day for two months, it is easy to estimate the additional acreage necessary to provide enough for the herd for the period of summer shortage. The ideal method of handling is to provide a small silo for summer feeding, as silage spoils least on top of a small silo during the warm weather, but if this is not practicable, the additional acreage of corn can be grown and the excess filled into the silo in the late fall after the silo is partly fed out. If the corn has been well shocked the late filling will make excellent feeding during the winter and there will be good silage left in the bottom for summer use. This method also involves considerable labour, not only in feeding but also in the extra cost of cultivating and storing the extra corn.

These two systems just outlined, while valuable in many cases, are, on account of the labour involved, not applicable to the most farms, particularly under present conditions. A betterment of pasture conditions seems the most generally useful advice now. A study of the question of pasture for dry weather demonstrates that the essentials are, (first) a thick, fast growing mat on the ground, and, (second) a crop that will spring up readily after being eaten off, and, (third) a crop whose growth of leaf and stalk is least injured by summer drought and the trampling of hoofs. The first essential can be provided by the thick sowing of any crop that is leafy in its growth, the second essential by those crops that, having a quick habit of growth have no early growth of a thick main stalk, but are leafy from the ground up, the third essential is provided by those crops that once having a good start are not seriously affected by heat or dry weather until the seed forming period begins. An examination of the different farm crops discloses that the three spring grown cereals, wheat, oats and barley, come the nearest to fulfilling the three essentials just mentioned. In addition the composition of the young growth of these plants is much similar to that of the early starting natural grasses.

Keeping all the above factors in view, the College Farm has tested, and now recommends the following pasture mixture, that has given exceptionally good results during the past two seasons. This mixture consists of one bushel each of wheat, oats and barley, and seven lbs. of red clover, per acre. This mixture is sown immediately after the spring grain seeding is finished, which is about May 15th or a little later. In about one month this thick mixture is usually about six to seven inches high, at which time the cattle are turned on to the pasture. On being eaten off, the plants immediately commence a rapid and thicker growth. To such an extent is this true that if the plants are not allowed to head out the growth will continue until well on in August, or early September. It is also well established that red clover will make a more certain catch when seeded with a pasture mixture than in any other way, for the reason that the young plant is not too much shaded and the trampling in dry weather keeps the soil tightly compacted with a slight mulch of dry earth on top.

During the season of 1915, seventy-five head of cattle, all over one year old, were maintained on twenty-eight acres of this annual pasture, eight acres of old natural pasture and thirty acres of third year sod, sixty-six acres in all, from first turning out in May until August 20th when about thirty-five head were removed to some second growth clover. During 1916, a very dry and hot summer, seventy-seven head were pastured on thirty-four acres of this annual pasture and thirty-six acres of permanent pasture, from the last of May to August 25th, without feeding one pound of silage or other coarse feed, and the milk flow of dairy cattle and growth of beef cattle and young stock were kept at normal during that time. On the last mentioned date about half the cattle were removed to some second growth clover, but the annual and permanent pasture carried at least half the stock the balance of the season.

From the results herein obtained, there can be no hesitation in recommending this pasture mixture to better live stock feeding conditions in summer, to any farmer. The seed itself is found on every farm. On nearly every farm, some tillable land is nearly always used for pasture that will give much better returns under this mixture than as grass or clover pasture and, moreover, a good catch of clover is assured for hay the following year.

Permanent Pastures.—We have in this Province a large area of rough land and steep hillsides, all unfit for cultivation, but that produce a large amount of fine natural pasture ideal for milk production. This is the best use to which this land can be put. It is evident, however, that good tillable land will not give the best returns if left to grow natural grasses, because much greater growth can be obtained from such land by growing mixtures of grasses and clovers that give a stronger and more vigorous growth throughout the summer season, than do the natural grasses. Good mixtures for this purpose must contain some clovers, which give a high protein content to the pasturage, and also those grasses that give quick early growth in spring, and that last well through dry weather. Where land has grown alfalfa, this seed can be used to good advantage, as it will stand pasturing by cattle reasonably well. Red clover and alsike, on account of their general use and ease of catch, should also form part of a permanent pasture mixture, and white clover, if seed can be procured, lasts for a long time under pasturage. A good permanent pasture mixture would consist of:

4 lbs. Red clover.	2 lbs. Tall oat grass.
2 " Alsike.	2 " Meadow foxtail.
2 " Alfalfa or white clover.	2 " Kentucky blue grass.
2 " Orchard grass.	3 " Timothy.

This amount would seed one acre. The best combination of pasturage for any stock farm would consist of two-thirds of an acre of good permanent pasture, and two-thirds of an acre of the annual pasture previously mentioned, for each head of cattle one year old and over. This amount, with the use of second growth on meadows for pasture, will supply the farmer with sufficient pasture without necessitating the use of soiling crops or even silage during any ordinary summer.

Grain Feeding on Pasture.—It is evident to all dairymen that cows reach their maximum milk flow during the late spring and early summer, because the fresh green grass is of the ideal composition for milk production, and is usually plentiful enough to supply all the wants of the animal with the minimum amount of labour and time in grazing. Under these conditions, the addition of grain will not stimulate the flow of milk to any profitable extent. While the change from stabling to pasturing is being made, however, the feeding of a small amount of grain will be found profitable. This tends to create a less violent change from dry feed to the watery immature grass, of which it is rather difficult for the cow to consume enough bulk to properly supply the necessary dry matter to fill all her needs. In addition to grain, a small amount of silage will often be acceptable at this time, but it is difficult to get the herd to eat any dry roughage unless it be extra good clover or alfalfa hay. As long as the pasture is plentiful and green, the feeding of grain will not be found to return immediate profit with cows of ordinary capacity. It will help, however, to build up the system to better withstand the shortage later on, and for this reason the feeding, to cows of better than ordinary productiveness, of a small concentrate allowance is to be recommended, as soon as pastures commence to show the least indication of failing. During the heat of summer, when flies are bad, the feeding of grain will be a great help in carrying the cows through these adverse conditions, with the minimum of shrinkage in milk flow. For this ration, bran, cottonseed meal, oil meal, and oats or barley, are the best concentrates, as the three former are usually then at their lowest price during the year. From one to two pounds per day of a mixture is sufficient feed while pastures are reasonably good, with a maximum of four pounds in hottest weather, which would be all that could be fed profitably. If the milk flow continues to decrease abnormally, it is a sure indication that the supply of roughage or pasture is short. This can be improved by more pasture, soiling crops, or silage, rather than by increased grain feeding.

Water in Summer.—A plentiful supply of clean fresh water is an absolute necessity in getting good results from the herd in summer. If a creek or spring is not available in the pasture, the herd will have to be supplied from a well. A well in the pasture with a windmill and pump is found to give good satisfaction if the machinery is regularly looked after and oiled. Where it is necessary to water near the barn, the cows should be allowed to drink their fill twice a day at the very least, and in hot weather three times, if it is at all practicable to get them to the water. Where a water system is installed in the stable, the cows can drink with most comfort and least annoyance when they are put in to milk.

Salt.—While on green pasture, cows will consume a great quantity of salt. This is best fed by putting a small handful in the manger once a day while the cows are inside. If the pasture is close to the buildings, where it can be renewed often, an old trough will do nicely for salting, and the cows can help themselves at will.

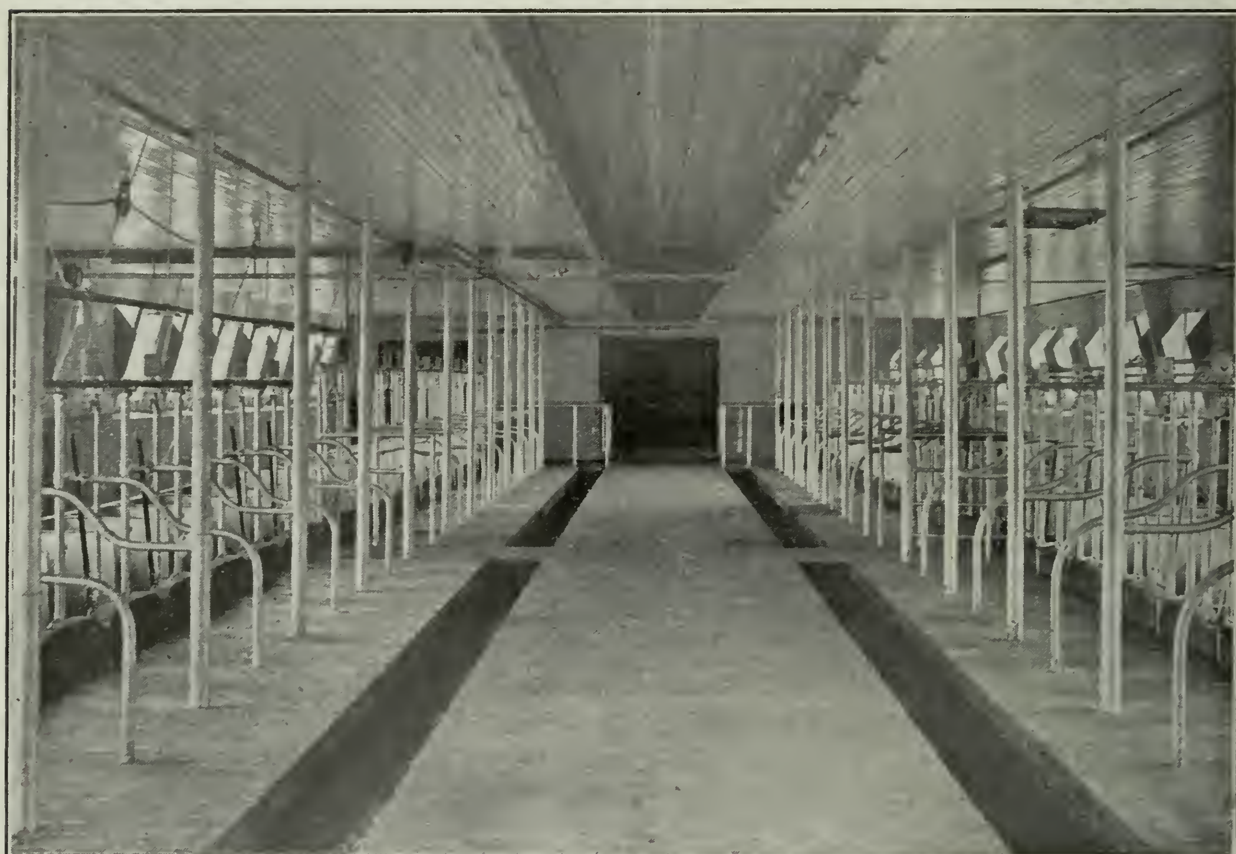
Shade.—In summer, shade is almost an absolute necessity in our climate. The cow becomes heated from pasturing in the open and pestered, to more or less extent, by the flies. When she wishes to rest and chew her cud, she should have a comfortable place to do so, where she can cool off and where the flies will not bother her so much. She will show her appreciation of this comfort by a good response at the pail. Pasture should always, therefore, be arranged with a view of providing shade.

The Milking Herd in Winter.

Weather conditions usually compel a gradual change from pasturing to stable conditions. While the dairyman wishes to make the most of the pasture that is usually plentiful in the fall, to leave the cows out in the cold and rainy weather, especially at night, is not profitable. This causes a serious shrinkage in the milk flow that would be avoided by keeping the cows in the stable and feeding some hay, silage and grain. When the nights become frosty and cold, it is advisable to keep the milking cows in the stable all night. Even if feed is plentiful in the pasture the cold nights cause a shrinkage in the milk flow that can, in this way, be avoided. In this case it may be unnecessary to feed much in the stable, the comfort of the cows being the main purpose in keeping them stabled. While the herd is being stabled at night and pastured by day, it is difficult to keep the animals clean. To avoid this as much as possible, some bedding is necessary. For this purpose sawdust, shavings, or cut straw are the most efficient. In addition, cows should be fed, milked, and turned out as early in the morning as possible, because it is when they lie down the second time that they become the worse fouled.

Winter Feeding.—Experienced dairymen have often noticed the enormous capacity for food that all animals possess when first stabled in the fall. This is a natural instinct inherited from the days of the wild cattle, when it was necessary that all animals accumulate as large a store of body fat as possible to tide them over the shortage of feed and rigorous climate of winter, and in the case of the breeding cow to put her in the best possible condition for maternity in the spring. As cows that have milked well throughout the summer are never in very high condition in the fall, liberal feeding is required at this time to maintain at normal the milk flow, and also to provide the food necessary to improve the bodily condition that the above mentioned instinct demands. Good dairymen find it profitable to provide well for both the above conditions, realizing that until she has reached good condition the cow is likely, if not well fed, to use the most of her feed to attain that object rather than to produce milk. Moreover, when she reaches good condition her maintenance cost will be less for the balance of the winter, than if she be low in flesh. It is well, therefore, to feed most liberally, with the best quality of feed, for the first two months of the stabling period, and if economy becomes necessary the herd of all ages are naturally able to stand it better towards spring. This applies particularly to the best use of hay and straw. It has been the writer's experience that it is better to feed good hay in fall and early winter, and when the herd is in good condition they will eat straw and poorer hay with more relish and, therefore, with better results. Where nearly all the cows calve in spring, before pasture starts, it is wise to retain some of the best hay for use when the cows freshen. But it will always be found profitable to feed well with some of the best feed on hand, early in the stabling period.

Feeding Two or Three Times a Day.—It has often been noticed that a cow on pasture likes to be reasonably full before she quits eating and lies down to chew the cud. She desires, also to have a considerable period of time to perform this necessary operation. It is advisable under winter conditions to follow as nearly as possible the method the cow herself would employ if left to her own devices. In the usual dairy herd, this points to the practicability of feeding only twice a day. This method gives the cattle a good spell to lie down quietly and chew the cud during the middle of the day, which they would not get in the short winter day if fed at noon. In addition, while labor is scarce, a longer time during the middle of the day for other work on the farm will always be found advantageous. In pure-bred herds, where cows are being tested for official records, and particularly



Interior Ontario Agricultural College Dairy Stable.

where milking is done more than twice a day, it is better to feed three times or even oftener, as a greater consumption of feed can be induced in this way.

Order of Feeding.—The order in which the different parts of the ration are fed in the day, depends much on the amounts of the various classes of feeds being fed. Where a large amount of silage and roots, and only a moderate amount of good hay, are used the best plain is to divide the succulent feeds into two feeds, morning and evening, and feed the hay in one feed, preferably right after the silage and roots in the morning. At this time it is more convenient to replace in the mangers the hay that inevitably is thrown out while the cows are eating. The meal ration is best fed on top of the silage, at both feeds. If straw, or poor hay, is being fed, these are best used at the last feed in the day so that the cows have a better chance to work them over during the long night period.

Regularity in Feeding.—Owing to her highly nervous organization, the dairy cow reacts very quickly to any sudden change in the daily routine of stable work, and such changes invariably cause a decrease in the milk flow for that and succeeding days. Therefore, regularity in all feeding, tending, and milking operations, is one of the most important features of successful stable management. Even though the herd may have the ability for high production and there be fed an abundance of the right kind of food, a herd will not produce profitably without regular care and attendance. The dairyman who has the best possible combination of these three factors is always the most successful.

Milking.

Milking should be done regularly, at the same time each day, and periods between morning and evening milkings should be of nearly even length as is possible. The cows should also be milked quickly and all the milk drawn at each milking. Slow milking induces in the cows a tendency to hold up their milk, so that it is difficult to get them milked cleanly. If the milk is not all drawn at each milking, the cows are not properly stimulated to produce their maximum and they dry off more quickly. The quality of the product depends largely on the thoroughness and cleanliness of the milking operation. The cows should be free from manure, particles of bedding and loose hairs. This can be accomplished only by keeping the cows brushed every day, and by brushing again the hind quarters just before milking. Wiping with a damp cloth, just before starting to milk, the flanks and udder will cause dirt particles and hair to adhere to the skin and prevent them dropping into the pail. The cleanliness of the cows can be greatly improved by clipping the hind quarters, flank and udder, at the beginning of the stabling. Milking should always be done with dry hands. Wet hand milking is a most filthy operation, as it causes dirt from the teats, in solution, to drop into the milk from which it is impossible to strain it. Cows with sore teats should be left till the last, to avoid spreading the contagion to other cows. If it is too painful to milk sore teats with dry hands, a little vaseline on the teats is to be preferred to wet hand milking, while the vaseline will have a beneficial action. A narrow mouthed pail will catch less dirt than the ordinary milk pail, and after a little practice will be found as easy to use.

The milking of heifers should have particular attention, as the habits of the cow's whole life are determined in the first lactation period. If the heifer is restive, it is better to spend a little time and use a little patience and kindness and milk her without tying her feet, which should be done only as a last resort. If it becomes necessary to tie her feet she will always be a risky cow to milk, and after every calving, thereafter, she will need to be tied, when a little more determination and patience at the first would have made her a quiet cow.

It is not always practicable to have the period between milkings, and it is not essential, that milkings be twelve hours apart, to get the maximum results from an ordinary dairy herd. Cows milked at ten and fourteen hours interval will produce satisfactorily, if the work is done regularly at the stated hours. It is well to remember that the milk after the long interval is invariably lower in butter fat test than that after the short interval. This factor must be taken into account by men supplying milk to the retail trade, where uniformity in the quality of the milk is an important consideration. Cows in official record work, whether milked two, three, or four times daily, should always be regularly milked at equal intervals, in order to keep the fat test of all milkings as near normal as possible. The point at which it is profitable to milk more than twice a day is one that cannot be definitely ascertained. With a grade herd it is doubtful if it would pay to milk more than twice; a little extra milk and some additional butter fat may be obtained by milking oftener, but unquestionably these would not pay for the extra labor involved, especially in the spring or summer season. With pure-bred cows, the small gain in milk and fat added to an already good production would naturally increase the value of the record more than the actual value of the excess product. With such cows, giving upwards of fifty pounds per day, thrice a day milking might prove profitable, and if sixty-five pounds per day is reached it becomes necessary to do so. Very few cows have given more than seventy-five pounds per day on twice a day milking, and it appears physically impossible for a cow to give more than eighty pounds under this method. At the same time where regularity in care and milking and an abundant supply of suitable feed is supplied, the right kind of cows will make very large and creditable records from twice a day milking, as the following records from the Ontario Agricultural College dairy herd will show:

Name of Cow.	Breed.	Age.	Lbs. Milk in 1 year.	Lbs. Fat in 1 year.
Young Springwood	Holstein	5	20,110	821
Blackie	Holstein—Grade	13	17,019	640
Molly Rue Rattler	Holstein	3	16,975	640
Molly Rue	Holstein	6	16,466	602
Margaret Cornucopia	Holstein	10	14,978	554
Iford Waterloo Baroness	Shorthorn	5	13,410	502
Fairy Duchess	Shorthorn	4	9,573	384
Flora Hope	Shorthorn	2	7,773	318
O.A.C. Minnie	Ayrshire	8	12,531	477
O.A.C. Glennie	Ayrshire	8	9,384	401

No doubt each of these cows would have made larger records had they been milked three or four times per day with the same care and attention which they received. These records give an indication of the possibilities of twice-a-day milking in official record work, and help to remove the idea from the minds of beginners in this work that it is useless to attempt it unless it is possible to so arrange the work of the farm as to milk oftener.

The Milking Machine.

The statement that the milking machine has now become a practical proposition, can now be made with considerable confidence. Practically all the standard makes of machines sold in this Province, the cheaper ones as well as the more expensive, are giving good satisfaction in the hands of a great many dairymen. There are, however, many instances where each make has not been successful. Analysis of the results that have been obtained by a great many dairymen show that success or failure depends upon the ability of the operator, and not on the make of the machine. All machines are somewhat complicated, and somewhat delicate of adjustment, so that to be successful the operator must exercise some mechanical ability, and strict care and attention to the needs of individual cows. Without these the milking machine has always proved a failure. It can hardly be said that the machine will get as much milk from the cows as good hand milking, but, properly handled, it will give better results than the average hand milking, and there is no doubt of its being a great economiser of labor and time. The machine has its place on the farms of dairymen who milk more than ten cows, it being doubtful economy to invest so much money for a smaller herd. It may also be doubtful economy to instal the machine in a herd of pure breds where much official test work, involving milking three or more times per day, is being done.

Regarding the quality of the milk from the machine, it is safe to say that where the machine is kept scrupulously clean it will produce nearly as clean milk as the most careful hand milking. Where the machine is not kept clean it produces the most impure milk imaginable, being full of the bacteria that cause the most destruction to the keeping quality of the product. These bacteria found in the unclean parts of the machine are more harmful even than many of those which fall into the pail during hand milking. Mechanical ability, incessant care and cleanliness only, can make a success of the milking machine.

Cleaning and Grooming.

Apart from appearances, brushing and grooming have a direct value and influence on the production and thrift of the herd. Brushing and grooming, by removing dust and dead hairs, contribute much to the comfort of the cow which, in a highly organised animal, is an important financial advantage. Keeping the skin and hair in a clean active condition also helps any animal in making better use of its feed. Moreover, cleanliness of the skin contributes much to the cleaner quality of milk, which adds to its value greatly. If cows are kept free from manure, the work of grooming a herd into a clean condition every day is very small. With a stiff corn brush one man can sufficiently groom at least two cows a minute. If a currycomb is necessary, an old horse currycomb, on which the points are slightly worn down, is more satisfactory, not being as severe on the cow as a new comb.

The proper use of bedding contributes much to the ease of keeping cows clean. In general, short or cut straw is preferable to long straw, which tends to mat under the bellies, or be kicked into the gutter, leaving bare of bedding the place under the cows' hind feet, from where comes the manure found on the flanks and sides. Cut straw, sawdust, shavings and chaff retain their position better under the movement of the feet, and therefore a smaller amount is necessary to keep the cows clean. Again, if cows are tended regularly, they acquire fixed habits as to lying down at certain times of the day, which gives an opportunity to scatter the bedding just before they lie down. This rarely takes more than a few minutes in any stable, and is time well spent in saving labor and grooming, and in adding to the appearance of the herd. Some men make a practice of tying the end of the switch of a cow's tail with a long string that reached from the ceiling to about a foot above the bottom of the gutter. This keeps the tail out of the liquid of the gutter when the cow lies down, and prevents the soiling of the cow's sides when she switches her tail on standing up. This scheme, of course, can only be used in winter, and where cows are turned out only occasionally.

The proper length of stall for each animal contributes much to its cleanliness. This will be dealt with more fully in the discussion of stables.

Watering.—Whether or not cows in the stable should have a supply of water within reach at all times, is not really important, provided milking cows can get their fill comfortably twice a day and the rest of the herd once a day at least. It is necessary that the water be abundant and pure, and that the cattle can get it conveniently and with comfort. Therefore, even if it is the common practice to turn cows out of the stable every day, the water supply should be provided in the stable. The cheapest and most simple installation is the use of a continuous concrete manger, which may be used both for feeding and watering. This avoids the expense of piping that is so necessary with a water bowl system and that occasionally gives trouble from freezing in severely cold weather. A drain pipe from the manger is necessary with this system to let out the excess water, but in most stables, this expense is negligible. Water turned into the manger twice a day is often enough for all practical purposes, because under natural conditions a cow requires a fill of water no oftener than this. There is some little time required in sweeping the manger before watering, but even this is negligible, as the bottom of the manger is always smooth, and particles of feed do not adhere to it. A good water bucket system once installed, of course, does not require much attention, except to see that the piping is not allowed to clog up or freeze. Comparing a fountain system that feeds from overhead with one that fills the bowls by gravity from a tank with ball float and valve, each system has its advantage. The former is less liable to be clogged up, but if the valves in any bowl gets stuck when open the stable will be flooded. The gravity system is slower in its operation, but there is less liability of flooding at the bowls. In installing the latter system each bowl should have a check valve that will prevent water once entering the bowl from returning to the pipes, carrying particles of feed and saliva that may cause a clog up or contamination of the water supply.

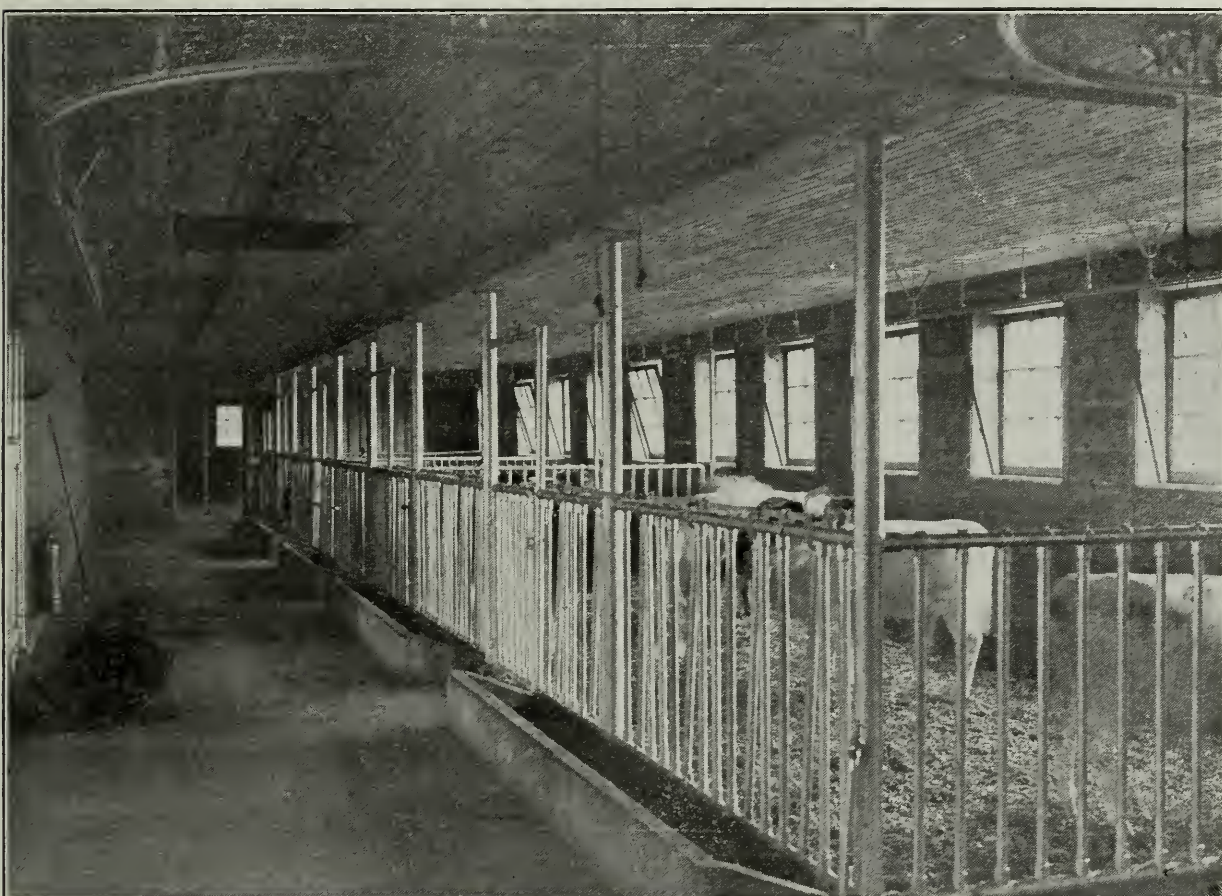
If water is convenient in the yard outside, watering in a trough is satisfactory except in cold or stormy weather, at which time cows will not drink their full supply. This is an important consideration with milking cows. Driving cattle long distances to water, though sometimes necessary, is not good practice from the standpoint of profitable returns.

Exercise.—Turning cattle out on fine days will give them some valuable exercise, but leaving them out in the cold causes a loss in heat that can only be made up by additional feed. Cattle in a well ventilated stable with an inside water supply will come through the winter in good shape without much outside exercise. Cows in heavy flow of milk are hard worked anyway and the value of outside exercise is problematical. An animal that is going sore on its feed should be turned out regularly.

The Cow at Calving Time.

The condition of the cow at and after calving has the greatest influence on the success of her ensuing lactation period. If she has had at least six weeks' rest since drying up, and has gained up in weight so that she is carrying considerable fat, she has stored up considerable energy both muscular and nervous that will be a much needed reserve to draw on during the strain of calving, and during the exacting continuous nervous strain of milking day after day. It has also been well established that the more fat a cow accumulates in her body before calving the higher will be the percentage of butter fat in the milk for some weeks after freshening. So the expense of feeding a cow well before calving not only creates a much needed reserve of energy, but is directly returned in the product immediately after calving.

In early summer, if a cow is dry all she needs is the good pasture found at that season. If pasture is scarce and dry, she should have as good supplementary feed as the milking cows, though grain feeding is not necessary. In winter, give a liberal supply of good roughage such as the milking cows are getting and laxative concentrates, such as two or three pounds per day of a mixture of any of the following: bran, oats, oil meal, brewers' grains, corn meal, or gluten feed, care being taken that bran or oil meal be included in the mixture. The feeding of a few roots is advisable at this time. As calving time approaches the most important consideration is to keep the bowels lax. Practically all the usual troubles that follow calving can be traced to constipation at this time, milk fever, chills, loss of appetite, and caked udder among them. If bran and oil meal, roots or silage are found in the ration there will usually be little danger in this respect. It is usually perfectly safe to continue the feeding of bran and oil meal right up to calving and even right after, unless there be undue inflammation of the udder. If the cow is constipated, or even if the manure is hard and dry, a dose of one and one-half pounds of salts and one ounce of ginger should be given before calving, and



Interior Ontario Agricultural College Calf Barn.

repeated if constipation is still evident twenty-four hours after calving. In this connection, a drink of the cow's first milk is a valuable laxative. This old and homely method is to be advised in any case, even if the cow is in the best of calving condition. To have the cow calve in a box stall, by herself, is to be preferred, unless the box stall be much colder than her usual place in the stable, as a chill is to be avoided at this time. If the cow's udder is hard and inflamed, it is a good practice to leave the calf with the cow for a day of two; otherwise the sooner the calf is taken away after it is dry the less the cow will miss it and the easier it will be taught to drink. If the calf is taken away immediately after birth, it should be briskly rubbed dry with straw, or some old rags or sacks. The cow should not be milked out clean for the first four days; rather should she be partly milked out three or four times a day at first. It is popularly supposed that milking out dry at this time brings on the nervous paralytic affection known as milk fever. Should this disease appear, as it sometimes will, in spite of all precautions, the simple effective remedy is to pump each quarter of the udder full of air, and tie the teats to prevent the air escaping. The equipment necessary for milk fever treatment should be in the hands of every stockman. If the afterbirth be retained, it should be removed by a competent person within forty-eight hours after calving. Although this is a simple operation, it should be done carefully and thoroughly, to prevent bleeding and to entirely remove all particles from the extreme forward parts of the uterus. After the afterbirth is all removed, the uterus should be flushed out with an antiseptic solution. For this purpose a solution of boracic acid or oxalic acid is to be preferred to carbolic acid or other coal tar products, which are harsh in their action and cause undue straining.

After three or four days the cow can be reduced to the normal milking periods, and her feed gradually increased until at ten days after calving she can be safely put on the maximum ration for the milk being produced. It is well, however, not to feed any barley, which is heating, or cottonseed meal, which is constipating, till at least two weeks after calving.

The Herd Bull.

The entire care of a dairy bull must be with the view of keeping his vigor and getting power at their highest point. In addition to the proper kind and amount of feed, he must have sufficient exercise in order that his system may be kept active and vigorous. The dairy bull has much the same large digestive capacity as a cow, so that when he reaches maturity he has the digestive power to lay on fat readily. This excess fat usually slows him up, makes him heavy, and he loses his procreative powers unless he is compelled to take enough exercise to keep down his condition. The feed of the bull, like that of the cow, needs to be of a bulky character, but should not be too coarse and watery as, for instance, a heavy silage ration that would develop too much middle, which in a bull injures his vitality, making him slow and clumsy. Clover hay should form the bulk of a bull's ration, in addition to a small amount of roots, silage and straw. With this kind of feed, a bull may require very little grain, except when he is doing heavy service. At such times, three or four pounds per day of bran, oats and oil meal would prove ample. If clover or alfalfa hay could not be procured, timothy or blue grass hay will give good results, but a little more concentrates, preferably bran, will have to be fed. As a bull has a large body to maintain, he requires considerable total feed. The following rations would be suitable for a bull 1,500 to 2,000 lbs.

Ration 1.—	Clover hay	20 to 25 lbs. per day.
	Oat straw	5 lbs. per day.
	Roots	20 lbs. per day.
	Silage	10 lbs. per day.
	Grain mixture	2 to 4 lbs. per day.

In summer, an equal weight of cut grass, or other soiling crops, could take the place of the roots and silage.

Ration 2.—	Timothy hay	15 lbs. per day.
	Corn fodder	10 lbs. per day.
	Roots	30 lbs. per day.
	Grain mixture	4 lbs. per day.

For a young and growing bull, usually active at that age, more liberal feeding can be safely done as growth has to be provided for. Even at that age, the roughage should consist largely of hay and straw and roots, rather than silage.

The handling of a bull often causes serious consideration, especially after he becomes old enough to do physical harm. No bull, no matter how quiet, should be trusted, as he may turn ugly at a second's notice, from no apparent cause. It is usually the quiet bull that hurts someone, as the cross bull seldom gets the opportunity. A bull is usually quieter if kept stalled where he can see the cows. He should have a box stall to himself where he has considerable room to move around. As a rule, however, when he gets older it becomes difficult to catch him in the stall. To avoid this, he should be tied with a light rope long enough to reach twice from the ceiling to the floor. One end is snapped to the ring in the nose, the other is passed through a pulley at the ceiling, near the door of the stall, and a weight of a couple of pounds fastened thereon. This weight is just sufficient to keep the rope tight and prevent a loop of the rope at the bull's nose from reaching the floor to be stepped on, while not heavy enough to inconvenience the animal in moving about the stall. At the same time the weighted end of the rope can be grasped on opening the door, to which the bull can be drawn without entering the stall. For exercise, the bull should be turned out in the yard every fine day. The more exercise he gets, the less vicious he will be. If he is difficult to catch in the yard, he can be tied by a rope to a pulley block, running on a rope or wire cable stretched overhead between two posts in the yard, with just enough slack in the rope so that he cannot get his foot through it. If one or both of the posts are in the yard, a stop must be put on the cable to prevent him from walking around the post and tangling him up fast. This is one of the best methods of handling a vicious bull, as he is always under control. If not too highly fed, most bulls of the dairy breed are active enough to take sufficient exercise. A bull over one year old should never be led out without a strong staff. If it is necessary to lead a cross bull, blindfolding him with leather or a folded sack will usually make him quite safe to handle. Dairy bulls, never allowed to get in high flesh and with sufficient exercise, have been known to remain active for service till ten years old or over.

The Calf.

The surest and safest method of improving the milking quality of a herd of cows is to raise the heifer calves from the best cows in the milking herd. It may not always be good practice to raise the heifer that is her dam's first calf; the dam may not turn out a profitable cow and by the time this is found out a certain amount of expense has been incurred in raising a calf that would not otherwise be kept. It is safer to select calves from proven cows, and even then there are many instances that cannot be explained of inferior heifers from heavy milking stock on both sides.

After birth, the calf should be removed from the sight of the cow when less than three days old. Some good dairymen advocate taking them away at birth, but the calf will get a better and more natural start if allowed to suck at will for the first day or two, while the udder of the cow will be benefited, and it is not a serious matter to teach a three day calf to drink from a pail. The usual well known method of using the fingers to teach a calf to drink from a pail has never yet been improved upon. Different, more or less, mechanical contrivances with artificial teats have been contrived, all of which owing to the necessity of washing have been found impracticable and if not kept clean do injury to the digestive organs, through contamination of the milk.

The growth of the calf during the first year will depend much on the start the calf gets the first month. It should, of course, have its mother's milk for the first three or four days. The fresh milk of the newly calved cow contains that product, colostrum, that is necessary to stimulate the newly born calf's digestive system into action. At the least the calf should have fresh milk till two weeks old, five to six quarts per day being sufficient. If it is desired to change on to skim milk, which is the only really successful method of raising good heifers, the change should be made gradually, substituting every day more and more skim milk for the same amount of fresh. It becomes necessary, of course, to provide in some way the fat a calf must have, but which is lacking in the skim milk. For this purpose flaxseed jelly is best. This is make by simmering a pound of ground flaxseed in three quarts of water, or boiling one pound of ground flaxseed in a gallon of water until a thick jelly is formed. When the change is being made from whole milk to skim milk, a tablespoonful of this jelly should be added to the milk, gradually increasing the amount until at one month old a half cupful may be fed at each feed. The Central Experimental Farms recommended the following mixture, to be fed in much the same way:—

One part ground flaxseed.
Two parts fine cornmeal, sifted.
Two parts finely ground oatmeal, sifted.

Boil and allow to stand twelve hours covered. Begin with one-eighth of a pound per day, when the calf is one month old; new milk for the month previous and no solids. Increase the amount per day as the calf grows older, until one-half pound is being fed.

As the calf gets over three weeks old, it will start to nibble at a little hay. Some good clover, or alfalfa, should then be within its reach at all times, till three months old. At about the same age it will commence to eat a little grain, and for this purpose there is nothing better than equal parts of bran and oats (whole oats preferred) fed in addition to the flaxseed or other food in the milk. In feeding calves, it must be remembered that skim milk must be more carefully fed than whole milk. Lacking, as it does, the natural butter fat, an overdose is almost certain to bring on indigestion and scours. If fed cold, when calves are used to warm milk, the same difficulty occurs. Care must also be exercised in keeping the pails clean and sweet. Sour skim milk can be safely fed after the calf is about three months old, if the calf is gradually made accustomed to it and it be fed entirely. Though skim milk is the best feed on which to rear calves, sweet whey can be used, if the change is gradually made from milk to whey, and the flaxseed or other jelly added the same as to skim milk. Where neither whey nor milk can be procured, the use of hay tea has been found of help. This is prepared by boiling cut clover or timothy until a strong tea is obtained. This is fed exactly the same as milk. Calves may profitably be kept on skim milk or whey till six or seven months old, and if extra size is desired, it may be kept up until ten months.

The pasturing of calves under six months old is not to be advised. The digestive system of the calf requires feed in more concentrated form than does the older animal. Grass, therefore, has so much bulk in comparison with the nutrients supplied, that the calf's system cannot handle it economically until developed by age. Moreover, the thin skin and fine hair of our dairy calves cannot well stand the blistering effect of the sun and flies when pasturing in the open. The calves will do much better if kept in a dry pen or shed, where they can be conveniently fed. If the pen is darkened during the heat of the day, the flies will not cause much trouble. When, however, they have reached the age of six months, and the worst of the heat is over, and pasture plentiful, calves will do well to be turned out, and exceedingly well if the feeding of milk and a little grain (say one or one-and-a-half pounds each, per day) be continued for a month. Calves that have had a run at pasture during the fall months usually get thin, but seem to feed and grow better during the ensuing winter, than if kept stabled the entire first year.

Until the calf is one year old, the ration should be of good quality hay, roots and meal, rather than too bulky; that is, containing too much silage or corn fodder. A small amount of silage may be fed the first winter, say six or seven pounds a day, at most, to add variety to the ration. Clover or alfalfa hay should form the bulk of the ration, and the grain ration need not be large, but should consist largely of bran, oats, and oil meal, all of which are suitable for young and growing animals. If dehorning is practised, and this operation is to be advised in at least all grade herds, it can be most easily done to the calf. The operation consists in application of moist caustic potash to the small horn or button, about the time it comes through the skin. Care must be observed to keep the potash from contact with the hands and from the eyes of the calf.

The Heifer.

Feeds and Care.—In spring all calves over seven months old can be turned out to grass which is plentiful, and is all the feed required till fall. Beyond seeing that there is plenty of pasture, shade and water, and salt twice a week, no other care is needed till late in the fall, as heifers may be safely left out as long as there is pasturage to fill them up. When brought into the stable the food should be plentiful, but bulky, in its nature in order to develop a large and efficient digestive system. Silage may be fed liberally; oat straw and a moderate amount of hay and roots, fed in comfortable quarters, will supply all the necessities for good growth and development. If a heifer is due to calve in the spring she should have a little grain added to her ration. For this purpose, two or three pounds per day of the grain mixture being fed to the milking herd will do. If the bulky part of the ration is not of very good quality, a little grain mixture can be fed to advantage, especially during the early winter.

Time to Breed.—It is usually not good practice to breed a dairy heifer till she is at least twenty months old. If she is of average size for her breed, if she should be bred earlier she is not likely to make both her normal growth and her best yield of milk during her first lactation, she will likely become stunted in her growth, and always be a small cow on that account. If she be extra large, the heifer may safely be bred to calve shortly after she is twenty-four months old. During the period a heifer is carrying her first calf, she requires occasional handling in order that she may make as little trouble as possible when first commencing to milk. Kind treatment at this time will be well repaid during her future milking life.

COMMON AILMENTS AND DISEASES.

Like all living creatures, the dairy animal is not always in perfect health. Since dairy cattle now live under rather artificial conditions they are no doubt afflicted by more ailments than if living under entirely natural conditions. The old saying "Prevention is better than cure" admits of no more proper application than in the dairy business. Therefore, the aim of all dairymen should be to give that care and attention that will ward off disease, than to depend on his own skill or that of his veterinarian to avoid serious loss from this source. Though the most stringent care cannot always prevent diseases from creeping in, the following of the simple rules of ventilation and cleanliness, the supply of abundance of good food, admission of sunlight and periodic disinfection of stables, will prevent most of the losses that occur in dairy stables from disease.

A discussion of some of the commoner afflictions of cattle that yield to treatment by the farmer himself, together with causes, prevention and cure, here follows:—

Abortion.—This disease is of two distinct kinds, mechanical or accidental abortion, caused by a fall, a blow, or a hook from another cow, and contagious abortion, due to the presence of a germ in the genital organs of the pregnant cow. The first kind only occasionally happens, and can be avoided only by care in handling the cows to avoid accidents of this kind. The second kind is the scourge of the dairy business. The germ of this disease has extraordinary vitality, which enables it to remain active in the system of the cow from one pregnancy to another, and great power of resistance, which enables it to survive medicinal treatment that does not have actual contact with the germ itself. Because the germ lives in the womb, which is tightly closed except for a few days after calving, it is, of course, impossible to bring the germ in direct contact with disinfectants for the greater part of the year. Therefore, there has not yet been found any course of medicinal treatment to which the disease has appreciably yielded.

The disease usually finds its way into the stable through the medium of a purchased cow that is infected, or a bull that has served an affected cow passing on the infection of healthy cows. The most obvious method of prevention is to avoid the introduction into the herd of either males or females from herds that are infected, and to prohibit the service of outside cows by the herd bull. Should the disease once get a foothold in the herd, the spread of the disease to all the cows is always very rapid, and even with the strictest treatment will take some years to entirely eradicate. There are the best grounds for belief that a cow may carry the affection and yet not abort, being of sufficient resisting power to prevent the disease from operating. It is also believed that when a cow becomes normal, after aborting one or more times, that she still retains in her system the infection, that may be transmitted to other animals. The latest investigation into the disease points to the probability of a heifer calf, born normally from a cow of either of the above kinds, carrying the infection in her system until she herself is of breeding age, when she may abort. The same investigations show that it is possible for a healthy heifer calf to become infected from the milk of an infected cow, and carry the infection until it causes her to abort at the first opportunity. These may explain the lack of success in eradicating the disease that has so far attended the strict methods of isolation, sanitation and disinfection heretofore practised by many dairymen. This would also partially explain the progress of the disease, through practically all badly infected herds; that is, that the infected cows seem to become immune after two or three years, and ensuing outbreaks are usually among heifers and purchased cows.

The only methods of handling an infected herd are isolation of aborting, or about to abort, cows from the rest of the herd, disinfection of stalls and gutters about the infected animals, and burning or burying all discharges and bedding from aborted cows. Added to these is the necessity of flushing of the vagina and washing of the exterior genitals, tail and thighs with an antiseptic solution till all discharges cease. The sheath of the bull should be cleansed with an antiseptic after each service. The best disinfectant for internal work is a three per cent. solution of carbolic acid, phenol or chloral naptholeum, or a ten per cent. solution of boracic acid, which has the advantage of not being so harsh as to cause severe straining, which sometimes is the result from the first mentioned disinfectants. For external use and disinfection of stalls and gutters, etc., a solution of carbolic acid, zenoleum, or any other like coal tar product, double the strength mentioned above. For use in disinfecting the stables a two per cent. solution of corrosive sublimate will also be found very efficient.

One of the frequent results of abortion is temporary loss of the breeding powers of the female. Good feeding and frequent flushing of the vagina, to expedite the healing of the organs after abortion, is the best treatment for this condition.

Just before going to press the Health of Animals Branch of the Dominion Department of Agriculture have issued the following statement regarding experimental work with this disease:—

The experiments which we have been making in the Health of Animals Branch of the Department of Agriculture, with the object of finding a means of controlling contagious abortion in cattle, have resulted hitherto successfully, and I am permitted by the Minister, the Honorable Martin Burrell, to make them public.

Experiment 1. Four heifers, aged 1 year, were inoculated with our protective vaccine January 26th, 1915. The test of the blood of these heifers showed that one of them was already infected with the bacillus of contagious abortion, and all four were living in a herd in which the disease was known to exist.

The four heifers were bred on the following dates: April 21st, April 23rd, April 23rd, and December 18th, 1915. They all calved, the dates being respectively January 26th, January 26th, January 12th, and September 11th, 1916.

Experiment 2. Ten yearling heifers were inoculated March 20th, 1915, four of which reacted to the test for contagious abortion. They were bred after an interval of three months. (Accurate dates cannot be given in this case, as the herd records were destroyed by fire). All became pregnant; eight carried their calves to full term and produced living offspring; two aborted.

Serum and Vaccine.

Experiment 3. Four heifers, yearlings, were employed to test a method of employing a serum as well as a vaccine. With the first two, the serum and vaccine were used simultaneously; with the second two, the serum was given ten days prior to the vaccine. When tested, the first two had reacted to the test; the second two did not react. The first two were bred December 16th, 1915, and August 25th, 1915, and both aborted—July 12th, 1916 and April 16th, 1916. The second two were bred December 23rd, 1915, and November 9th, 1915, and produced living calves September 20th, 1916, and August 5th, 1916. This experiment was unsatisfactory and gave conflicting results, but shows that the simultaneous method of giving serum and vaccine did not prevent infected heifers from aborting.

Experiment 4. In this experiment an effort was made to find out how far the vaccine treatment would prevent abortion in cows which had previously aborted.

Eight cows were selected, ranging from two to seven years in age. All had previously aborted, one of them three times, the others once. All but one reacted to the test for contagious abortion. None were pregnant when inoculated nor bred afterwards until some weeks had elapsed. The result showed six cows produced living calves at full term; and one proved to be barren and was slaughtered; and one cow reacted when the herd was tested with tuberculin and was slaughtered, having previously aborted.

The method used in this experiment was a double inoculation with a mild vaccine first, followed by a strong vaccine several days later.

Experiment 5. Four cows, aged two to seven years, and four yearling heifers were used. The cows had all aborted previously, one of them twice, the others once. Three of them reacted to the test for contagious abortion. All were treated by the double method, and were bred, after a suitable interval, with the following result: One of the cows, the one that had aborted twice previously, aborted again. All the others produced living calves.

Should Make Application.

These experiments have resulted in obtaining 27 living calves from 34 cows and heifers in badly infected herds. This encourages us to hope that we have a really useful method of procuring immunity to the disease, and we are anxious to enlarge our experience by extending our work to other herds.

With this object we now offer to treat free of charge a limited number of herds in which contagious abortion is present. Owners are requested to make application in writing to the Veterinary Director General, Ottawa, stating the number of breeding females in the herd.

Applications will be dealt with in the order of their receipt.

F. TORRANCE,
Veterinary Director General.

Bloat.—This ailment is caused usually by a too heavy feed of damp green feed, such as red clover, corn, or rape. The best preventive is to have animals partially satisfied before turning on to such feeds as above, or to drive the animals out before they have had a chance to gorge. In moderate cases a dose of two tablespoons of turpentine in a pint of raw linseed oil will work a speedy recovery. If the case is severe, immediate tapping with a trocar and cannula at a point equidistant from the hook point, loin edge and last rib on the left side. This should be followed by the dose of turpentine and raw oil mentioned above, and light feeding for three successive days. Tying a short piece of fork or broom handle crosswise in the animal's mouth has also been found to give quick relief.

Blind Teats.—This trouble arises from different causes, but is usually the result of a growth in the milk channel, following an attack of mammitis or garget. It is sometimes caused from a deep wound such as a barb wire cut. Should the trouble commence while the cow is in full milk, little can be done except to milk with a milk tube, kept clean and sterilised, and when the cow goes dry the growth can be partially removed with a teat bistuory. This operation should be performed only by a competent veterinarian.

Bloody Milk.—An injury to one or more quarters of the udder, or an attack of garget, are the usual causes of this ailment. Frequent milking of the affected quarter, and bathing with hot water twice daily, usually effects a cure.

Cow Pox.—This is a common trouble during the spring when cows are first turned out to pasture, and is usually spread from cow to cow by the hands of the milker. The use of zinc oxide, carbolic salve, or even vaseline and sulphur, after each milking, is the best treatment. When the disease first appears, the affected cow should be milked last to avoid spreading to other animals.

Foul in the Foot.—Sometimes from the presence of dirt between the toes, the animal's foot will become swollen and sore. The foot should then be scraped and washed clean, with a disinfectant, every day, and the foot kept wrapped in a sack containing a gallon of moist bran.

Garget or Mammitis.—Garget is well known to all dairymen. The natural swelling of the udder at calving time must not be confused with this disease, which may occur at any time in the milking period. Caked udder is another common name for the trouble. The usual cause is a chill due to cold in the udder brought on by draft or by contact of the udder with the cold damp floor or ground. If taken at the beginning, a cure is usually effected by keeping the cow in a warm dry place and dosing her with Epsom salts, or raw oil. Frequent massaging of the quarter, followed by rubbing with sweet oil, castor oil, or lard, is also to be advised. Should the case become severe, fomentations with hot water three times a day will be necessary. The udder must then be rubbed perfectly dry and camphorated oil rubbed in. This is rather severe treatment, and may cause the temporary drying up of the quarter. The worst cases may require the use of a hot poultice of flaxseed, bran, or hot wet rags. The disease, or at least one form of it, is contagious, so that in all cases the milk or fluid from the affected udder should be drawn into a separate pail and destroyed, and the udder disinfected externally with a five per cent. solution of carbolic acid.

Inversion of the Womb or Casting of the Withers.—The above words describe the condition where the womb, or calf bed, appears in a large mass, inside out, on the outside of the cow's body. It usually follows a difficult calving, and denotes a breaking or tearing of the ligaments that hold the uterus in its proper place in the body. When a cow has once had this trouble, it is liable to occur again after any succeeding calving. The operation of returning the uterus is a difficult one. To overcome the straining of the cow, tie a quarter-inch rope tightly around the body just back of the shoulder, and another just forward of the hooks. The uterus should then be washed off with clean cold water, with a very small trace of disinfectant. Then the mass can be slowly and carefully forced back into place with the closed fist. An occasional dash of cold water over the parts will reduce the size by driving out part of the blood. To hold the uterus in place after being returned, the lips of the vulva may be stitched for a couple of days. Or, after placing a tight surcingle around the cow's chest, two small ropes may be brought from it over the cow's back, on each side of the tail, crossed or knotted just under the tail and brought down, one on each side of the udder next to thighs, and tied tightly to the surcingle under the chest. Then the cow's hind feet should be raised six inches higher than her fore feet, for about a week. If cows, heavy in calf, acquire the habit of standing back in a deep gutter, the gutter had better be filled up level to avoid bringing on this trouble.

Lice.—These pests are difficult to eradicate in a stable. They often have a good foothold before they are noticed, particularly on animals with long, thick hair. They show their presence by the unthrifty dry appearance of the coat and loosening of patches of hair. Two good washings of the whole animal, with a five per cent. solution of Creolin, Zenoleum, or crude carbolic acid, about ten days apart, will kill most of them. Dusting the roots of the hair thoroughly with a mixture of hellebore and dry cement is also efficacious. If the hair is very long and thick, it will often pay to clip the animal before treating.

Lump Jaw.—This is a hard growth or swelling close to the bone of the lower jaw. As it is very infectious the animal should be isolated from the other cows before the swelling bursts. The only known remedy is a dose of two drams of iodide of potash in half a pint of water given every day for seven days. If the swelling does not reduce in that time, repeat the dose. In the case of a valuable animal, treatment may be worth while. An ordinary one might better be slaughtered as soon as the disease is noticed, as the meat can then be used. It is contrary to law to sell meat from an animal in the advanced stages of the disease.

Milk Fever.—Parturient apoplexy is another name for the same disease. This trouble affects only heavy milking cows within a few days after calving. It never attacks a heifer at her first calving, and rarely is it found if the calf is allowed to run with the cow for the first week. It rarely attacks a cow whose bowels are in a laxative condition and which is being lightly fed on laxative foods, and if the cow is not milked out clean during the first three days the disease seldom occurs.

The symptoms are: loss of appetite, uneasiness, and partial paralysis of the limbs, or inability to rise or walk. Soon the cow goes down in an unconscious or semi-conscious condition. As the cow has difficulty in swallowing, she should never be drenched while in this condition, as all or part of the liquid may flow into the lungs and cause almost certain death. Of late, the disease has been found to yield readily to the air treatment. This consists in pumping the quarters full of air and confining the air by tying the teats tightly with tape. This may be done with a bicycle pump, or a rubber atomiser bulb, attached by a piece of rubber tubing to a milking tube, or by the use of a special milk fever outfit of much the same nature, in which the air has to pass through a chamber filled with medicated cotton. The teats should first be partly milked out, then washed off. The tube to be inserted should also be clean and sterilised. Air may be pumped into each teat till well distended, then the teat should be tied with a tape to prevent its escape. One injection will usually be found sufficient, but it may be repeated if necessary.

Paralysis of the Bowels.—This disease sometimes attacks cows during the first few days they are turned out to pasture. It is supposedly caused by lying on the damp cold ground. The cow refuses to eat anything, though she shows no pain at first, and gradually becomes weaker and weaker through lack of feed. In three or four days she will go down, will be unable to rise, and in a day or two will usually die in great agony. Unless taken at its inception, the disease is fatal. Strong stimulants, such as nux vomica, sulphate of iron, and bichromate of potash administered by a veterinary will sometimes work a cure at this stage.

Pneumonia.—Inflammation of the lungs, as it is commonly called, attacks cattle only in cold weather. The symptoms are lack of appetite and ambition, rapid breathing and a crackling sound in the lungs, heard when the ear is applied to the chest. The disease is usually ushered in with a severe chill, followed by high fever. A veterinarian had better be called in, and the animal placed in a dry stall, not necessarily too warm, but free from draughts. The animal is not likely to eat, but she may take a bran mash or boiled potatoes. The medicine given should consist of a pint of raw linseed oil at the beginning, followed every three hours by a quart of thin flaxseed gruel and two ounces of whiskey. A good strong mustard blister over the lung, left on two hours, will help relieve the pain. The animal should be kept blanketed and free from draughts till fully recovered.

Retention of the Afterbirth.—The cause of this disease has never yet been ascertained. It attacks calving cows in all the varying stages of bodily condition, age, and breeding, at all times of the year, and in all weather. It is found after most cases of abortion or abnormal births. If the afterbirth does not come away within twelve hours after calving it will not come away naturally. To avoid the poisoning of the system by the decay of the tissues of the afterbirth in the womb, it is necessary to remove them. This should be done by at least the third day after calving. After providing himself with a pail of warm water, in which is a disinfectant, the operator should strip to the waist, wash his hands and arms in the water, and coat them with some oil, vaseline or lard. The arm should then be inserted in the vagina, and the hand follow up the placenta into the womb until the first attachment is reached. This is a bulbous button-like projection, or cotyledon, from which the placenta can be separated by the finger and thumb. Follow up the placenta until the tissues are all removed from the cotyledons, at all times exercising a steady pull on the end of the placenta hanging from the cow. This is a hard, tedious operation, but should be done with as little roughness as possible, to avoid bleeding at the cotyledons. After removal of all parts of the afterbirth, the uterus must be flushed out with a gallon of warm antiseptic solution. For this purpose a solution of boracic acid is advised as it is not so harsh and causes less straining. A mild solution of carbolic acid, about two per cent., will also be efficient. If there is any discharge, a second flushing out inside of forty-eight hours is to be advised.

Ringworm.—This is a fungus growth more often found on calves than on mature animals. Treatment consists in painting with iodine, or a couple of applications of sugar of lead and cream, one to four parts by weight. Kerosene oil will often work a cure, but leaves the surface raw, and retards the growth of the new hair.

Tuberculosis.—This disease is much more common in our Ontario herds than is usually supposed. This is due to the fact that animals well fed and cared for do not show any outward indications of the disease, until the disease has reached the well developed stage. There is no known cure for the disease, and treatment consists only in preventing its spread to healthy animals. The presence of the disease is indicated only by the application of the tuberculin test. Every farmer would be wise to test all his cattle at least once a year. If only a few animals react, they should be disposed of to avoid infecting the balance of the herd. In its first and middle stages the disease does not usually affect the sale of the meat. If quite a number react, so that immediate disposal would cause a severe loss, all possible means should be taken to isolate the reacting ones from the healthy cows, both in the stable and in the pasture. The calves from diseased cows are always born healthy, and, if removed at birth from contact with the mothers, and fed only the milk from healthy cows, they will be as free from the disease as calves from dams that have no tuberculosis.

Warbles.—These lumps, that develop on the backs of cattle, just under the skin, are the larvæ or grubs of a bot fly that lays its eggs the previous summer. Turpentine, or a mixture of one part sulphur to two parts lard, smeared on the lumps will kill the grubs as soon as they make an opening in the skin. Large warbles can be squeezed out by hand, and destroyed.

White Scours in Calves.—This is an infectious disease attacking young calves. Though due to the presence of a germ in the digestive tract, it rarely occurs where proper cleanly methods of feeding are practised. The symptoms of the disease are loss of appetite and energy, slight bloating, and an offensive white color to the manure. An immediate purgative of two ounces of castor oil is necessary, and the feed should consist of warm whole milk till the trouble abates. Many dairymen report good success from feeding in the milk a couple of tablespoonfuls of a mixture of one half ounce formalin in twelve ounces of water. Cleanliness and regularity in feeding, however, will always avoid trouble of this kind.

The Medicine Chest.

The foregoing discussion on the treatment of diseases demonstrates that most of the common ailments can be successfully treated if the farmer has on hand a few of the simple remedies that are recommended for use in this connection. Every stable should be supplied with the following drugs, kept in a locked cupboard, each separate kind being distinctly labeled to avoid mistakes.

10 lbs. Epsom salts 1 lb. Ginger 1 gal. raw linseed oil 1 quart castor oil	Purgatives and laxatives.
½ pint olive oil. 1 lb. lard 1 pint camphorated oil 1 lb. vaseline	Applications to udders and teats.
1 pint of turpentine	Bloating.
1 lb. carbolic acid 1 lb. boracic acid 1 gal. Zenoleum, Creolin or Chloral Naptholeum	Disinfectants.
½ lb. Sulphate of Iron ½ lb. Gentian 1 pint whiskey or brandy	Tonics and stimulants.
½ doz. sticks Caustic Potash	For dehorning calves.

In addition to the above, the following appliances for treatment of diseases and the administration of medicines can profitably be included:

Drenching bottle with long neck.	Injection pump, or
Trocar and Cannula, for bloating.	6 ft. half-in. rubber hose with glass funnel.
Graduated measuring glass.	Hard rubber syringe.
Milk fever apparatus.	3 milking tubes.
Clinical thermometer.	Set of hand clippers.

DAIRY BARNS AND EQUIPMENT.

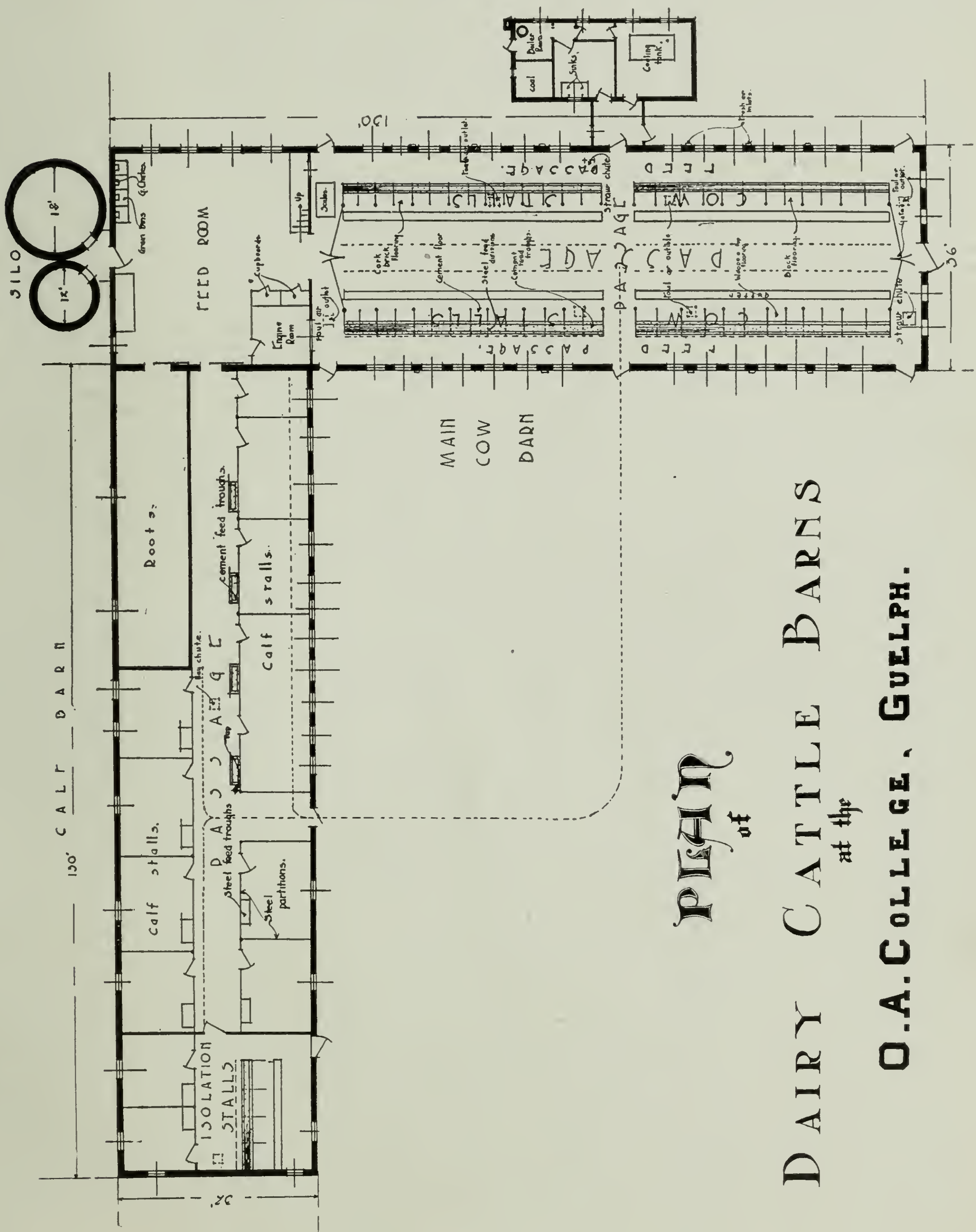
The dairy farmer does not build new buildings or remodel old ones, on the average, more than once in a lifetime. When the necessity arises, therefore, for a change in the quarters of the live stock, considerable thought and planning must be given to the proposition, because once completed buildings cannot easily be altered, and mistakes and inconveniences must be put up with for many years. Careful consideration must be given to the following features of a new or remodeled building:—

1. Capital invested in keeping with value of farm.
2. Location of building.
3. Floor space needed for animals.
4. Storage room for feed.
5. Shape of building.
6. Best materials to build with.
7. Convenience of lay-out.
8. Ventilation.
9. Light.

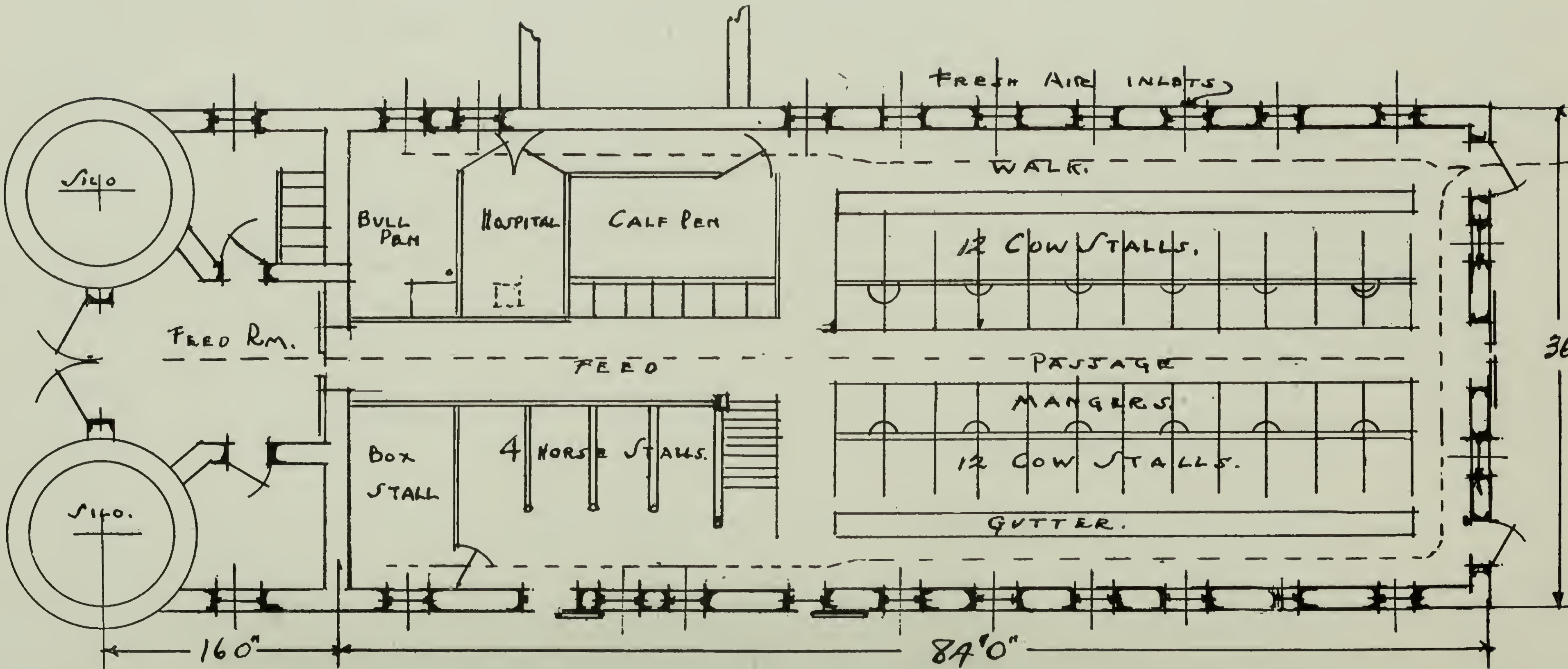
Capital Invested.—It is perfectly true that a farmer rarely gets much for his buildings if he sells his farm, but buildings are a necessity on all farms, and, though the capital invested therein does not yield any direct return, properly planned buildings may be the means of adding to profits by saving labor on live stock and storing crops, and by increasing the health and efficiency of the live stock. From a business standpoint, buildings should supply the necessary permanence, space, convenience, and ventilation, with the least possible investment of money in architectural effect, or fancy equipment that adds nothing to the utility or life of the building.

Location.—The first requisite in the proper location in a barn is natural drainage. No system of artificial under-ground drainage will keep dry a building erected in a low place, or remove excess surface water from such a barn yard where men, cattle, and horses are daily trampling. A side hill sloping to the south or west is the ideal place. The location should also be studied out in relation to other buildings already built, or likely to be built in the future. The dairy barn should be just a reasonable distance from the house, but ought to be as near as possible to piggery, straw sheds, and other buildings, with which the daily work of the farm necessitates constant communication. Should it be possible to build in the lee of a wind break, the location would be much improved.

Space Necessary For Animals.—In estimating the dimensions of a stable, fifty feet of floor space per animal stabled will be found about the amount necessary. This figure will provide all the necessary space for all passages, alley ways, and box stalls, in addition to the space actually occupied by the cattle. A slightly smaller amount may be found convenient if a large proportion of young stock is being raised. It would not be wise to build on a much larger plan. This would provide a lot of waste room and would be too cold in most parts of the Province. To provide the necessary balance between heat and ventilation, an allowance of



from four hundred and fifty to five hundred and fifty cubic feet of air space should be allowed to each animal stabled. With the amount of floor space per animal above mentioned, this cubic requirement would necessitate a ceiling from eight and one half to nine feet high. This height makes possible the best distribution of light in the stable.



A Good Barn for a 80 to 100 Acre Farm.

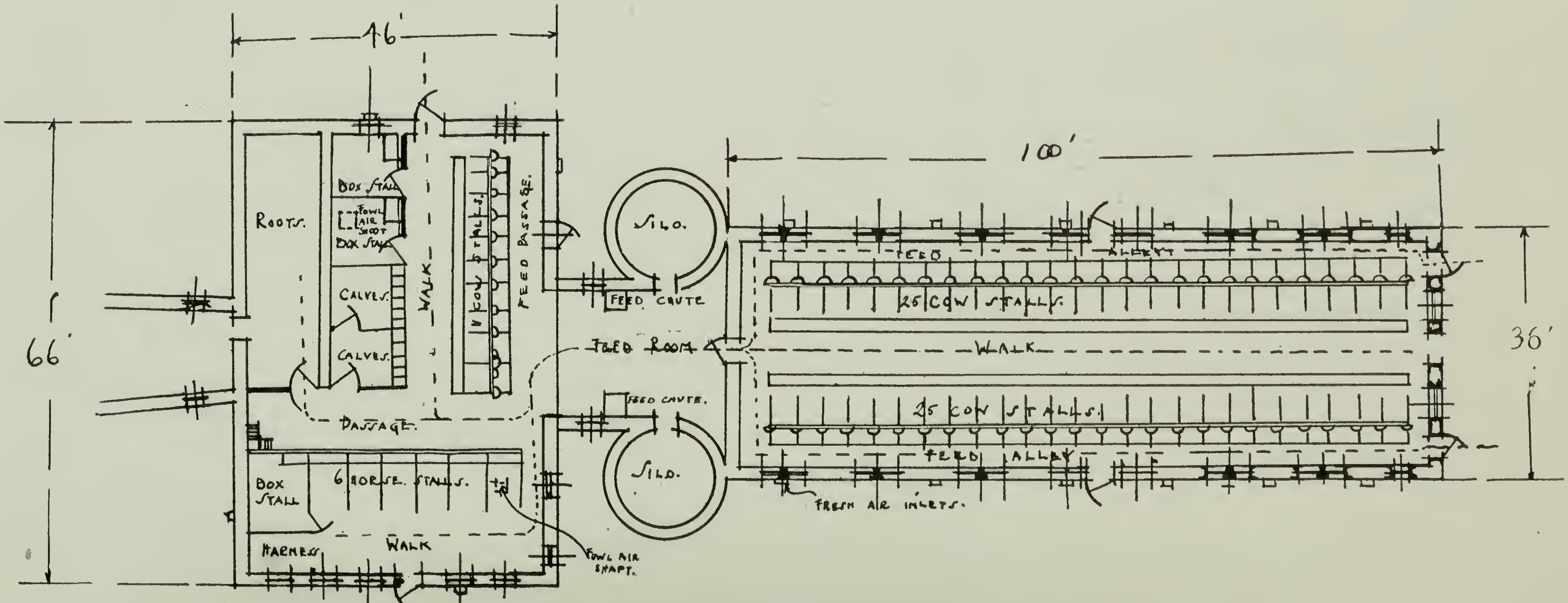
Storage For Feed.—To store the necessary hay and grain for a herd of cattle, it is well to estimate on at least 800 to 900 cubic feet of space for each animal. This will also provide for one barn floor and practically all the straw that would be used for bedding. If grain is to be stored and threshed in the same barn, somewhat more space will be necessary. For silage space, provision for 150 to 175 cubic feet per animal will be found sufficient.

Shape of Building.—When the size of the barn has been decided on, the next consideration is the shape of the building. It is now well established that the best arrangement to economize on cost of building, space, and labor of feeding, is cattle below and feed above. Though the separate one-story barn for cattle is often advised, a little thought will show that this arrangement involves too much labor carrying feed, and too great expense in building, to be economical under our Ontario conditions, even though there be some advantages in regard to ventilation and sanitation. In remodelling old buildings, however, where a large barn is already built that will provide storage space in plenty, it may often pay to build a one-story addition to house part of the stock. The best arrangement, all things considered—convenience, light and ventilation, is to have two rows of cattle running the length of the building. For such, a total width of about 36 feet is sufficient to provide plenty of room. Narrower barns are more expensive to build, considering capacity, while wider barns provide more stable space than can be economically used by two rows.

Where the horses, cattle, and calves are to be housed in one compact building, an "L" shaped or "T" shaped barn often lends itself to convenience of layout, with the minimum expense, particularly if there is an already erected barn that can be worked into the barn. Where it is necessary to have a threshing floor the "T" shaped barn would be preferable, with the barn floor across the middle of the top of the "T," under which wing would be housed the horses, calves, feed-room, etc. The cow stable could then be built in the upright part of the "T", over which would be stored the most of the hay. The silo could be placed in one of the angles of the two wings, convenient to feed-room. The "L" shaped barn also lends itself to some such arrangement, if the wings are so placed that the barn floor has connection with both of them.

In cases where it is considered advisable to have a great amount of storage room, it might be wise not to make the building too long and high. In this instance, if the barn were built 42 feet wide or over, the stable arrangement could provide for two rows of cattle, and a row of box stalls and calf pens, the latter being along one side. With such an arrangement, the ceiling would need to be high, with high windows to give plenty of light to the middle of the stable. In an extra wide stable, the rows of stalls can be placed crosswise. This is not usually an arrangement that economizes space, as, in addition to the feed passages and cattle walks, there must also be a long passage the length of the stable to make connection with all parts of the stable. This is pretty near all waste room. It would, of course, be impossible in a work of this kind to enumerate all the different styles of buildings that could be satisfactorily adopted. Some of the general ideas have been outlined, and there will be found in the adjoining pages some plans of buildings that may suggest to those interested some ideas that can be incorporated in their building plans.

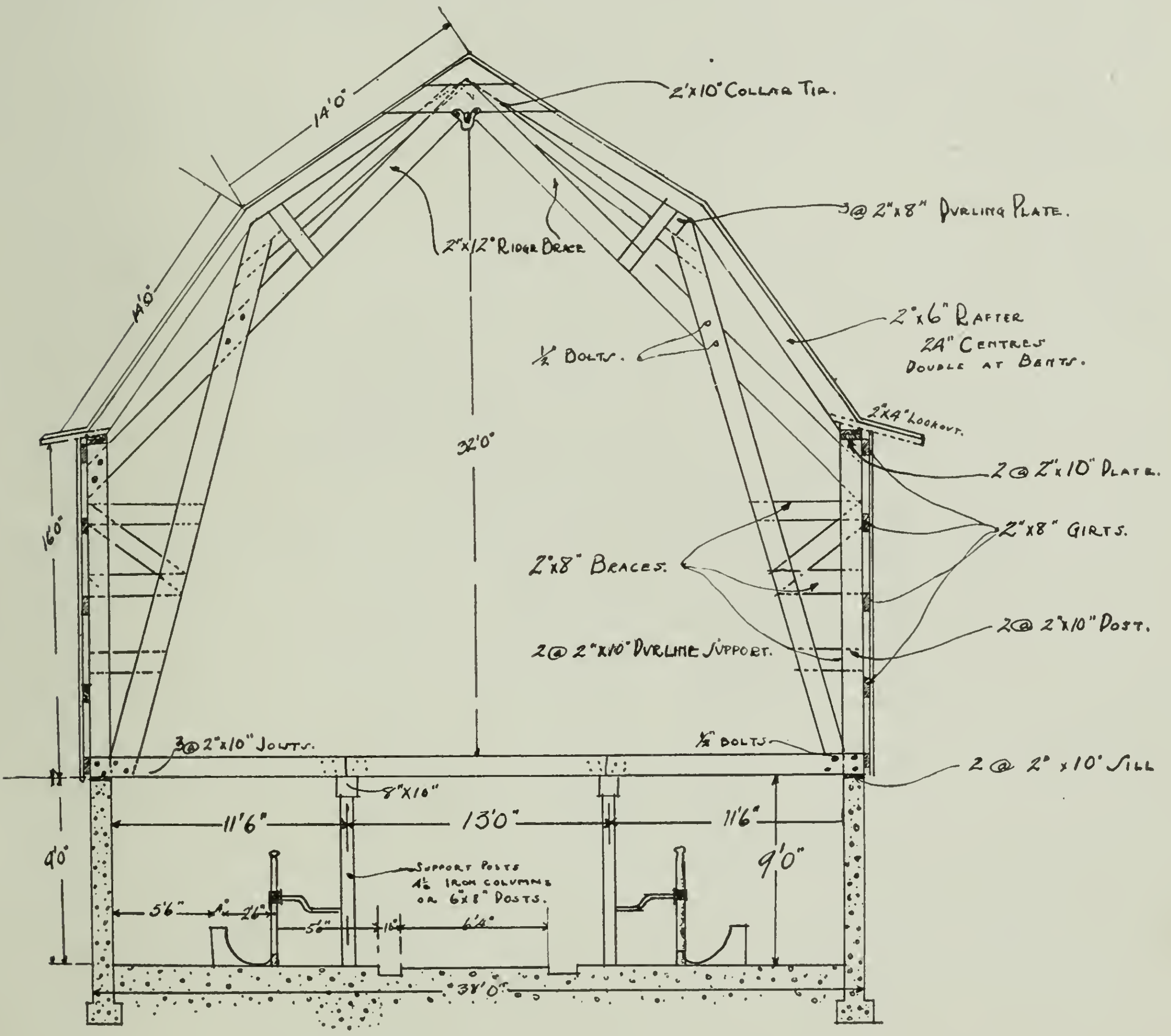
Building Materials.—For foundations, stable floors, and, in most cases, for stable walls, nothing has yet been invented that is as satisfactory as cement. All stable floors should be of concrete, if the materials necessary—gravel, sand, and crushed stone, can be at all obtained. Cement floors are permanent, non-absorbent,



Barn for Large Dairy Farm.

and waterproof, therefore clean and sanitary. When covered with plank where the cattle stand, they are warm, dry, and cause no ill health. They require little or no repairing, and will last as long as the superstructure of the barn, and, moreover, at present prices for lumber, they are nearly as cheap at first cost as good wooden floors.

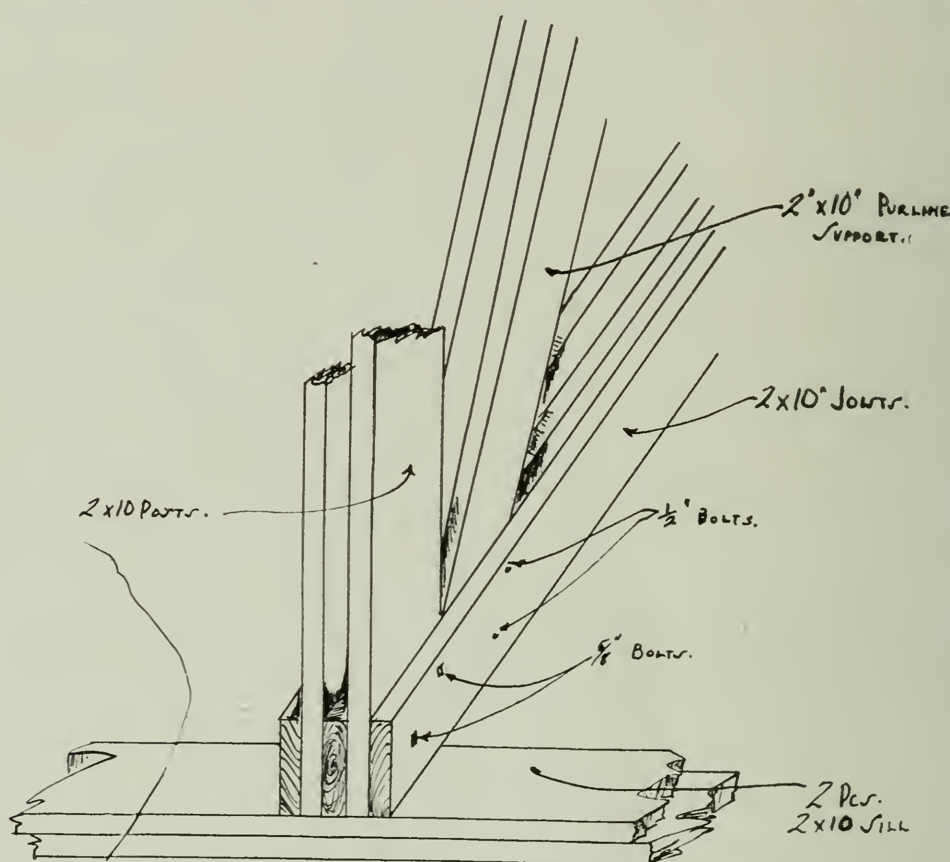
For stable walls, cement is also satisfactory, being strong, permanent, windproof, and water-proof. Solid walls are rather good conductors of heat, and, therefore, a trifle inclined to be damp in cold weather. For this reason the hollow concrete block, the hollow cement wall, or the brick-lined wall are to be preferred if the extra expense can be easily borne. However, if a good ventilating system



Cross Section of Good Plank Frame Barn.
Bents are 12 to 14 feet apart. End bents have no ridge brace, but have 2 in. x 8 in. girts spiked crossways every 4 feet.

is installed the solid concrete wall, if well built and smooth, will give good satisfaction. Where wood building material is available, or can be bought cheaply, this kind of wall is also satisfactory, if the points are tight and windproof, and the frame of the barn is sufficiently strong to carry the maximum weight of barn and contents in all kinds of wind storms without twisting. Wooden walls are usually dry, particularly if there is an air space in the wall and plenty building paper is used. If the animals are pretty well crowded in a stable, ordinary walls, double-boarded, only on the outside of the studding, will keep in plenty of warmth except in our severest localities. The use of galvanized iron and steel for stable and barn walls is getting some attention now. For stable walls, steel or iron outer walls, with an inside lining of wood, would no doubt be satisfactory, if cost was reasonable. For walls of mows and lofts, steel alone would be satisfactory. Steel shingles, on account of their long life, and fire-resisting powers, are being much used. Galvanized iron or steel roofs are not satisfactory for one-story stables, or where the stable air can escape into the upper barn, on account of the congealing of moisture in cold weather and dripping down when milder weather comes. All-steel barns are now being put on the market, and when prices of this material become normal these barns will find many users, as the prices of wooden building material keep advancing. The square timber frame of barns is giving place rapidly to plank frame construction, some details of which will be found on adjoining pages. Brick and stone are now out of the question, in economical barn construction, on account of the high cost of material and labor of erecting.

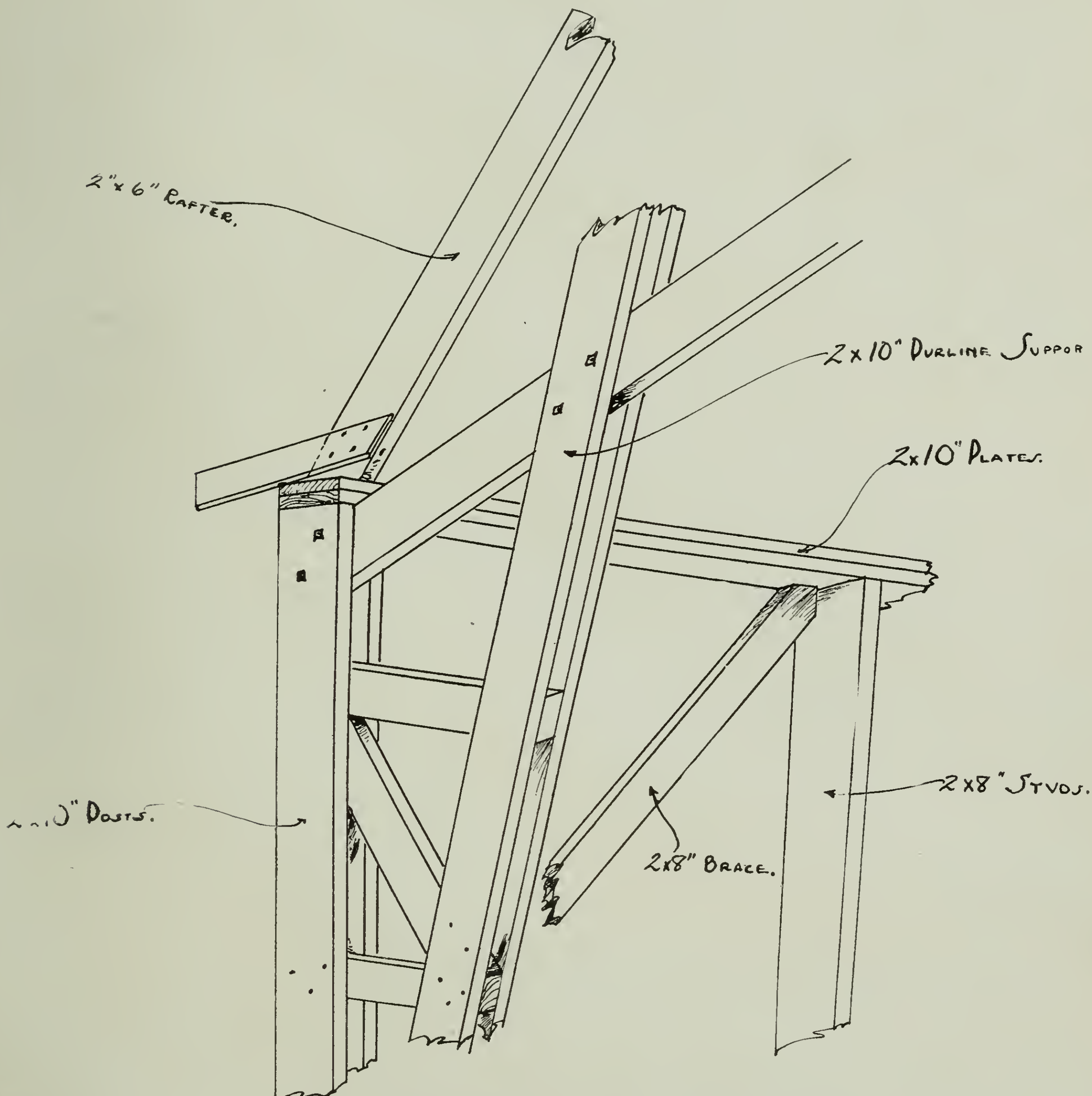
Layout of Stables.—Where two rows of cows are to be placed the length of the stable, it becomes necessary to decide whether the cows shall face the windows



Detail of Sill in Plank Frame Construction.

or face the middle of the stable. Each method has advantages that the other does not possess, but experience and observation lead to the belief that the first method is to be preferred. True, having all cows face a common feeding passage permits of greater ease in feeding, but when we consider that the actual work of feeding in a herd does not occupy nearly as much time as the milking, cleaning stables and cows, bedding, and turning cows in and out, all of which are obviously much easier done from a common passage behind the cows, we are forced to admit that the balance of convenience is on the side of facing cattle outward. Moreover, where cows face inward, it becomes impossible to keep the walls from being splashed with manure as the cows pass along the walk, while trouble in tying up cows is often caused by cows getting in the wrong passage. The hay chutes from above are better placed along the wall than in the middle, where they would be in the way of the horse-fork above. It is often possible to arrange a stable with the manure passage in the middle, so that a sleigh or wagon can be driven right through, taking up the manure from both gutters. This will be found an excellent arrangement to save handling of manure, as it may be drawn direct to the field.

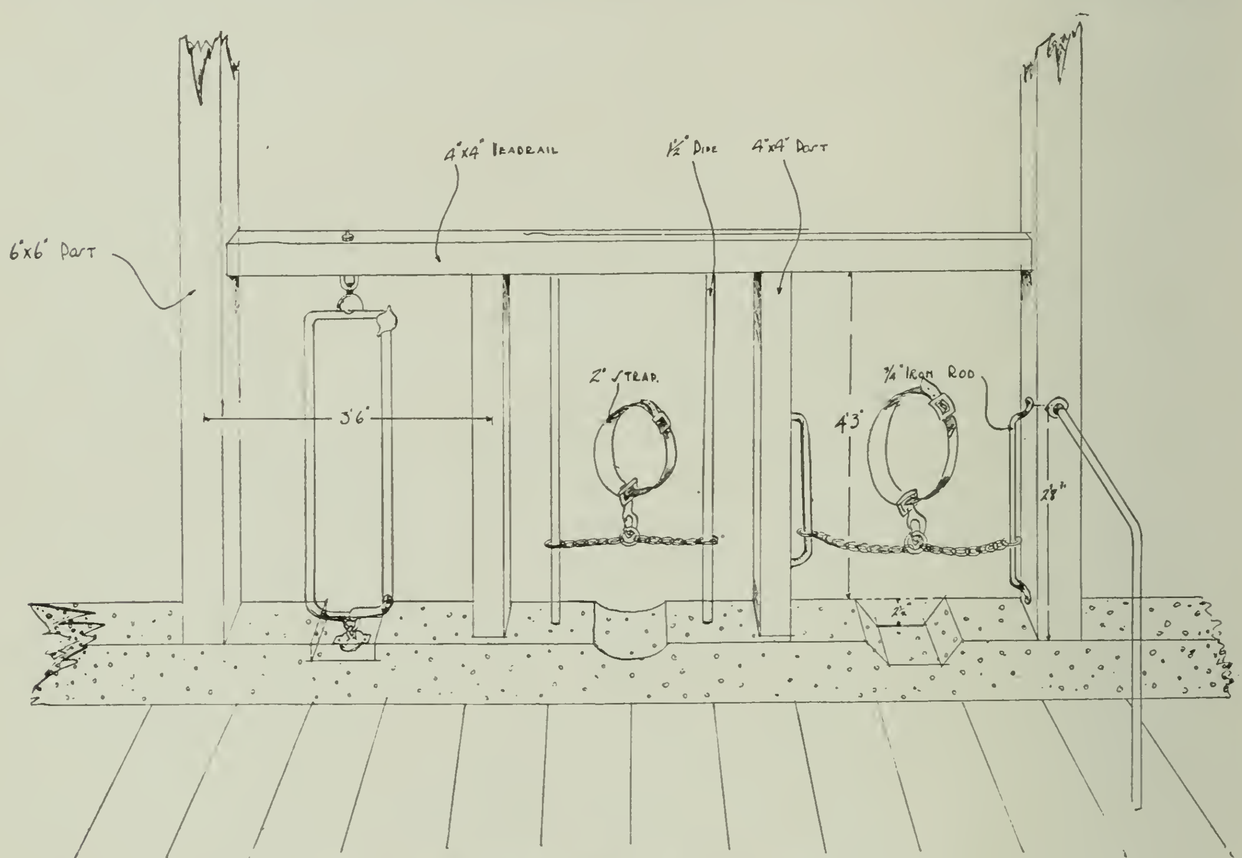
Where there is just one oblong barn, the silos should be placed at one end, preferably the north, so that they will not shut off any light from the side. The feed-room can then be placed at that end. If the barn floor is above the feed-room,



DETAIL AT PLATE IN PLANK FRAME CONSTRUCTION.

the driveway can be made into a good roothouse, and the grain, feed and chop will be in a handy place for handing down into the feed-room, through a chute from the granary above. Where the barn is "L" shaped, the feed-room and silo could occupy the same place, and the wing of the barn would run off from that end, making a good connection with the feed-room, silos and root-house. The feed-room need not be large, space to hold feed carts or barrows, a root pulper, a large meal bin, and a cupboard for tools and medicine, and, if necessary, a pile of mixed feed, such as silage and straw.

The equipment for tying, watering, and feeding cattle, should be the simplest possible, consistent with strength and safety. The swinging stanchion is, for all practical purposes, the handiest, cleanest, cheapest, and safest tie, giving also all the freedom necessary. The framework for holding the stanchion may be of wood or iron construction, either one being good, but the wood being much cheaper, 4 x 4 or 4 x 5 timber being strong enough for head rail and short posts between stanchions. With the swinging stanchion, stall partitions between cows are not necessary. In fact it is doubtful if the short partition usually extending two-thirds of the way to the gutter is of much actual use to the cow, either standing up or lying down, unless the tying is done with chains, in which case a stall partition is necessary as the cows have considerable freedom with their heads. However, if a partition is desired, a piece of inch and a half pipe, bent in a curved right angle, with



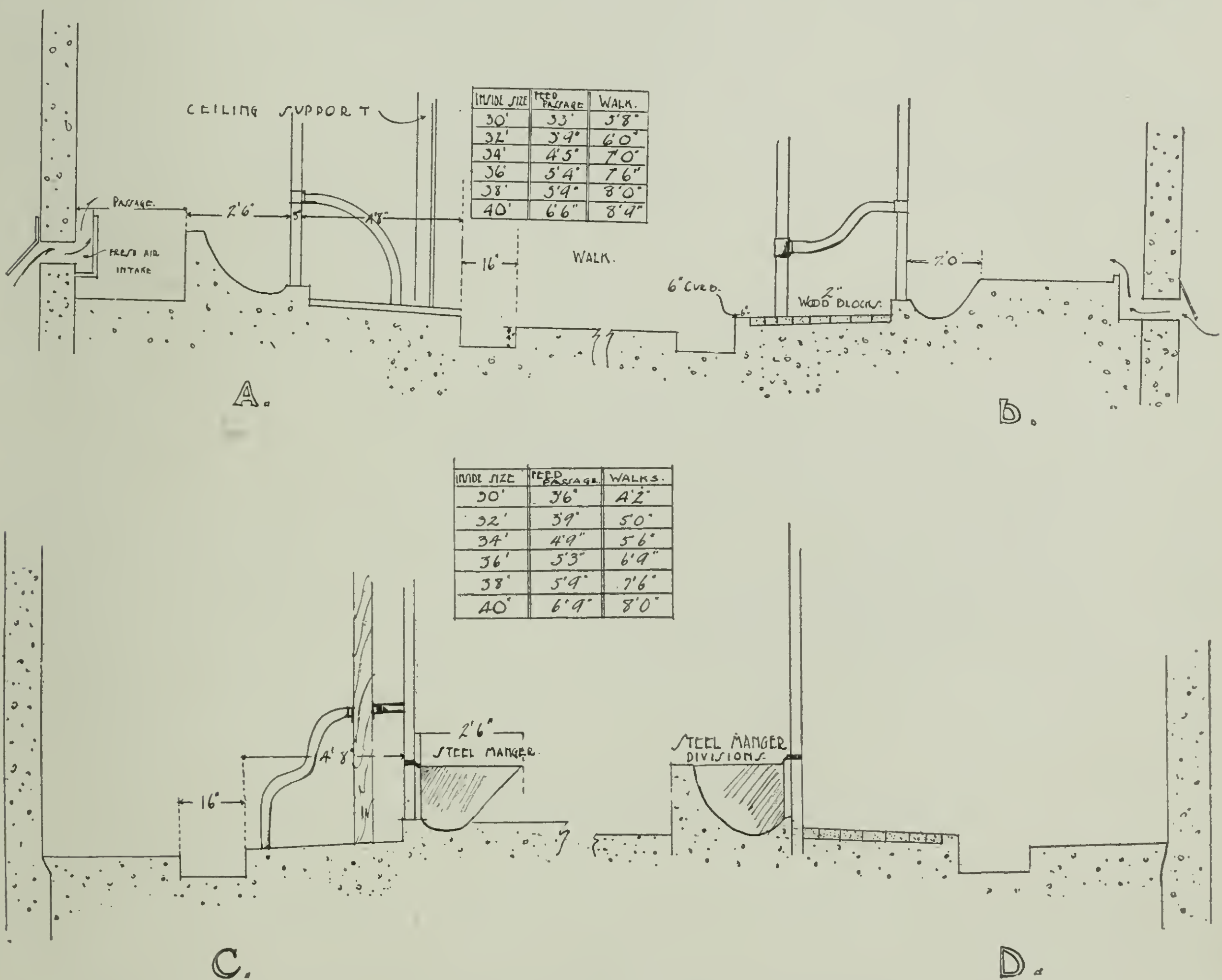
Cheap Stanchion and Cow-tie Construction.

(*a*) With stanchion no stall partitions are necessary.
(*b*) With chain-tie partitions at least between each two cows are needed.

the lower end in the cement floor about sixteen inches ahead of the gutter, and the upper end attached to the posts between the stanchions three feet above the floor, is all that is necessary. Posts that support the barn above, should be placed in the stable in the line of the cattle stands, as they are a nuisance if they come in manure gutters or passage ways. The length of the cattle stand from manger to gutter will vary according to the size of the cattle. Five feet six inches will be long enough for the largest cow, while four feet six inches would be the minimum for small cows, like Jerseys, for instance. It may be found advisable to make this stand the maximum length at one end of the stable, and narrow it down to the minimum at the other end. This permits of grading the animals according to size, from one end to the other. Yearling heifers may be stood on a stand but a little over four feet long. Three feet and a half is about the correct width of stall to allow for each cow, unless the animals are extra large. For the sake of adding apparent size to the cattle, the stand should be three or four inches higher than the walk behind. The stand should have a slope of one inch from manger to gutter.

The gutter may be of varying sizes and shapes, but a square-cornered gutter, about seven inches deep next to the cattle stand, and three or four inches deep next to the passage, and sixteen inches wide, will be found large enough and will cause no trouble to the cow in stepping over. The bottom should be flat, as an inclined bottom may cause a bad slip and damage to a valuable cow. On the adjoining page will be found different types of mangers and gutters.

The passage behind the cows should be at least 5½ feet wide, much better



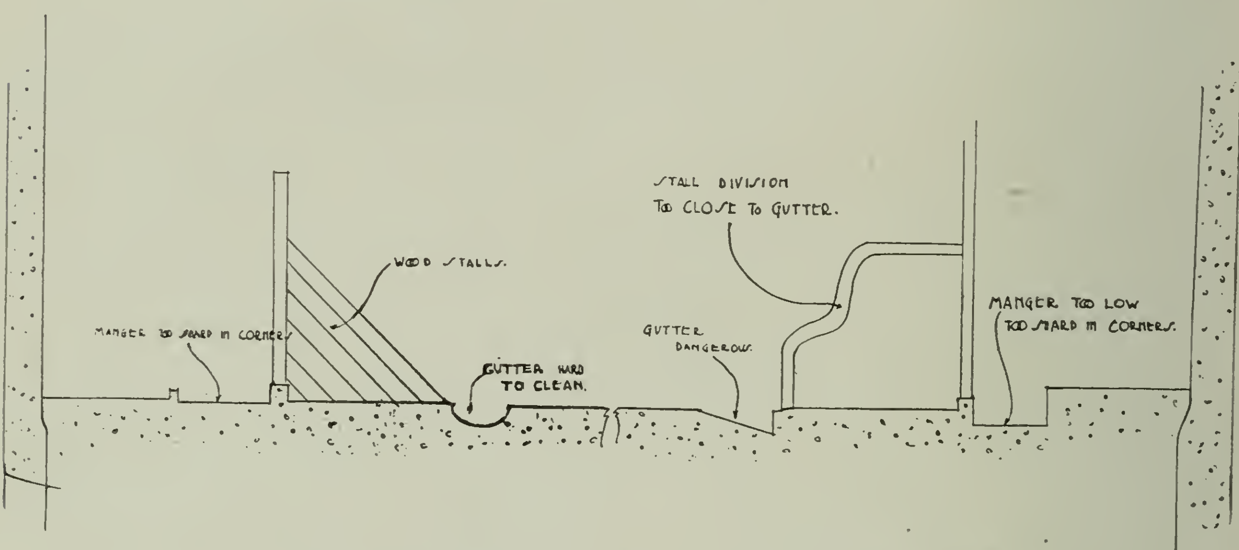
Good Types of Stable Floors, Mangers, Gutters and Fresh Air Inlets.

A. Measurements in centre are based on 4 ft. 8 in. length of cattle stands. Where necessary to build longer stands the extra length can be taken off width of walk and feed passages, preferably the latter.
B. For barns 32 ft. in width or less, manger and feed passage B is best, as there are no higher mangers to waste space.
C. Steel manger in C has no bottom.
D. A and D are the best styles of mangers to be used without divisions.

six to seven feet between gutters. If cows face inward, the walk should be at least four feet from wall to gutter. This passage may be only slightly crowned to drain off any water to gutters. It should never be finished with a smooth surface, as it is too slippery. While new, a sprinkling of sand should be kept on it when cows are being turned in or out.

Cement mangers are of so many different styles that a description of each kind is impossible, here. In general, they need to be at least two feet wide at the top, and to have a sloping side next the feed passage, and the bottom corners rounded to facilitate easy cleaning. A good manger can be made by raising the feed passage a foot higher than the bottom of the manger, sloping off the passage two feet from the stanchion line. Manger partitions between cows are not an absolute necessity in ordinary herds. They are needed in stables where official testing is done, to keep cows from stealing the rations of their neighbours that are being better fed. Where partitions are considered necessary in mangers, the kinds of steel partitions that can be raised out of the way are to be preferred, thus providing a continuous manger that can be easily cleaned and used as a watering trough. The use of wood for mangers can hardly be advised now. The manger bottom may be a couple of inches higher than the cattle stand.

The curb between the cattle stand and the manger should also be of cement. Six inches above the manger bottom is a sufficient height, and four to five inches thick will give sufficient strength. The middle ten inches of curb in each stall must be dropped three inches, so that the bottom end of the stanchion will let the cow's neck down low enough to be comfortable when she is lying down.

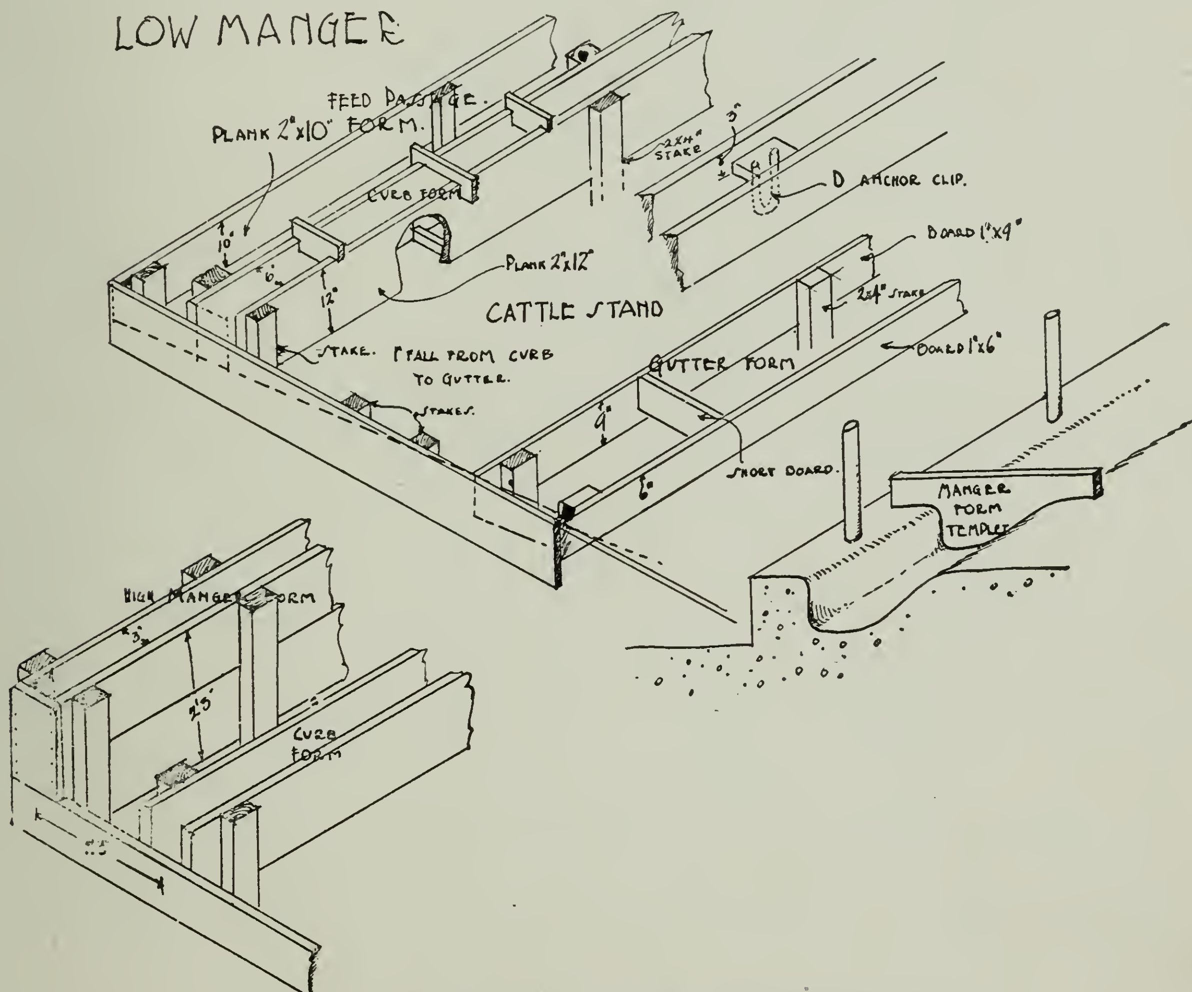


Undesirable Manger, Gutter and Stall Construction.

The feed passages may be of varying widths, but from three to five feet will be found to work out alright. As the best method of carrying silage, roots, and meal is in barrows or carts, passages should be smooth and have no abrupt steps. Where it is necessary to raise or lower the levels, this should be done by gradual slopes in the floors.

Calf pens and box stalls should be placed in a building or wing separate from the cows, if possible. Where this is not practicable, they are better placed at one end of the rows of cows. They may be of varying sizes. A couple of box stalls should be at least 9 ft. x 9 ft., to use as calving pens, or for sick cows. A couple of small ones, say 6 ft. x 6 ft., or 6 ft. x 5 ft., can often be worked in to advantage, and do very well for very small calves. If the posts in the calf barn are wood, good cheap partitions can be made with strong hog fence, No. 9 wire, stretched tightly, with a wooden rail on top. If the front of the pen is made with wooden or steel calf-stanchions, with a cement manger outside in the passage, the best arrangement for feeding and economizing room is obtained. An extra large pen can occasionally be divided off with hurdles or movable partitions to make two or three smaller ones.

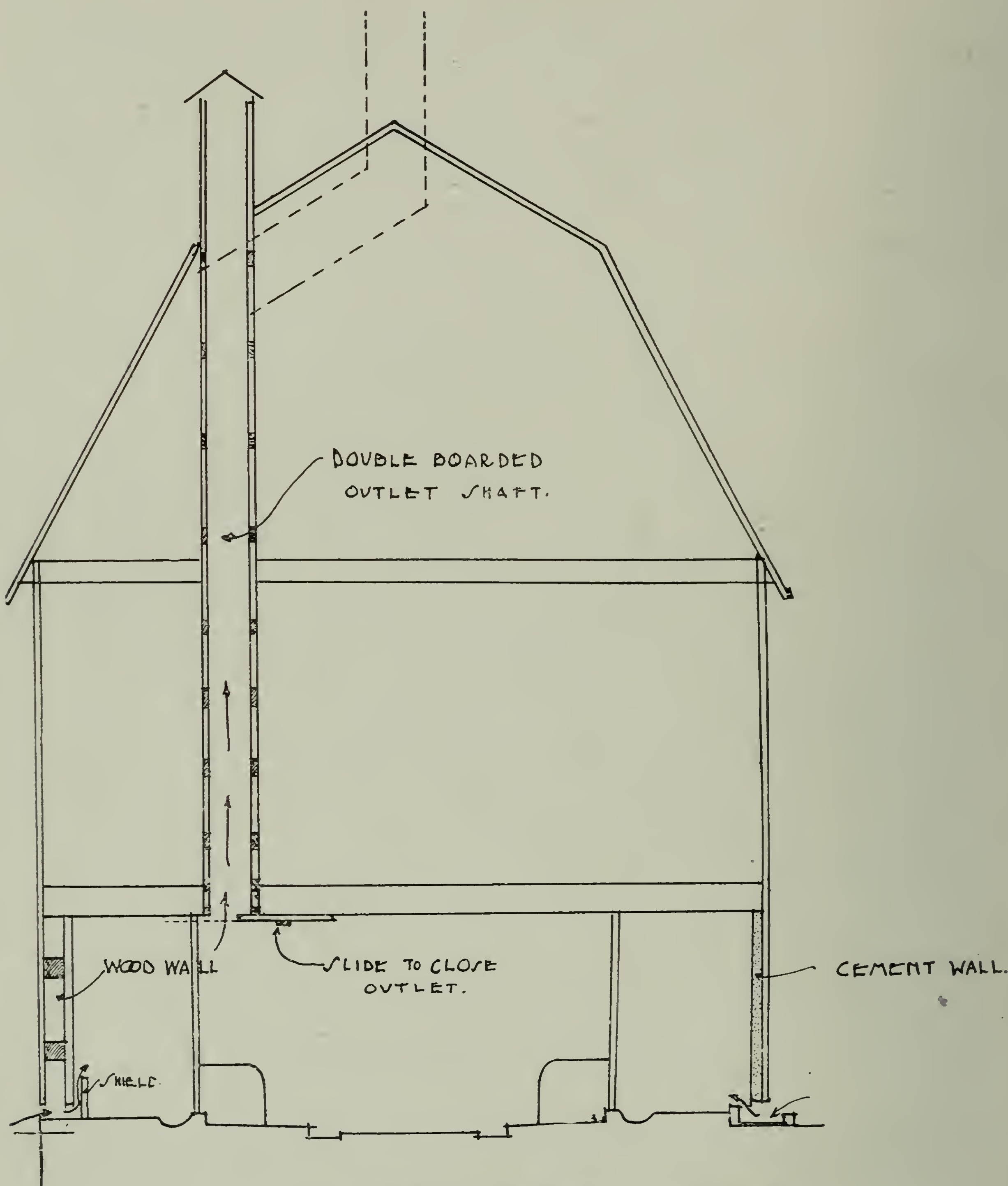
Ventilation.—The question of ventilation is the one usually least considered when building and remodelling stables. This should not be so, when it is considered that the maintenance of good health in the herd depends more on ventilation than on any other single factor. There can be no doubt that the great prevalence of tuberculosis in Ontario cattle is due to housing animals in the close damp air of low, unventilated stables. Moreover, a good ventilation system costs little to install when buildings are being erected or remodelled. The chief requisite of a system of ventilation is a uniform supply of fresh air without draughts, and the steady drawing off of foul damp air, without lowering the heat of the stable too rapidly. Various systems have been invented and put into use in Ontario stables. Of these, that known as the Rutherford system, is possibly the only one that gives



Form Construction for Laying Concrete Floors.

general satisfaction in our climate. This system operates on the same principle as a stove. Fresh air being admitted at the floor, heated and fouled by the animal, and raised to the ceiling where it passes out as foul air by ventilating shafts through the roof, carrying with it the moisture that accumulates on the ceilings, in our cold climate.

An accurate estimate has been made of the necessary size of inlets and outlets in this system. The minimum requirements are eight square inches of inlet space, and fifteen square inches of outlet space, for each animal in the stable. However, as no system of ventilation will work automatically in all sorts of weather, without causing draughts or undue lowering of stable temperature, it is advisable to provide about 25 per cent. to 30 per cent. more inlet and outlet space than the above-mentioned requirements. This, of course, necessitates the use of dampers in the system, particularly the outlet system, to control the flow of air. In mild weather the system can be thrown wide open giving more than actual requirements



Rutherford System of Ventilation.

Inlets 7 in. x 12 in., outlets 15 in. x 15 in. With square pitch roofs outlet may follow inside of roof to ridge of barn (see dotted line).
Where there is no horse fork in barn, outlet may run up middle of barn through the ridge.

of flow of air, and in severe weather the outlets can be closed down below the minimum size if it is found necessary to conserve heat and avoid freezing in the stable.

The inlets should each be not less than 12 inches by 6 inches, in size of opening. For twenty head, therefore, there should be 20 x 10—200 square inches of inlet, which would necessitate three inlets of the above size. These inlets should be placed about six inches above the floor line, being holes right through the wall with a wooden or tin shield on the inside to deflect the incoming fresh air upward, so it would not blow directly on the cows. Or, the inlets may come in through the foundation just below the wall, and open directly upward in the passage, covered by a grate or surrounded by a 4 inch curb to keep out dirt. The outside opening should also be protected by a sloping cover, to keep out rain and snow.

The outlets for foul air should each be at least 15 in. x 15 in. Smaller outlets cause too much friction to provide a smooth flow of air. For twenty head of cattle, as above, the best outlet space would be 20 x 20—400 square inches.

This would require two outlets, 15 inches square, or two circular ones each 16 inches in diameter. These flues should be smooth inside and tightly built for proper circulation, and should extend out through the highest part of the roof and be topped by a cupola to keep out rain and snow. If it is desired to bring them out part way down the side of the roof, the top of the cupola must extend higher than the ridge of the barn, in order that eddies of wind, formed by the roof, shall not interfere with the draft in the outlets. At the bottom of the outlet shaft there should be a damper or trap-door that can be operated by a rope, or else a sliding trap-door that can partly or entirely close up the outlet if necessary in severe weather. The outlets should leave the stable above the backs of the cows, as near the heads as possible. The space necessary above for horse-fork room, in most barns, prevent the outlets being built in the middle of the barn.

This Rutherford system has the great advantage of being cheap of construction. More expensive systems have been advocated, such as the King system, which has proven a failure in this cold climate, principally because it draws out the foul air from near the floor and makes no provision for drawing off at ceiling the moist air that causes dampness in our cold weather. In this connection it is well to mention that even the Rutherford system will not entirely carry off the excess moisture from ceilings that are not ceiled below the joists. The joists cause pockets that interfere with the free circulation of air. It is well to remember that no system of ventilation will work automatically. They all need control, and success will depend on the attention they get, particularly in cold weather.

Light.—Light is one of the best disinfectants and germicides known to science, and, as it is absolutely free, stables should have as much as possible. Windows should be large, high, and as frequent in the walls as strength of building will allow. Six square feet of glass for each animal stabled is not too much, and if the stable is low, seven feet would give better results. The best construction of window is one that swings open from the top. This deflects the wind upward toward the ceiling, preventing serious draught on the cows. In districts where cold is very severe, double windows will be found very useful in keeping the stable warm, and preventing the heavy accumulation of frost on the inner windows. This accumulation shuts off light and makes interior of the window frames very sloppy at thawing time.

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Ontario Department of Agriculture

WOMEN'S INSTITUTES

BULLETIN 254

WAR BREADS

How the Housekeeper May Help to Save the Country's Wheat Supply

By ETHEL M. CHAPMAN

TORONTO, ONTARIO, AUGUST, 1917.

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Ontario Department of Agriculture

WOMEN'S INSTITUTES

WAR BREADS

HOW THE HOUSEKEEPER MAY HELP TO SAVE THE COUNTRY'S WHEAT SUPPLY.

One of the lessons that Canadians have to learn from Europe is that white bread is not the bread for war-time; that when the supply of wheat is low, bread must be made of other grains than wheat; also that in the milling of the wheat the manufacturer must put a greater proportion of the grain into flour and less into cattle-feed. By including a higher percentage of the whole grain in the part manufactured into flour, in the process of milling, as the Government of Great Britain has required, and may soon be the regulation in Canada, we would save from one-eighth to one-ninth of a barrel of wheat flour per capita in the year. A further saving may be effected by the addition of some rye or corn flour to this wheat flour. Every pound of flour saved means more bread for the army.

But until the system comes into general use, or until the supply of white flour already manufactured is used up, every woman in her own home can do some patriotic saving by supplementing her supply of white bread with breads, biscuits, etc., made from the flour or meal of other grains, or from the whole wheat or graham flour or bran. The constant use of these coarser breads might not agree with some people, but as a rule they will be found more healthful than the finer white bread. The recipes given in this bulletin, together with general instructions for bread-making in the home, suggest a variety of ways of saving the nation's wheat supply.

RAISED BREADS.

Raised Brown Bread.

2 cups corn meal.
¼ yeast cake.
2 cups rye flour.
½ cup molasses.
1 teaspoon salt.
⅛ teaspoon soda.
¼ cup lukewarm water.
2 cups boiling water.

Pour the boiling water on the corn meal. When lukewarm, add dissolved yeast cake and remaining ingredients. Beat well, let it rise over-night, beat again and pour into greased bread pans. Bake in a moderate oven from one and one-half to two hours.

Rolled Oats Bread.

2 cups boiling water.
½ cup molasses.
½ tablespoon salt.
1 tablespoon butter.
½ yeast cake dissolved in
½ cup lukewarm water.
1 cup rolled oats or oatmeal.
4½ cups flour.

Add boiling water to oats and let stand one hour. Add molasses, salt, butter, dissolved yeast cake and flour. Let rise, beat thoroughly, turn into buttered bread pans, let rise again and bake.

Rye Bread, No. I.

2 cups scalded milk.
2 tablespoons butter.
1 tablespoon sugar.
3 cups flour.
2 teaspoons salt.
½ yeast cake dissolved in
¾ cup lukewarm water.
3 cups rye flour.

Put butter, sugar and salt in mixing bowl; add scalding milk, and when lukewarm, add dissolved yeast cake and white flour. Let rise to a spongy consistency, add rye flour and knead. Let rise again, and shape into loaves or rolls. Place in greased pans, let rise until double in bulk, and bake.

Rye Bread No. II.

1 cup scalded milk.
1 cup boiling water.
1 teaspoon lard.
1 tablespoon butter.
⅓ cup brown sugar.
1½ teaspoons salt.
¼ yeast cake dissolved in
¼ cup lukewarm water.
3 cups white flour.
Rye meal to make stiff dough.

To milk and water add lard, butter, sugar and salt. When lukewarm add dissolved yeast cake and flour, beat thoroughly, cover, and let rise until light. Add rye meal until dough is stiff enough to knead. Knead thoroughly, let rise to double its bulk, shape in loaves, place in greased pans, let rise until double in bulk, and bake.

Entire Wheat Bread.

2 cups scalded milk.
⅓ cup sugar or ½ cup molasses.
1½ teaspoons salt.
5 cups sifted entire wheat flour.
¼ yeast cake dissolved in ¼ cup lukewarm water.

Mix milk, sugar, or molasses, and salt. When lukewarm add yeast cake dissolved in warm water, and flour. Beat well, let rise until nearly double its bulk. Beat, turn into greased bread pans, let rise until nearly double its bulk, and bake for about one hour in a moderately hot oven.

Graham Bread with White Flour, No. I.

2 cups scalded milk.
⅓ cup molasses.
2 teaspoons salt.
¼ yeast cake.
¼ cup lukewarm water.
2 cups white flour.
4 cups graham flour.

Mix milk, molasses and salt. When lukewarm add dissolved yeast cake and both white and graham flour, sifted. Beat well. Let rise until almost double its bulk, beat again, place in greased bread pans or shape as biscuits. Let rise until nearly double in bulk and bake in an oven which is a little cooler than for white bread. Allow about one and a quarter hours for loaves and thirty minutes for biscuits.

Graham Bread with White Flour, No. II.

2½ cups hot water or milk.
⅓ cup molasses.
1½ teaspoons salt.
¼ yeast cake dissolved in
¼ cup lukewarm water.
3 cups white flour.
3 cups graham flour.

Add sweetening and salt to hot liquid; cool, and when lukewarm add dissolved yeast cake and flour. Beat well, cover and let rise to double its bulk. Beat again and turn into greased bread pans. Let rise to nearly double its bulk and bake.

Bran Bread.

2 yeast cakes.
2 cups milk, scalded and cooled.
1 cup lukewarm water.
½ cup molasses.
7 cups flour.
5 cups bran.
4 tablespoons lard or butter.
2 teaspoons salt.

Dissolve the yeast in the lukewarm water and milk. Add molasses and four cups sifted flour. Beat well. Add the bran, lard or butter, salt, and the balance of the flour, or enough to make a dough that can be handled. Knead well, cover, and let rise until double in bulk. Divide into loaves and place in greased pans. Let rise until double in bulk and bake in a moderate oven.

Corn, Rye and White Flour Bread.

2 cups lukewarm water.
1 yeast cake.
½ tablespoon salt.
½ cup molasses.
1 cup rye flour.
1 cup corn meal.
3 cups white flour.

Dissolve yeast cake in water, add remaining ingredients, and mix thoroughly. Let rise to double its bulk, knead and shape into loaves; let rise again to double in bulk, and bake.

QUICK BREADS.

Boston Brown Bread.

1 cup rye meal.
1 cup granulated corn meal.
1 cup graham flour.
1½ teaspoons soda.
1 teaspoon salt.
¾ cup molasses.
2 cups sour milk or 1¾ cups sweet milk or water.

Mix and sift dry ingredients, add molasses and milk, stir until well mixed, turn into a greased mould (a one-pound baking-powder can makes an attractive shaped loaf) and steam three and a half hours. The cover should be buttered before being placed on mould, and then tied down with string; otherwise the bread in rising might force off the cover. The mould should never be filled more than two-thirds full. For steaming, place mould on a trivet or saucer in a kettle of boiling water, allowing the water to come half-way up around mould. Cover closely and steam, adding more boiling water as needed.

Sweet Milk Brown Bread.

1 cup white flour.
2 cups graham flour.
¾ teaspoon soda.
1½ teaspoons salt.
¾ cup molasses.
1¾ cups sweet milk.

Sift the soda and salt with the flour, add the molasses and milk, and beat well. Pour into a greased mould and steam three hours.

New England Brown Bread.

1½ cups stale bread.
3¼ cups cold water.
¾ cup molasses.
1½ teaspoons salt.
1½ cups rye meal.
1½ cups corn meal.
1½ cups graham flour.
3 teaspoons soda.

Soak bread in two cups of water. Rub through a collander, add molasses, dry ingredients mixed and sifted and remaining water. Stir until well mixed, fill buttered one-pound baking-powder tins two-thirds full, cover and steam two hours.

Health Bread.

3 cups bran.
1½ cups graham flour.
1 cup white flour.
¾ cup molasses.
1 teaspoon baking powder.
2 cups milk.

Sift together the dry ingredients. Beat in the milk and molasses, pour into greased pans, and let stand in the pans for about one-half hour before baking. Bake about one and one-quarter hours in a slow oven.

Bran Bread.

2 cups bran.
2 cups white flour.
1 cup brown sugar.
1 cup sour milk.
1 teaspoon soda.
1 teaspoon salt.

Sift the salt and soda with the white flour. Add the bran and sift again. Add sugar and beat in sour milk. Bake in greased pans.

Potato Bread.

3 pounds potatoes.
1 cup lukewarm water.
5 to 6 cups whole wheat flour.
1½ tablespoons salt.
3 tablespoons sugar.
2 cakes compressed or dry yeast, softened in ½ cup lukewarm water.

Boil the potatoes in their skins until very soft. Pour off the water, and peel and mash the potatoes while they are still hot. When the potatoes are lukewarm add the dissolved yeast cake, then the other cupfuls of water and the salt and sugar. Mix into this one scant cupful of flour, and allow the sponge to rise for about two hours. Add the remainder of the flour and knead thoroughly until the dough is smooth and elastic. Let rise until nearly double in volume, then knead and shape into loaves. Let these rise to double their volume and bake.

Rice Bread.

¾ cup lukewarm milk and water.
¾ cup uncooked rice.
2 teaspoons salt.
1 tablespoon sugar.
1 tablespoon butter, lard or dripping (if desired).
1 cake compressed or dry yeast.
6 to 8 cups whole wheat flour.

Cook rice until tender in boiling water to which one teaspoonful of salt has been added. Put the sugar, salt and fat (if used) into the mixing bowl and pour over them a half cupful of the liquid. Add the yeast cake softened, in one-quarter cup of the lukewarm water. Add two cupfuls of flour and the boiled rice which has been cooled until lukewarm. Allow this sponge to rise until very light, then add the rest of the flour. This dough is so stiff that some pressure is necessary to work in the last of the flour. Allow the dough to rise until double in bulk, knead and shape into loaves; let these rise until double in bulk, and bake.

Johnny Cake.

1 cup yellow corn meal.
1 cup bread flour.
⅓ cup sugar.
1½ cups sour milk.
½ teaspoon soda.
½ teaspoon baking powder.
1 teaspoon salt.

Mix and sift the dry ingredients twice, and gradually add the sour milk. Beat well, and bake in a shallow greased pan, in a moderate oven.

Virginia Corn Bread.

1 cup corn meal.
½ cup boiling water.
½ cup bread flour.
1 egg.
1 teaspoon baking powder.
¼ teaspoon salt.
⅓ cup grated cheese (optional).

Stir the boiling water into the corn meal, add the beaten egg and stir in flour, salt and baking powder, sifted together. Stir in the grated cheese. Mix quickly, and drop by tablespoonsful in a hot frying-pan greased with bacon fat.

BISCUITS, GEMS AND MUFFINS.

Whole Wheat, Bran or Rye Biscuits, No. I.

(With sour milk or buttermilk.)

1 cup white flour.
1 cup bran, rye or whole wheat flour.
½ teaspoon baking soda.
1 teaspoon baking powder.
1 teaspoon salt.
2 tablespoons butter, lard or dripping.
About ¾ cup sour milk or buttermilk.

Sift together the dry ingredients two or three times, and lightly rub in the shortening. Gradually work in the milk, using a broad-bladed knife. Toss lightly on a floured board and roll out to about one-half inch in thickness. Cut or shape into biscuits and bake immediately in a quick oven.

Whole Wheat, Bran or Rye Biscuits, No. II.

(With sour cream.)

1 cup white flour.
1 cup bran, rye or whole wheat flour.
½ teaspoon soda.
1 teaspoon baking powder.
1 teaspoon salt.
1 cup thick sour cream.

Mix and bake the same as in Recipe No. I.

Whole Wheat, Bran or Rye Biscuits, No. III.

(With sweet milk, skim milk or water.)

1 cup white flour.
1 cup bran, rye or whole wheat flour.
3 teaspoons baking powder.
1 teaspoon salt.
2 tablespoons butter, lard or dripping.
About ¾ cup sweet milk, skim milk, or water.

Mix and bake as in Recipe No. I.

Potato Biscuit.

½ yeast cake.
1 cup milk.
2 cups flour.
1 egg.
½ tablespoon granulated sugar.
2 cups mashed potatoes.
½ teaspoon salt.
1 level tablespoon butter.

Bake and mash three or four large potatoes, enough to make one quart. Place in bowl, add salt, sugar and butter. Take a cupful of the milk, heat till lukewarm, dissolve yeast cake in it, and add enough flour to make a sponge—about half a cup. Set sponge aside in warm place, free from draught, to rise. Bring the balance of the milk to boiling point and then add it to the potatoes, salt, sugar and butter. When sponge has risen and dropped back add it to the potato mixture. Then add the egg well beaten, the remainder of the flour, and mix all together thoroughly. Let rise in a warm place. Butter a baking dish and drop the mixture in spoonfuls, as the dough should not be handled. Let rise again and bake from fifteen to twenty minutes.

Graham Muffins, No. I.

1¼ cups graham flour.
1 cup white flour.
1 cup sour milk.
⅓ cup molasses.
¾ teaspoon soda.
1 teaspoon salt.

Mix and sift dry ingredients; add milk to molasses; combine mixtures and bake.

Graham Muffins, No. II.

1 cup graham or entire wheat flour.
1 cup white flour.
4 teaspoons baking powder.
¼ cup sugar.
1 teaspoon salt.
1 cup milk.
1 egg.
1 tablespoon melted butter.

Mix and sift dry ingredients; add milk gradually, egg well beaten, and melted butter. Bake in hot oven in buttered gem pans for about twenty minutes.

Whole Wheat Muffins.

2 cups whole wheat flour.
2 teaspoons baking powder.
1 teaspoon salt.
2 tablespoons shortening.
2 tablespoons sugar.
1 cup milk.
1 egg.

Mix and sift flour, baking powder and salt; add sugar, milk, egg well beaten and melted shortening. Bake in greased gem pans in a hot oven.

Bran Gems.

1 cup bran.
1 cup white flour.
¼ cup sugar.
1 teaspoon salt.
4 teaspoons baking powder.
1 cup milk.
1 egg.
1 tablespoon melted butter.

Mix and bake the same as Whole Wheat Muffins.

Corn Meal Gems.

½ cup corn meal.
1 cup flour.
3 teaspoons baking powder.
1 tablespoon sugar.
1 tablespoon melted butter.
½ teaspoon salt.
¾ cup milk.
1 egg.

Mix and bake the same as Whole Wheat Muffins.

Oatmeal Muffins.

1 cup cooked oatmeal.
1½ cups flour.
4 teaspoons baking powder.
2 tablespoons sugar.
½ teaspoon salt.
½ cup milk.
1 egg.
2 tablespoons melted butter.

Mix and sift flour, sugar, salt and baking powder. Add half the milk and the egg well beaten. Mix the remainder of the milk with the cooked oatmeal and add to the dry ingredients. Beat thoroughly, then add melted butter. Bake in greased gem pans.

Rice Muffins.

2¼ cups flour.
¾ cup hot cooked rice.
5 teaspoons baking powder.
2 tablespoons sugar.
1 cup milk.
1 egg.
2 tablespoons melted butter.
½ teaspoon salt.

Mix and sift flour, sugar, salt and baking powder. Add half the milk, egg well beaten, the remainder of the milk mixed with the rice, and beat thoroughly. Add the melted butter. Bake in greased gem pans.

Buckwheat Gems.

½ cup sugar.
1 egg.
3 tablespoons butter.
1 cup milk.
1 cup buckwheat flour.
¾ cup white flour.
2 teaspoons baking powder.
½ teaspoon salt.

Beat the sugar into the egg and add the melted butter. Add alternately the milk and buckwheat flour, then the white flour into which the baking powder and salt have been sifted. Bake in greased gem pans.

METHODS OF MAKING BREAD IN THE HOME.

(From Bulletin 245—Food Values, by Prof. R. Harcourt, O.A.C.)

How much more economical home-made bread may be depends upon many conditions which we will not attempt to discuss here. But without allowing anything for labor, and presuming that the fuel used in baking the bread would be burned anyway for cooking, heating, etc., there is sufficient margin to warrant the economical housekeeper to seriously consider the matter. For the convenience of those who wish to try making bread the following long and short methods are given:

Long Fermentation Method.

1 dry yeast cake.
2 quarts liquid.
2 tablespoons salt.
2 tablespoons sugar.
2 tablespoons lard.
Flour.

Note.—All measurements are level.

Preparation of Ferment.—Put a pint of water at a temperature of about 90 degrees F., into a bowl, drop the dry yeast cake into it and soak for half an hour; then stir in enough flour to make a thin batter, add one tablespoon sugar, and beat with a dover beater until well mixed and full of bubbles. Stand in a warm place (about 70 to 80 degrees F.) until light, which will take from four to five hours.

Preparation of Sponge.—When the ferment is ready put the rest of the sugar, salt and lard into a bread-pan, bring the rest of the liquid to 90 degrees F., and add it to the ingredients in the pan. Add enough strong flour to make a batter that will beat without spattering; add the ferment and beat until it looks smooth and elastic. This will probably take fifteen to twenty minutes. Cover closely and keep at a temperature of 70 degrees F., until light and spongy. This will take from nine to ten hours.

Preparation of Dough.—When the sponge is ready stir in strong flour until too stiff to use the spoon; then mix in more with a stiff-bladed knife or the hand until the dough no longer sticks to the fingers. Turn the dough out on the moulding-board to knead, leaving the pan quite clean. The dough should knead without flour being put on the board or hands; if it proves sticky return it to the pan and mix in more flour. Remember that while too slack a dough makes coarse-textured bread, too stiff a dough makes slow-rising bread which will dry out quickly. Knead lightly until the mass is elastic and velvety, the surface covered with a film of tiny bubbles, and a cut with a sharp knife shows the inside full of fine even bubbles and free from lumps or unmixed portions. Grease the bread-pan lightly with sweet dripping, warm both pan and cover if they are cold, put in the dough, cover closely, and keep in a warm place (about 80 degrees F.) until rather more than doubled in volume, or until a gentle slap with the tips of the fingers causes it to fall in. This will take from two to three hours.

Knead lightly in the pan for a minute to get rid of the larger bubbles and return it to rise a second time until double in volume. This will take from one to two hours.

Divide into loaves that will half fill the bread tins. Knead each piece only enough to get rid of large bubbles and smooth the surface and put it into a greased tin. Keep in a warm place (about 70 or 80 degrees F.) until doubled in volume, when they should have a bold, nicely-rounded appearance.

Bake an hour in a moderate oven. When done, the loaves should give a hollow sound when tapped on the bottom.

When baked remove at once from the pan and stand on edge or across the top of the pans that the air may get to all parts and cool it quickly.

Short Fermentation Method.

2 cups scalded milk.
2 tablespoons sugar.
4 teaspoons salt.
2 cups water.
2 tablespoons shortening (butter or lard).
1 compressed yeast cake.

Dissolve yeast and sugar in half a cup of lukewarm water. To the rest of the lukewarm liquid (90 degrees F.) add sufficient warm flour to make a batter that can be beaten without spattering, add yeast mixture and beat until smooth and silky. Cover and put in a warm place free from draughts for from one and one-half to two hours. When light add lard, salt and enough flour to make a dough that will not stick to the hands or board. Knead until smooth and elastic. Place in warmed and greased dish to rise again until double in bulk, about two hours; shape to half fill well-greased bread pans. Cover, let rise till double in bulk and bake in moderate oven for about one hour.

The above calls for strong spring wheat flour. Soft fall wheat flour may be used for the dough stage, but must be kneaded down before it has quite doubled in volume each time. It is not advisable to use soft flour for the ferment and sponge stages, as it does not stand the long fermentation.

Home-made yeast may be used instead of the dry yeast. Use one cup home-made yeast and only three and one-half pints of liquid.

The liquid may be part milk (scalded) and part water. The latter may be potato water, *i.e.*, water in which two or three potatoes have been boiled, removed and finely mashed and returned to the liquid.

The potato water may form the liquid for the ferment stage, and the mashed potatoes added when the sponge is made. Potatoes give that silkiness of texture so much desired by breadmakers.

If the dough is kept covered while rising it will not form a crust. If it seems inclined to form a crust moisten with warm milk and water. A crust is to be avoided, as it makes a streak through the loaf if kneaded in at the early stages and an unsightly crust on the baked loaf if allowed to form in the last stages.

The second rising of the dough may be omitted, although the extra rising makes the loaf a rather finer texture.

The bread-mixer may be used to knead the dough after it is known exactly how much flour the liquid will need to make dough of the right stiffness.

APPENDIX

ANNOUNCEMENT OF DEMONSTRATION-LECTURE COURSES, 1917-18.

The Women's Institutes of Ontario are deeply engrossed in patriotic work, chiefly the making of supplies and raising of money for the Canadian Red Cross Society, and their activities will no doubt be confined almost entirely to such effort so long as the war lasts.

Those who have worked so faithfully and well in the interests of patriotism are, we think, entitled to the services of an instructor, and many who have not assisted in patriotic work will no doubt be drawn to the Institutes through the holding of classes for instruction and will, at the conclusion of the course, join with the Institute members in renewed efforts along patriotic lines.

Greater efficiency in the choice and preparation of foods, the choice and making of clothes, and in the care of the sick and wounded are of importance at all times, and especially when the nation is engaged in war. The instructors sent out will make the courses as practical as possible and will always keep before the members of the class the importance of the greatest efficiency at a minimum of outlay.

Courses will be given as follows, beginning as early as the Institutes can organize classes this fall and continuing throughout the winter. Each course will consist of ten lectures, accompanied by demonstrations: (*a*) Domestic Science (Food Values and Cooking); (*b*) Home Nursing and First Aid; and (*c*) Sewing.

The members of the Institute are to be given first chance to join the classes, then the privilege may be extended to others in the community.

In arranging for and holding classes the Institutes will be required,—

(*a*) To make application to the Superintendent of Institutes for the course desired on application forms to be secured by writing to Institutes Branch, Parliament Buildings, Toronto.

(*b*) To provide a well-lighted, clean, properly heated and ventilated hall suited to the work undertaken.

(*c*) To guarantee classes of the following numbers:—

1. "*Domestic Science*"—and
2. "*Home Nursing and First Aid*"—Minimum of 20, and the class may be as large as the hall will accommodate.
3. *Sewing*—15 to 18. Not more than 18 will be instructed at the one time.

(*d*) To provide supplies as follows:—

1. *Domestic Science*—Table, stove (gas or coal oil).
2. *Home Nursing and First Aid*—The necessary bandages, etc., will be provided by the instructor.

3. *Sewing*—A considerable amount of table space is required, three feet wide and about two feet deep for each person. Three or four sewing machines. These, in most cases, will be loaned by the members of the Institute, or possibly a local agent will be glad to furnish them.

(*e*) Collect fees as follows:—

25c. from each member of the Institute and 50c. from non-members. The money thus collected will be used to defray expenses in connection with the course, such as rent of hall, heating, lighting, assistance for demonstrator, etc.

In all cases the money on hand from this fund at the conclusion of the course shall be placed in the Institute treasury. The 25c. extra charge to non-members entitles them to membership in the Institute for the current Institute year.

The regular Institute moneys are not to be used to pay expenses in connection with these courses. If the fee announced above is not sufficient to cover local expense, then the members of the class must make up the amount.

In the Sewing Course $1.00 *extra* will be charged each member of the class, this amount to be collected by the instructor and mailed to the Superintendent of Institutes at the time second lesson is given.

(*f*) Appoint a committee to secure hall, see that it is properly cleaned, heated and ventilated, and to secure the necessary supplies. The secretary of the committee shall collect fees, keep an exact account of expenses, and present a financial statement to the members of the class at the conclusion of the course. The secretary shall also be required to keep a record of attendance at each of the lessons. At the conclusion of the course she shall furnish a report upon attendance, finances, etc., to the Superintendent of the Institutes Branch. The secretary may be paid for her services in connection with the class in accordance with the wishes of the members.

The rule will be for instruction to be given in the afternoon, beginning at 1.30, 2.00 or 2.30 o'clock. In exceptional cases, where it is agreeable to both instructor and classes, two lessons may be given a day—morning and afternoon. Where additional classes are formed for the girls in "Domestic Science" or "Home Nursing and First Aid," instruction will be given in the morning, or, where more convenient, in the late afternoon.

Instruction will be given from day to day, five days a week for two weeks at each centre, except in those districts where the Institutes conveniently located can make arrangements for the carrying on of the work at two or more points concurrently.

Domestic Science.

(Food Values and Cooking.)

Lesson.	*Programme.*
No. 1.	Vegetables—Fresh, starchy and dried. Special food functions and methods of cooking.
" 2.	Fruit—Typical methods of cooking; combinations making the best use of home-grown fruits.
" 3.	Canning of Vegetables, Fruits and Meats.
" 4.	Milk—Soups, puddings and combinations, with special relation to infant, children's and invalid diet.
" 5.	Cereals and Cheese—Various methods of cooking; their high food value compared with other more expensive foods.
" 6.	Meat—Roasting and broiling; braised dishes, stews and soups; uses of the different cuts, and food value compared with other foods. Menus planned to save Beef and Bacon.
" 7.	Meat Substitutes, Fish, Eggs, Legumes.
" 8.	War Breads, Biscuits, etc.
" 9.	Simple Desserts.
" 10.	Salads.

The instructor may substitute other lines of work for one or two of the lessons announced if thought desirable.

The Institute must provide a helper to assist the demonstrator in preparing for the classes and in cleaning up after the demonstration. It will usually be necessary to pay such helper for her services. In some Institutes volunteers assist from week to week.

Home Nursing and First Aid.

The object of this course is to enable women to easily obtain a knowledge of how to care for the sick in the home, what to do in an emergency and how to do it: how to render at all times the best possible assistance to the doctor or to the nurse, when her services are necessary, although very often that expense can be saved because of the ability of the woman of the home to handle the situation.

Throughout the course the pupils have practical work in reading the clinical thermometer, counting pulse and respirations. The keeping of a chart is also taken up; this consists in keeping a simple exact record of the various things mentioned thereon.

List of Demonstration-Lectures in Home Nursing:—

1. Sick Room—Sanitation, Ventilation, Care, etc.
2. Bed-making for Various Forms of Sickness.
3. The Bath.
4. Emergencies.
5. Hot and Cold Applications.
6. Bandaging.
7. Disinfectants and Observations of Symptoms.

8. The Administrations of Food and Medicine.
9. Baby Hygiene.
10. Review and General Discussion.

The instructor and members of the class may substitute other subjects for two or three of the lessons announced.

If the Institute members so desire, the instructor will give a few special talks or lessons to the older girls in the school as well as other young girls of the neighborhood.

SEWING.

The Sewing Course will consist of ten lectures, as follows:—

Two lessons on Plain and Fancy Stitches, including Button-holes and Eyelet.
Two lessons on Tailored Skirt.
One lesson on Drafting and Cutting.
Three lessons on One-piece Dress—Fancy.
Two lessons on One-piece Dress—Plain.

The above course may be changed by arrangement with the instructor concerned.

Each pupil must supply the following:—

Notebook.
One 12-inch rule.
One spool white cotton, 60.
One spool white cotton, 40.
One paper needles No. 7, long, sharp.
Small pincushion well filled with pins, scissors, thimble.

It is essential that the room provided for the class be well heated and lighted, and contain sufficient space for a class of fifteen to eighteen, to which number the class will be limited. Very few private homes are suited for class purposes. Preference will be given to those places which can provide suitable hall. Sunday school rooms are quite suitable and the long tables used for tea meetings serve very well for the use of the class.

Much appreciation has been expressed of the excellent results obtained in Demonstration-Lecture courses in Sewing. The simple methods employed in cutting, fitting and making the garments enable those who have had no experience in dressmaking to accomplish the work.

It is most essential that all members of the class be present at the first lesson, for if they miss even one session full benefit cannot be derived from the course. Additional pupils will not be admitted after the work is once begun, unless at the discretion of the instructor. Those taking the course are strongly urged to be guided by the advice of the instructor in selecting style of garment to be made. Although we give no guarantee to the members of the class, they need have no hesitation in bringing the best materials, as the garments are carefully planned and fitted. During the course each pupil will receive many valuable hints in dressmaking and sewing.

In many of the counties, where District Representatives of the Department of Agriculture are located, arrangements will be made for the holding of Short

Courses in Domestic Science at the same time and place as courses in Agriculture are being given to the men and boys. Full particulars regarding the same will be sent to the Women's Institute at or near the place chosen for the holding of the Short Course in Agriculture. These joint courses proved of great value and interest last winter and have been followed at many centres by aggressive work along patriotic and community improvement lines, and we strongly urge the Institutes so fortunate as to be located in or near a centre chosen for a Short Course in Agriculture to form classes in Domestic Science. Most of these courses will continue for only two weeks, but if the Institutes so desire, arrangements willl be made for an extension of the time for another week, especially if a large number of girls promise to take advantage of the same.

Instruction in any of the courses announced herein will be given as soon as classes can be formed, and satisfactory arrangements made. We would advise the Institutes desiring to take instruction to make application at once, and if it is thought well an instructor will be sent two or three weeks in advance to assist in organizing the class and to complete arrangements.

If you wish one of the courses outlined for your centre, ask your secretary to make application.

GEO. A. PUTNAM,
Superintendent.

Toronto, August 25th, 1917.

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

BULLETIN 255

Tuberculosis of Poultry in Ontario

By

DAN. H. JONES, B.S.A.
Professor of Bacteriology

TORONTO, ONTARIO, OCTOBER, 1917

Fig. 1.

Fig. 2.

Fig. 1. *Bacterium tuberculosis* (avian variety) in smear from intestinal tubercle of hen. Stained with Ziehl-Neelsen's method, x 1,000 di. (Original).

Fig. 2. Adult hen in advanced stages of tuberculosis showing extreme emaciation due to the disease. The owner of the bird who sent it for examination stated that it had continued to eat heartily but had not been laying for some time. The crop was full of grain. Other members of the flock were affected with the disease in all stages, and many died during the previous eighteen months. (Original).

BULLETIN 255] [OCTOBER, 1917

Ontario Department of Agriculture

ONTARIO AGRICULTURAL COLLEGE

Tuberculosis of Poultry in Ontario

DAN. H. JONES.

INTRODUCTION.

We are constantly receiving sick and dead fowl for examination as to the nature and cause of their sickness and death.

A large percentage of the birds received are badly affected with avian tuberculosis.

During the last five years we have received tubercular fowl from the following places in Ontario:

COUNTY.	POST OFFICE.
Bruce	Lucknow.
Brant	Paris.
Durham	Courtice, Bowmanville, Ida.
Dufferin	Grand Valley.
Essex	Harrow, Leamington.
Grey	Blantyre, Clarksburg.
Halton	Freeman, Burlington.
Kent	Ridgetown, Cedar Springs.
Lambton	Camlachie.
Lincoln	St. Catharines.
Lanark	Perth.
Norfolk	Courtland, Vittoria.
Oxford	Ingersoll.
Ontario	Pickering.
Perth	Stratford, Listowel.
Peterboro	Peterboro.
Peel	Inglewood, Caledon.
Simcoe	Thornton, Elmvale, Orillia.
Victoria and Haliburton	Oakwood.
Welland	Ridgeway.
Wentworth	Ancaster.
Wellington	Eden Mills, Guelph, Ballinafad, Drew.
York	Toronto, West Toronto, Mount Albert.

Previous to receiving tubercular fowl from the above list of places we had received similar specimens from Algonquin Park and the counties of Elgin, Hastings, Huron, Middlesex, and Waterloo.

From the above list of places it will be seen that tuberculosis of poultry is widespread in the Province of Ontario. It is most probable that the disease is present in flocks in many other places in the province from which birds have not been sent to us for examination.

As the disease is liable to cause heavy losses by cutting down egg production and by causing heavy mortality in the flock where it is present, this bulletin is prepared to give information regarding its cause, nature, method of spreading and eradication.

CAUSE OF THE DISEASE.

Tuberculosis of fowls is produced by *Bacterium tuberculosis* (avian variety) gaining entrance to the system of the birds and multiplying in various of the body tissues where it produces the tubercles characteristic of the disease.

Bacterium tuberculosis is a very small microscopic organism, appearing under the high power microscope as a thin rod, straight or slightly bent, sometimes granular. It varies in length, usually from 2 to 5 microns, i.e., from 1/12,000 to 1/5,000 of an inch and is about 0.3 microns or 1/17,500 of an inch in thickness. It is present usually in large numbers in tubercular tissue taken from infected birds. Its presence in such material can readily be demonstrated by means of proper bacteriological technique. (See Fig. 1).

There are three recognized varieties of *Bacterium tuberculosis*: (1) *Human*, which causes tuberculosis in man; (2) *Bovine*, which causes tuberculosis in cattle, swine and sometimes man; (3) *Avian*, which causes tuberculosis of birds, but which has not been proven to be a common cause of tuberculosis in man or the domestic animals.

NATURE OF THE DISEASE.

Formation of Tubercles.

When *Bacterium tuberculosis* gains entrance to the body tissues it feeds on the body juices surrounding it and multiplies sometimes rapidly, sometimes slowly. While so developing and multiplying it produces a toxin or poison which acts on the tissue cells surrounding it, thus causing a local disturbance, finally resulting in degeneration and death of the tissue cells affected. A mass of such cells constitutes a tubercle. From such a tubercle the bacteria pass in the blood or lymph stream to other parts of the body and produce more tubercles.

A tubercle is thus a mass of degenerated or dead tissue cells caused by the development of *Bacterium tuberculosis* within the tissue, and as the tubercles enlarge and multiply following the multiplication of the bacterium, the organ affected is slowly destroyed.

The tubercles thus formed are usually pale yellow in color, sometimes cheesy, sometimes fibrinous, sometimes gritty and sometimes pus-like in texture. In fowl they are usually cheesy or gritty and vary in size from smaller than a pin-head to as large as an egg, the most common being about the size of a pea.

Occurrence of the Tubercles.

In fowl affected with the disease the tubercles are most commonly found in the liver, spleen, intestines, and mesentery. Other parts of the body, however, are frequently affected, such as the lungs, bones, ovaries, kidneys, etc.

SYMPTOMS OF THE DISEASE.

(A) Antemortem Symptoms.

In live fowl it is difficult to detect the disease in its early stages. As the disease advances, however, the following symptoms are liable to develop:

1. Emaciation. Notwithstanding the fact that the affected bird's appetite keeps good, and it continues to eat as much or more than the healthy fowl, it will frequently get thin until eventually it becomes little more than skin and bone. The breast and legs lose all their flesh, and on picking up the bird it will be found to be very light in weight. (See Fig. 2).

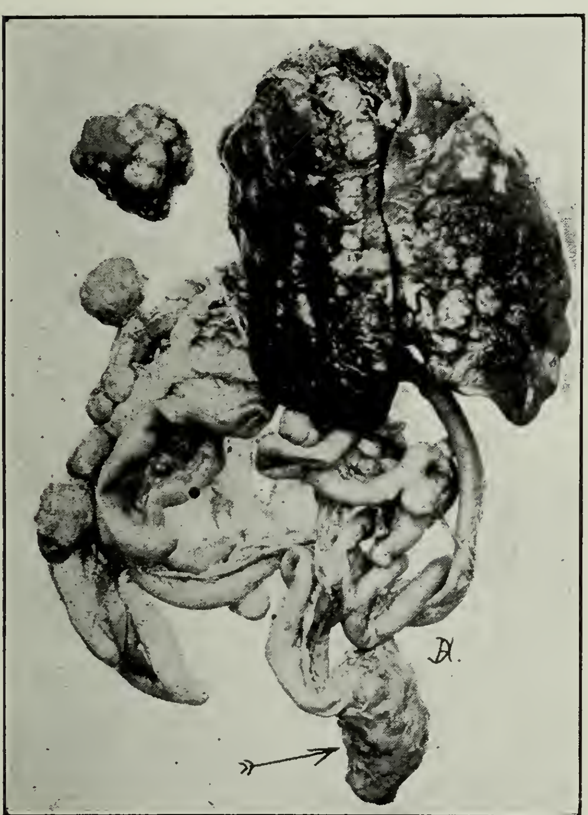

Fig. 3.

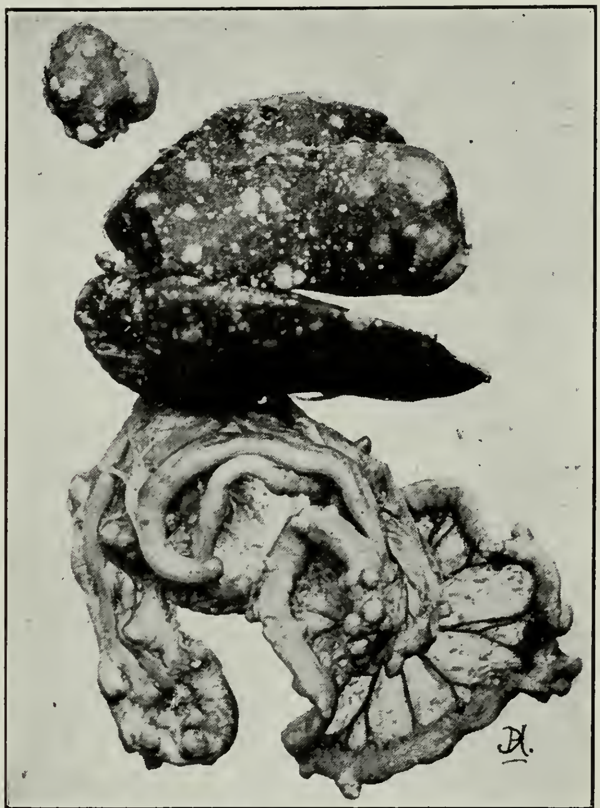

Fig. 4.

Fig. 3. Liver, spleen and intestines very badly affected with tuberculosis. This specimen was removed from hen shown in Fig. 2. The irregular-shaped, various-sized, white-looking swellings are the tubercles. Note particularly the large tubercle at the end of the intestines. This was at the junction of the colon with the cloaca and had almost closed the passage. The droppings from this bird were heavily infested with *Bacterium tuberculosis.* (Original).

Fig. 4. Liver, spleen and intestines of hen badly affected with tuberculosis, showing many small, as well as large tubercles.

This symptom, however, does not always occur; some birds even in advanced stages of the disease will remain fat, such birds will be very mopy and inactive.

2. Paleness. The unfeathered parts of the head, around the eyes and mouth, the comb and wattles, become pale and dull and though the eyes usually remain bright and clear, they lack life and fire and are often closed. The feathers become dry and lack lustre of health.

3. Listlessness. Affected birds gradually lose their vigor and become listless and inactive, being inclined to mope around and lie down when not feeding.

4. Lameness. When tubercles develop in the bones and joints lameness occurs.

5. Egg laying is frequently reduced to a minimum.

(B). Postmortem Symptoms.

Though it may be difficult to determine with certainty whether or not the disease is present in the live bird, it is comparatively easy to determine the presence of the disease in birds suffering from it which have died, or have been killed for examination.

The presence of tubercles in the liver, spleen, intestines or other parts, as previously described, is indicative of the disease. But as there are other diseases which may cause conditions in the liver, lungs and intestines closely simulating tuberculosis, it is usually necessary, if we are to be certain whether tuberculosis is present or not, to make a bacteriological examination of the affected parts. This examination can be made only by the bacteriologist who has the necessary apparatus. We are prepared at the Bacteriological Laboratory of the Ontario Agricultural College to examine free of charge and report upon any suspected cases which are sent in for examination.

Tubercles in the Liver.

The liver is the most commonly affected organ in cases of fowl tuberculosis. The tubercles are readily seen as pale yellow spots or lumps, varying in size, scattered over the surface, and sometimes projecting from the surface, and when the liver is cut open they will be found present throughout the whole mass of the liver tissue.

The tubercular liver is usually softer and more easily torn than the healthy liver, and the tubercles, as little lumps, are easily broken away from the surrounding tissue. (See Figs 3 and 4).

Sometimes an enlargement of the liver accompanies the disease. We have found tubercular livers that were five or six times larger than normal. Such livers were one dense mass of tubercles. In such a case, practically the whole of the liver tissue was dead, and the enlargement was due to an attempt of the liver to get the better of the disease. (See Fig. 5).

Tubercles in the Spleen.

The spleen is the little purplish red organ situated just under the liver. When the liver is tubercular the spleen is usually also affected. As in the liver the tubercles can be easily seen as white or pale yellow lumps varying in size and usually sticking out from the surface, thus making the spleen irregular in shape and frequently enlarged. (See Figs. 3 and 4).

Turercles in the Intestines.

The intestines are the next most commonly affected organ in cases of fowl tuberculosis. Here the tubercles are found within or on the intestinal walls as hard lumps ranging in size from a pea to a chestnut. Their presence here is liable to cause considerable constriction leading to partial stoppage of the bowels. The droppings from a bird so affected are heavily infested with the tubercle bacteria, and readily spread the disease among the flock. (See Figs. 3 and 4).

Tubercles in the Lungs.

While tubercular affection of the lungs is common in human tuberculosis, it is not so frequently present in avian tuberculosis. However, the lungs of birds are sometimes affected with tuberculosis, and, as in the case of the liver and spleen, the tubercles are found in the lung tissue as little hard, pale yellow lumps which interfere with the action of the lungs, and gradually destroy the lung tissue. (See Fig. 6).

Similar looking lumps are produced in the lungs of little chicks, often resulting fatally, in the disease known as Aspergillosis, which is caused by the fungus *Aspergillus fumigatus.* The spores of this fungus are occasionally present on grain and other chicken food. When these microscopic spores get into the chick's lungs they germinate, and the fungus develops, producing tubercle-like lumps, which cannot be distinguished from genuine tubercles except by microscopic examination.

Tubercles in the Bones.

Tubercles are liable to be present in any of the bones of the body of infected birds. They are most commonly found in the leg bones, particularly at the joints. They will appear as pale yellow irregular swellings of the bone. Their presence at the joints causes inflammation, soreness, softening and decay with accompanying difficulty of movement. (See Fig. 6).

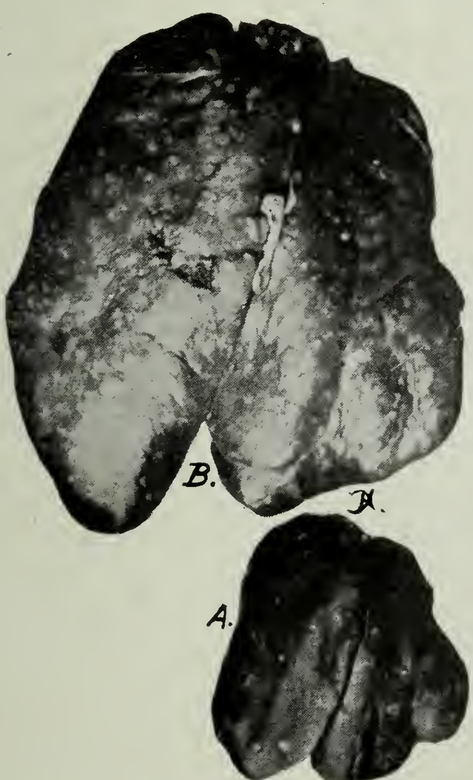

Fig. 5.

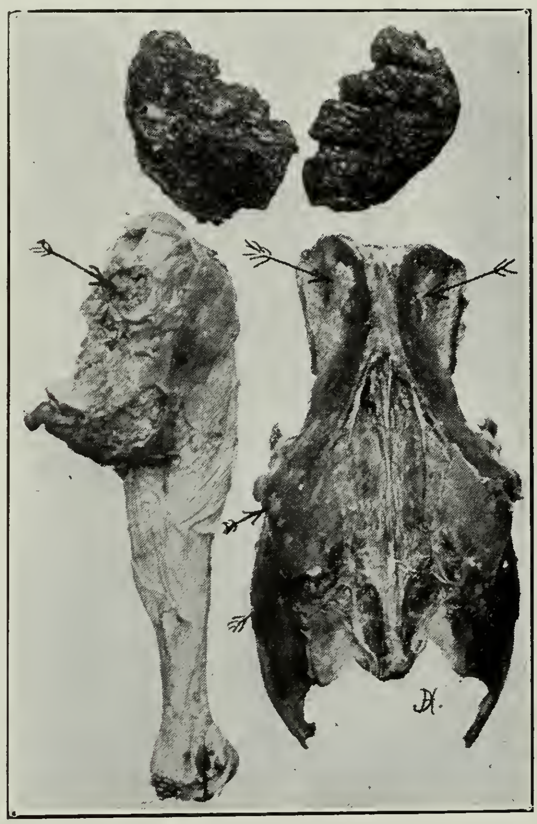

Fig. 6.

Fig. 5. Livers from two hens affected with tuberculosis.

A. Liver in early stages of the disease, a few small tubercles being present. This liver was normal size, being 2 oz. in weight.

B. Liver in advanced stages of the disease. This liver was full of tubercles and much enlarged, being 9 oz. in weight. (Original).

Fig. 6. Tubercular lungs and bones from a hen. (Original).

Tubercles in the Ovaries.

Occasionally tubercles are found in the ovaries. In such cases there is danger of the eggs being infected with the tubercle bacteria. Chicks hatched from such eggs are liable to have the disease develop at an early date.

DISSEMINATION OF THE DISEASE.

Tuberculosis usually enters a flock through the introduction of a bird suffering from the disease. A bird, as previously described, may be quite seriously affected without showing any marked external symptoms. Such a bird will readily spread the disease through the flock by its contaminated droppings.

CONTROL AND ERADICATION OF THE DISEASE.

Care should be taken in buying new stock that birds are obtained only from flocks known to be free of the disease.

When once the disease gets established in a flock it is difficult to eradicate except by the most drastic measures. The quickest and most effective method is to kill off all birds that have run with those proven to have the disease and to disinfect the entire premises as thoroughly as possible.

New stock should be obtained from healthy sources, but should not be placed on the runs which had been used by the diseased flock, for a year or more. The houses, providing they have been thoroughly disinfected, may of course be used.

The first thing to do in putting the poultry premises in sanitary condition is to scrape the roosts, walls, ceilings, floors and nest boxes of the houses thoroughly clean with a hoe or other convenient implement. Accumulated manure may be mixed with lime, spread on the land and plowed under. Loose litter, pieces of boards or other valueless material should be completely burned. When this has been done the entire inside of the houses may be washed down with some good disinfectant such as carbolic acid, one part in twenty of water, zenoleum, lysol, chloronaphtholeum, or other disinfectants, in the strengths indicated by the manufacturers. Any of these may be put on with a spray pump. In place of these, quicklime in the form of whitewash may be used, prepared as follows: Slake the quicklime by adding water in the proportion of one and one-half pints of water to each quart of lime, or by weight, sixty parts of water to one hundred parts of lime. The resulting dry powder is hydrate of lime. For use mix one quart of this with four quarts of water. This must be freshly prepared in small lots and used immediately. It is best applied by means of a spray pump, although it may be put on with a brush or broom. If a spray pump is used, the slaked lime should be put through a fine sieve or strainer in order to prevent clogging of the nozzle. It is important that every crack and crevice and every particle of surface be covered with the disinfectant. After disinfection, clean boards may be placed beneath the roosts to catch the droppings, thus facilitating the work of future cleaning. Slaked lime placed on these boards will absorb the moisture from the droppings besides adding to their fertilizing value. Disinfection of the houses should be carried out at intervals as long as any diseased birds remain in the flock.

To disinfect the runs is a difficult matter, because it is impossible to have the disinfectant come into contact with each minute particle of soil. The best that can be done is to completely cover the ground with freshly-slaked lime and plow under. Sow some quick growing crop for green manure, lime and plow under again. By this method the soil can eventually be well disinfected. The fact must be kept in mind, however, that any tubercular fowls may be continually reinfecting the soil by voiding the tubercle bacilli with their droppings; consequently, it would be impossible to keep the soil free from infection so long as diseased fowls were kept on that ground.

Ontario Department of Agriculture

FRUIT BRANCH

BULLETIN 256

The Wintering of Bees in Ontario

By

MORLEY PETTIT, Provincial Apiarist

Snug in their winter home these bees require absolutely no care from October till April.

TORONTO, ONTARIO, OCTOBER 1917

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Ontario Department of Agriculture

FRUIT BRANCH

The Wintering of Bees in Ontario

MORLEY PETTIT, PROVINCIAL APIARIST.

INTRODUCTION.

The beekeepers of Ontario lose from 10 per cent. to 50 per cent. of their colonies through winter loss and "spring dwindling" every year. The colonies which survive, being subjected to the same conditions, are weakened in population and vitality in the same proportion. This is an enormous waste which, if applied to other live stock, would be ascribed to some epidemic. The majority of beekeepers, however, take the smaller loss as a matter of course, and the larger with plans to do better "next year." It would be surprising that the heaviest loss usually occurs in the southern counties, if one did not remember human nature, and the fact that bees *will* winter there after a fashion in an average winter without protection. They are, therefore, not protected, and the periodical "old fashioned" winter takes off 75 per cent. of them, completely destroying many whole apiaries.

The bee literature of America for a generation and more has been filled with theories on the wintering of bees and the causes of loss. Many of these theories have since been exploded or ignored; but, as a result of countless experiments and a free interchange of ideas, successful beekeepers have developed methods of wintering founded on principles which recent scientific investigation is proving to be in the main correct. It would be useless, and often unfair, to attempt to give credit to the originators of different methods or ideas. Like hive-nectar in a honey-flow, these are free currency amongst beekeepers who read and attend conventions, and when credit is given, the inventor is liable to be ignored and the copyist made famous.

It has been well said that bees cannot be managed by rule, as they never do things invariably. No doubt, if we understood all the factors of environment and the influence of each on bee-behavior, we could say that, given such and such conditions, and bees will behave so and so. In wintering bees in Ontario, beekeepers follow two opposite plans. Some place their bees in a repository, such as a cellar underground, where they attempt to keep them inactive by trying to control all the factors of environment, such as light, temperature, ventilation, etc., until such time as the season and weather permit them to resume their summer activities. Others protect the hives on their summer stands, leaving the bees free to come out and fly whenever weather permits. Both of these plans, when carried out intelligently, have been found to yield good results, and while much is yet to be explained in this difficult problem successful wintering has been more nearly reduced to a "rule of thumb" than almost any other branch of bee management.

PRINCIPLES OF SUCCESSFUL WINTERING.

As all good rules are based on sound principles, it will be profitable to call attention to some of the principles of wintering before describing methods of applying them. It has been well said by the authors of Farmers' Bulletin 695 of the United States Department of Agriculture: "Causes of the death of individual bees or a colony of bees in winter, barring unusual accidents, are only two in number: first, inadequate stores, and, second, excessive heat production." It has been shown by Phillips and Demuth, the authors of the above-mentioned bulletin, that at hive temperatures between about 57° and 65° Fahrenheit a normal broodless colony of bees does not form a cluster, but the bees remain inactive on the combs. When the hive temperature falls below 57° Fahrenheit the bees form a cluster, and those in the centre begin to generate heat by muscular activity, while those in the outer portion serve as insulators by crowding close together, usually with their heads towards the centre of the cluster. The innermost portion rapidly

O.A.C. apiary in summer. Note that alternate rows face in opposite directions, and hives easily form groups of four for winter packing.

acquires a temperature considerably higher than that of the air about the bees before clustering was necessary, often going to 90° Fahrenheit in normal colonies and higher in abnormal ones. The muscular activity necessary for heat-generation causes increased consumption of stores; this, in turn, causes an accumulation of fæces within the bees, which is more rapid if the stores contain a high percentage of indigestible materials, and the presence of fæces causes discomfort, which increases activity, often resulting in death from excessive heat generation. When the accumulation is so excessive that the bees are unable to retain the fæces, there is a discharge in and about the front of the hive, and the colony is said to be affected with dysentery. Mild days, which allow bees to fly freely and discharge normally reduce the danger of loss from this cause.

With this general explanation it may be stated that the successful wintering of bees depends on the bees, the stores, the hive, the immediate surroundings of the hive which we may call the location, and the general surroundings, including latitude, climate and weather.

The Bees.

Bees may be compared to minute "dry batteries." Each is "charged" with so much vital energy which, when expended, cannot be replaced. This should be used in profitable labor, such as gathering nectar, secreting food for larvæ or wax for comb, and so on. In the working season bees expend their portion of energy and wear out in a few weeks. Those which emerge in autumn, after the season's work is over, are expected to conserve their energy for the spring brood-rearing, expending as little as possible in maintaining colony temperature during winter. Young bees, with their full "charge" of energy are, therefore, most desirable in autumn, and there should be plenty of them to divide the responsibility of retaining favorable cluster conditions during the winter. The queen should also be young and vigorous to insure rapid development of colony strength in spring.

View of O.A.C. apiary giving prominence to single cases. These are more expensive and their use is largely a matter of preference.

The Stores.

As bees do not discharge the refuse from the digestion of food, except in flight, this is retained in the intestines during the cold months of winter. With this in view it is easy to see the importance of supplying the colony in winter with stores containing the smallest percentage possible of indigestible matter. The best quality of honey well ripened is considered a good winter store; unfortunately, we are not always sure what has been stored in the brood-chamber during the autumn months. Sometimes bees gather from sources which do not give the best of stores. They may gather it during the cool weather, when they are not able to ripen it properly, and a degree of fermentation may result. Such stores as this are liable to cause dysentery in the winter. Sometimes these inferior honeys granulate readily in the brood-chamber during winter, and this granulated honey is sure death to the colony. If, on the other hand, we give each colony ten pounds or more of syrup made from pure sugar rather late in the fall, we are sure of the kind of stores they have next the cluster, and know that, so far as food is concerned, the colony will winter successfully.

It is found good practice by many of our most successful beekeepers to leave extracting supers on the hives as long as the bees are liable to be gathering anything. When the supers are removed this takes away most of the honey they have been storing, leaving the brood-chambers rather light and ready for a heavy feed of sugar syrup. Each colony is then fed as much sugar syrup as it will take up to 40 or 50 pounds. It is then known to be in good condition so far as the stores are concerned.

The Hive.

The hive should be suited to the size of the cluster. It should be either warmly packed with good, dry material or placed in a cellar, and should be well ventilated. The entrance should never be closed, but should be contracted if sufficient upward ventilation is given. Those who practice wintering with sealed covers leave the entrances much larger than those who have upward ventilation. It is better to have the entrances so arranged that mice cannot enter the hive during winter. An entrance not more than ⅜ inch wide will make this practically sure.

The Location.

This is, to a large extent, beyond the control of the average beekeeper. He keeps his bees where he lives. But for commercial beekeeping great care should be exercised in choosing a locality. While the presence of an abundant honey flora is the first consideration, spring sources of nectar and pollen play an important part in bringing the colonies up to the main honey flow in the best of condition.

The latitude does not make so much difference as one might think. Colonies properly put away seem to winter about as well in the north as in the south of Ontario, only of course the northern bees require more protection and consume more food.

For outside wintering the apiary should be dry and sunny, and especially should be sheltered from cold winds. If a natural windbreak is not available an artificial one of some kind should be put up. Some use a latticed fence six or eight feet high. When sheltered from winds this way it does not matter very much which way the hives face. Many prefer a southern exposure, but it is largely a matter of convenience. In some apiary arrangements, where alternate rows face in opposite directions, the rows are placed to run north and south facing the hives east and west. This gives every entrance some sun during the day. Naturally the northern entrance is more objectionable than any other. An apiary in winter should not be disturbed by cattle or other things travelling about and jarring the hives. Complete quiet and absence of outside disturbance is one of the important factors in successful wintering. Where bees are wintered in a cellar the place should be kept dry and totally dark. It should be carefully ventilated to keep the air sweet at all times, and the temperature should be kept at about 40° to 45° F. The rule of avoiding disturbance applies even more to cellar than to outside wintered bees.

METHODS OF OUTDOOR WINTERING.

The elements of success in wintering bees have now been outlined, and the beekeeper may winter his bees in any way he likes, so long as he observes these principles. He may winter out of doors or in the cellar, and if out of doors he may place packing around each hive separately or around groups of two, four, six, eight, or any other number that suits his convenience. Many successful winterers use the individual case, others pack two in a case, and others four in a case. Larger cases than these are not recommended as being less convenient in many ways. In addition to the points mentioned above it is important to note that the hive should not be moved far from its summer stand for packing. The winter cases make sufficient change in the appearance of the apiary to cause the bees enough confusion when they fly afterwards without also changing the location of their entrances.

The Quadruple Case.

The quadruple case described in the following paragraphs has been found very successful by a number of beekeepers. The four hives are placed tightly together in one box, two facing east and two west. This box provides for about 3 inches of packing on all sides of the four hives, and 8 or 10 inches on top. There is no packing between the hives or under them. The stand, which is eight inches high and made solid, prevents drafts of air underneath. The entrances open out through the sides of the box, so the bees are always able to fly when weather permits. They are packed up as soon as possible after supers are off, then fed all the sugar syrup they will take early in October.

Preparation of Hives.

The size of the box will depend on the dimensions of the hive used. The ten-frame Langstroth hive as made in Ontario is 20 inches long, 16⅝ inches wide and about 9½ inches deep. The bottom-board is 22½ inches long and 1¾ inches deep. These are outside measurements. The space inside the bottom-board is ⅝ inches deep. If the frame-rests in these hives are so arranged that the tops of the frames are even with the tops of the hives, that is, if the beespace is underneath the frames, the space between the bottom-bars and the floor of the bottom-board will be about one inch, which is sufficient for wintering. If, however, the beespace is above the frames and the bottom-bars come even with the bottom of the brood-chamber the space will be only ⅝ of an inch, and should be increased by tacking half-inch strips on the rim of the bottom-board all around, or by using the wedges which are frequently used to enlarge the entrance for swarm control in summer. The entrance of the hive is left full width and this extra depth all winter. The projecting bottom-board is bridged over by means of a ⅜-inch board, 2½ inches wide and 16⅝ inches long, laid flat, and extending from one side rim to the other, so as to make a tunnel from the entrance of the hive to the flight hole in the end of the box. After all four hives have been fixed in this way they are ready to put into their box.

THE WINTERING BOX AND STAND.

The wintering box consists of the floor, two ends, two sides and the roof, all finished with cross cleats, so that each is a separate piece which can be taken down and piled flat with the others when not in use. Seven-eighth inch matched lumber is used throughout. The sides and ends are placed outside the floor to turn the rain, and are supported by the corner cleats which rest endwise on the corners of the floor. The inside dimensions of the box are 24½ inches deep, 40 inches wide and 45½ inches long. It has a flat roof projecting 4 inches on all sides and covered with prepared roofing. This box is placed on a stand about 8 or 10 inches high, made of four boards ⅞ inch by 8 or 10 inches, nailed into a rectangle. The ends are cut 40 inches and the sides 45½ inches long.

They are nailed up with the shorter pieces nailed on the ends of the longer ones, and the outside dimensions of the resulting stand are 40 inches by 47¼

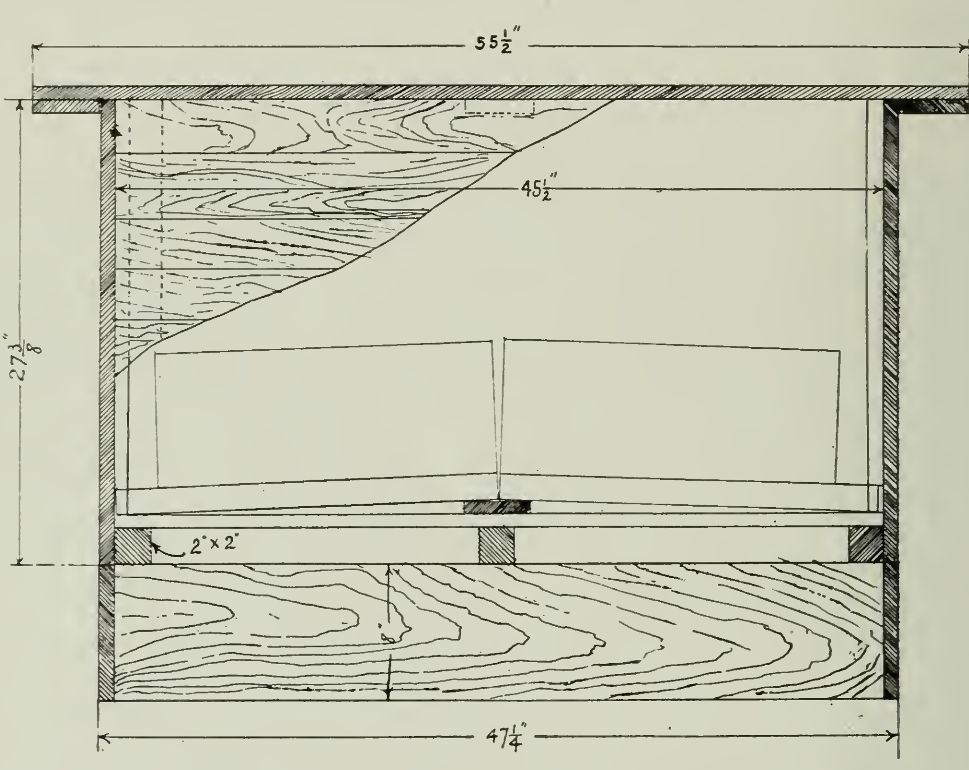


FIG 1.—Side elevation of 4-hive Wintering Box, with side cut away to show construction.

inches. To make the floor of the wintering box, first lay down three pieces, each 2 inches square by 40 inches long; then nail on these ⅞-inch matched lumber, cut 45½ inches long, making the floor 40 inches by 45½ inches. It will be seen that when this floor is laid on the stand it comes just even with it at the sides, but is ⅞ inch short of it at each end. In other words, the outside length of the stand and of the wintering box are the same, making a smooth surface from the ground up, where the bees have their flight holes, but the stand is made narrower as a convenient way of supporting the cross cleats of the floor.

After the stand, with the floor in place, is levelled up with a spirit level, using scraps of thin lumber under the corners, a board ⅞ inch by 4 inches by 36 inches is laid flat across the middle of the floor to support the backs of the four hives, giving them a tilt forward toward the ends of the box. The four hives are placed close together with the four corners meeting at the exact centre of the floor. The front ends of the bottom-boards will then come just about to the edges of the floor, and should almost touch the ends of the box when they are put in place.

The wintering box is made 24½ inches deep inside, so the hives can be supered, if necessary, before they are unpacked. As the outside dimensions of the floor are 40 inches by 45½ inches, these will be the inside dimensions of the box, whose sides and ends must project down over the floor about 2⅞ inches to cover it and its cross supports, and leave no opening between it and the stand. Each side and each end of the box will need an upright at each end of it, ⅞ inch by 2 inches by 24½ inches, and if these are all placed ⅞ inch back from the end of the lumber a locked joint will be formed which will not admit dampness. (See Fig. 3.) The sides of the box are 45½ inches long by 27⅜ inches high. The ends would be 40 inches plus ⅞ inch at each end to cover the ends of the sides, against which they are clamped or nailed, or 41¾ inches long by 27⅜ inches high. When these two sides and two ends are made up and placed together, the outside dimensions of the box thus formed will be 41¾ inches by 47¼ inches.

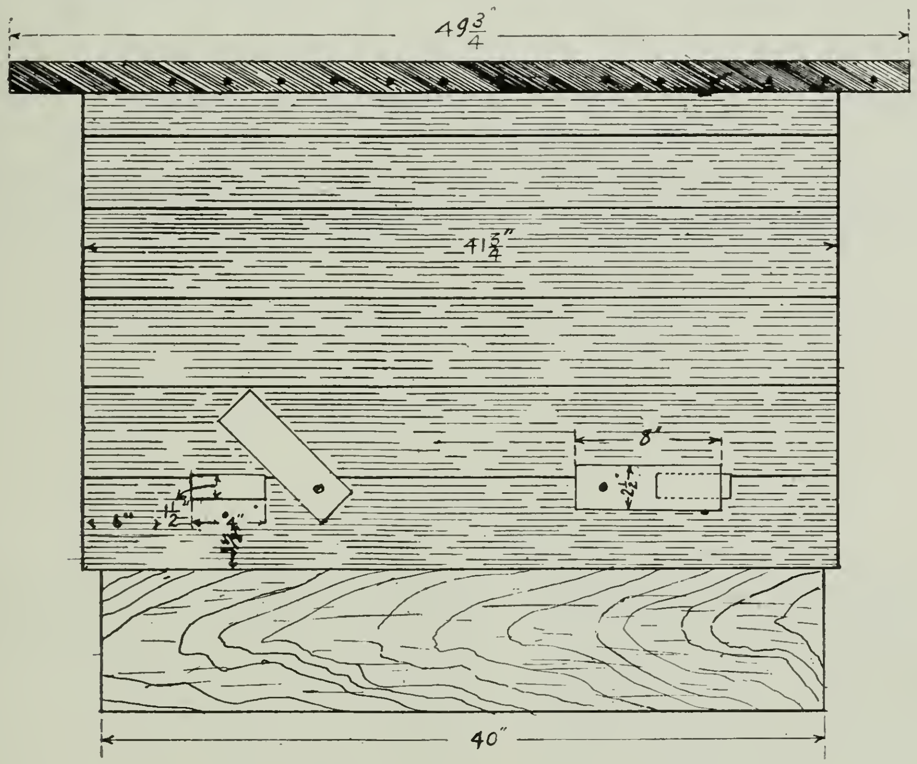


Fig. 2.—End Elevation of 4-Hive Wintering Box, showing arrangement of Entrances.

After the ends are made up the entrance holes should be cut. These must come opposite the hive entrances and should be as deep as the bridge will allow, but need not be the full width. They are placed as far apart as possible to prevent bees mixing when they fly. Measuring 6 inches in from each end and 3⅝ inches up from the lower edge of the box-end locates the lower outer corners of the two entrances. The holes are then cut 4 inches long horizontally, and 1½ inches high. In cold weather each is reduced to a vertical entrance ⅜ inch by 1½ inches by means of a piece of thin board 2½ inches by 8 inches, fastened with a screw or an ordinary wire nail on which it turns as on a pivot. When closed down it comes ⅜ inch short of closing the opening, leaving the ⅜ inch by 1½ inches vertical entrance. A nail driven just below it prevents its coming down too far. When raised up the opening is full size for cleaning out dead bees, or for ventilation on hot days in spring or autumn. The vertical entrance is less liable to clog with dead bees or ice than the horizontal one would be.

The roof is made perfectly flat and large enough to project 4 inches on all sides. That is, it is 49¾ inches by 55½ inches, allowing ¼ inch for play. It is made of ⅞-inch lumber, with a 4-inch cross piece of the same material at each end and in the middle. The middle cross piece should be just 40 inches long, to fit inside the box; the end cross pieces fitting outside, and forming a telescope projection ⅞ inch deep, to prevent dampness from drawing in underneath.

The cover should fit closely enough to exclude mice, but should have openings underneath sufficient for the air to draw through over the packing, and take away moisture arising from the bees. This cover is overlaid with prepared roofing.

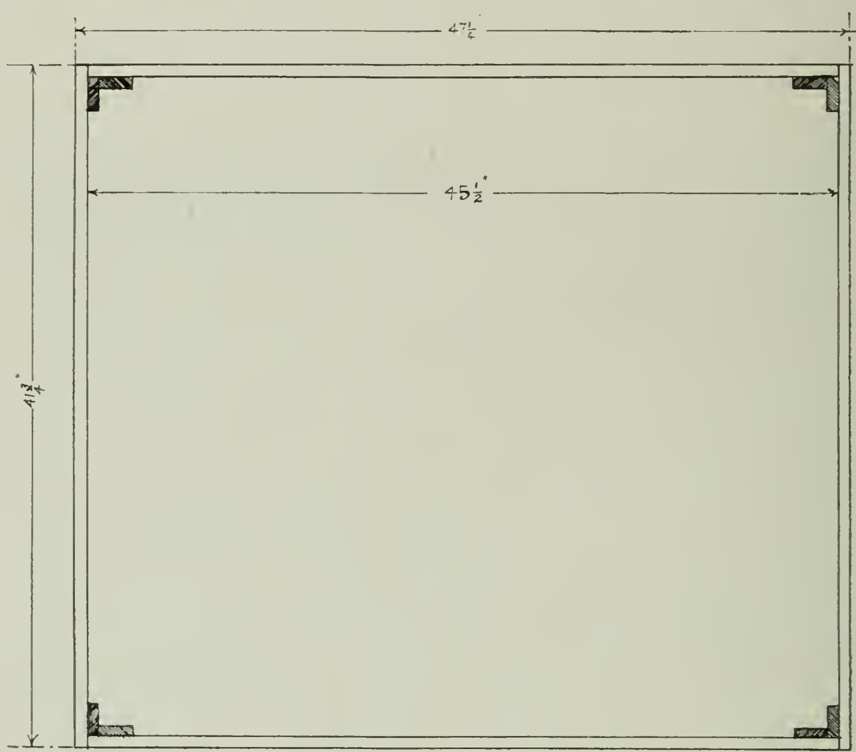
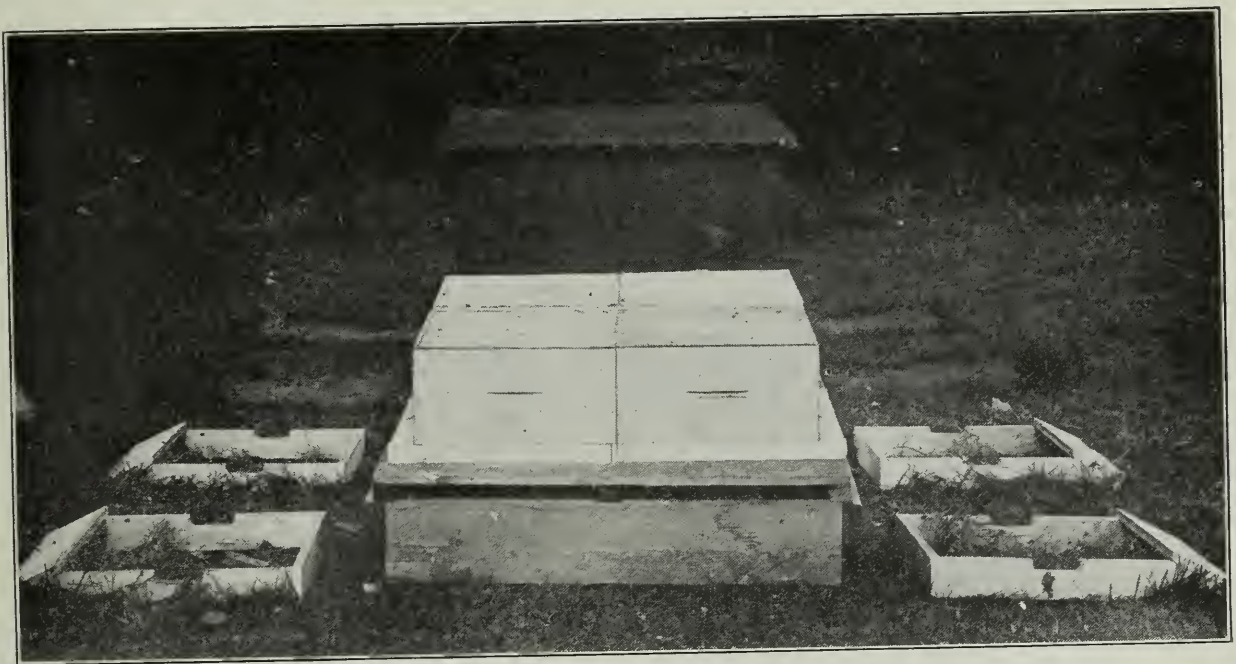


Fig. 3.—Outline of 4-Hive Wintering Box, showing weather-proof joint at corners.

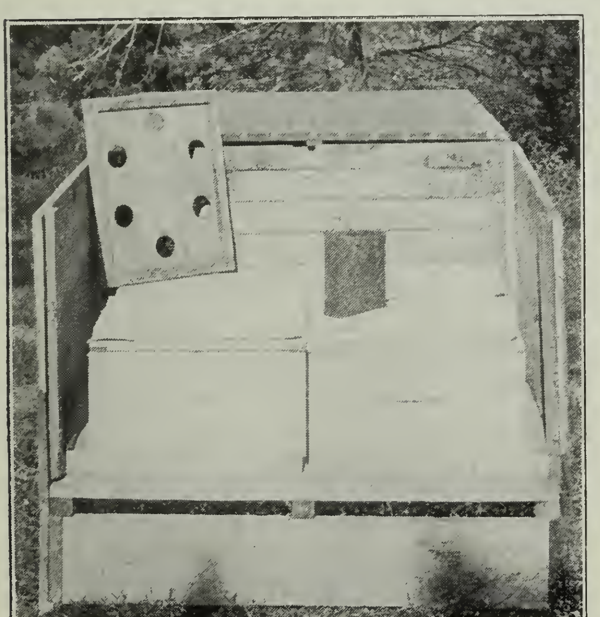
Packing the Hives.

When the four hives are in place on the floor of the winter box, with their entrance bridges adjusted, the sides and ends of the box are set up and fastened at each corner with three clamps, hooks or wire nails. The bridges must fit closely to prevent packing material clogging entrances. If the bees can reach this material at all they will dig out quantities of it and perhaps choke their own entrance. The summer cloths or honey-boards are next removed and replaced by feeder-boards (to be described later) with burlap spread over them and two or three thicknesses of newspaper over that. The packing is then filled in and crowded down well on all sides until the box is filled to within two inches of the top. At no time must the material touch the roof. The air must circulate freely over it to prevent dampness collecting.

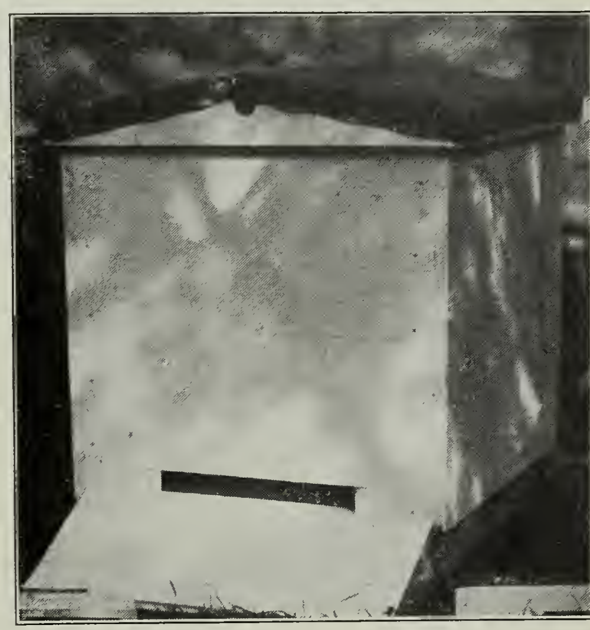
The best packing material is cork chips, which can sometimes be obtained from fruit stores handling Spanish grapes. Forest leaves are excellent, and planer shavings or chaff are good; but sawdust, clover chaff or anything which draws and holds dampness should be avoided. Some use straw, but it is too open and cold unless cut fine.



The collapsible wintering box makes hive-lifting for packing and unpacking very easy. The stands shown are in their permanent summer location.



The hives in place and three sides of case set up. A feeder-board is shown, also one feeder pail.



Single wintering case, with large entrance used in summer. This entrance is greatly reduced in winter.

FEEDING FOR WINTER.

At all times during summer and early autumn care should be taken to see that colonies do not starve. So long as they have enough for daily food winter feeding should be delayed until the first half of October. Each hive should then be given all the syrup it will take. This may be anywhere from 10 pounds to 40 or 50 pounds, depending on the strength of the colony and the amount of stores it already has. The syrup is made of two parts best granulated sugar to one of water. Boil the water, then add the sugar and stir till thoroughly dissolved. The only points to be observed are to avoid scorching the sugar and to see that no granules are left in the syrup to start crystallization after it has been stored in the combs. The feeder consists of the feeder-board and atmospheric feeders. The

The four hives have been packed on sides, feeder-boards are in place and 2-quart fruit jars with syrup inverted over them. In cool weather packing material is filled in amongst the feeders to conserve hive temperature. If this is not done the bees will not take the feed. When the jars are empty they are removed.

board is made of ⅜-inch lumber cut 16⅝ inches by 20 inches, to fit the hive like a honeyboard. Circular holes 2½ inches in diameter are made in it for the feeders with key-hole saw or extension bit. When in place there must be a bee-space over the frames. If the hive does not provide this a ⅜-inch rim is nailed to the board. The feeders are two-quart fruit-jars covered with cheese-cloth held on by the ring, or ten-pound lever-cover honey pails, with a number of small, holes punched in the lids. When these are filled and inverted over the holes in the feeder-board, atmospheric pressure prevents any leakage, and the bees take the syrup through the cloth or perforations and store it in the combs.

When feeding time comes in the early part of October, the packing is removed from over the feeder-boards and a number of filled pails or jars are inverted over the holes. If the days are warm this is done towards evening to prevent robbing, and if the nights are cool packing is put around the feeders to hold the brood-chamber heat and help the bees take down the feed. As fast as feeders are emptied they should be refilled, until the bees signify that they have enough by ceasing all work on the feeders. The latter are then removed, the burlap, paper and packing are replaced, and the roof is adjusted for the winter. The feeding may take a week or more in cool weather, but should be gotten through with as rapidly as possible after it is once started.

If these directions have been followed carefully the bees will require no further attention until spring. In fact, some extensive beekeepers prepare their bees in a similar manner, then go to the city, and do not see them again till May. It is better, however, to visit the apiary frequently, not to disturb the bees in any way, but to see that no accident has happened, such as fence blowing down, covers off, etc. When a warm day occurs towards spring and the bees are flying, the entrance doors should be raised and dead bees raked out with a wire. Snow drifting over the box may do no harm, but uniformly good results are obtained by not allowing it to be higher than the entrances around the box.

CELLAR WINTERING.

A few years ago this was the most popular method of wintering bees in northern climates. Most beekeepers in Ontario and in the Northern States considered that their bees wintered more successfully in cellars than out doors. Since methods similar to that described above for wintering out of doors have been perfected the tendency is all the other way and out-door wintering is being practised successfully as far north as bees have yet been kept in New Ontario. There are still many, however, who have cellar space under dwellings or in similar places suitable for wintering bees which can be used at little expense in preference to making up cases for wintering out doors.

In general terms the conditions required for successful cellar wintering are: first, total darkness; second, an even temperature, at which the bees will remain perfectly quiet. This is usually found to be about 40° to 45° F. The cellar can be kept this way most easily when it is nearly all underground, as it is then less subject to the outside changes which occur from time to time during the winter. The cellar air should be kept pure by a proper system of ventilation, and should be neither too dry nor too damp. The hives themselves should have good ventilation, which may be obtained by removing the summer covers and placing light, porous packing on top, such as a layer of felt, a cushion of chaff, or something of that nature. Many find it an advantage to pry the hives from the bottom-board and block them up with 3/8-inch blocks at the back, allowing a current of air to pass from the entrance across under the cluster and out the back. The hives may be piled one above the other on stands which keep the lowest hive at least one foot above the cellar floor. In fact the best wintering is usually found nearest the ceiling of the cellar.

The bees should be carried into the cellar just at freezing-up time, preferably the next day after they have had a good cleansing flight. In Southern Ontario this would be the latter part of November and earlier in the more northern latitude. It is only injurious to bees to leave them on their summer stands during freezing weather in the fall, when they are to be placed in a cellar. On the other hand, if warm weather occurs after the bees have been carried into the cellar, it is often difficult to keep them quiet. In fact the uncertainty of weather for setting in in the fall and for carrying out in the spring is one of the chief objections to cellar wintering, if one adds to that the fact that the cellar requires a certain amount of attention in the way of regulating ventilators all winter. Then, when the hives are removed from the cellar in the spring they have to pass through inclement weather without the protection they should have, for they require about the same labor and expense for packing up as they would have required in the fall if wintered on their summer stands.

Row of quadruple cases with entrance doors open as in warm weather of spring or fall. These doors close ⅜-inch short of ends of openings leaving winter entrances ⅜-inch wide by 1½ inches high.

Setting Bees Out of Cellar.

Setting bees out of the cellar in spring seems like a small matter; but a mistake made at this time often brings disastrous results. The date, the day and the weather are all subjects for careful choice. There are certain principles connected with the behavior of bees which must be considered in setting them out of the cellar. These may be enumerated before discussing the time and manner of the operation.

Under the most favorable conditions, bees in winter remain quietly clustered on their combs, consuming very little food and rearing no brood. Unfavorable conditions of temperature, humidity, etc., also improper food, cause uneasiness indicated by a buzzing or humming sound in the cellar, brown stains of dysentery on hive fronts, and an increased death rate of individual bees. The uneasiness raises the cluster temperature to the brood rearing point, and brood rearing adds to the sum total of activity, causing increased consumption of food and increased accumulation of fæces, which the workers are unable to void except in flight. The flight of healthy bees in a cellar is prevented by darkness and a low temperature; but those which have become diseased by an overload of fæcal matter either develop dysentery and discharge at the hive entrance or fly out into the dark, or to a light carried by an observer, never to return to their hives. This flight of individuals is another indication of poor cellar conditions.

The date of setting out will depend on the condition of the bees and of the season. Colonies which contained mostly young bees and good stores the previous autumn will, in favorable cellar conditions, endure and profit by a longer confinement than others not so fortunate. In visiting the cellar to judge conditions, no kerosene light should be used on account of the odor, but a small electric light or wax candle. When bees are quiet and not showing dysentery, they should be left in until snow is gone from the yard, and there is something for them to gather outside. The melting of snow can be hastened by shovelling it about whenever it thaws. The usual rule is to wait, if possible, until soft maple blossoms begin to open.

Carrying bees out in January or February for a winter flight, then returning them to the cellar, was tested quite thoroughly some years ago, and condemned as poor practice. Where bees cannot be successfully cellar-wintered without this they should be packed and wintered on their summer stands.

When the approximate time of setting out has been decided upon, the day and hour must be selected. In making a selection we must take into account the tendency of bees to become excited when first brought out of the cellar into daylight. This excitement is increased by a restless condition of the bees previous to bringing out, by jarring and delay in carrying, and by the day being very warm. It may be reduced by opening doors and windows the previous evening to give the cellar a good cooling off overnight, by handling the hives very carefully to avoid disturbance, and by selecting a day which is not too warm. It should be noted that excessive airing of the cellar in spring, while it provides temporary relief, will ultimately increase the uneasiness unless the hives are soon taken out. The first flight of the bees should be accompanied by sunshine, still air, and a temperature of 50° to 60° F., indicated by a thermometer hanging in the shade. Excitement, causing large numbers of bees to fly at once, is liable to result in drifting, particularly if the wind becomes strong. By "drifting" is meant many bees going into certain hives, making those colonies too populous and depleting the strength of others.

This term requires some explanation. When a young bee comes out of its hive for the first time in the summer, it will be seen to turn its head toward the entrance upon taking wing, flying in front of the hive in circles, each circle growing larger as it goes further from the hive until it is lost to sight. In this way it impresses upon its memory the exact spot of "home." On subsequent trips these precautions are not taken, and it leaves its hive in a direct line of flight, never looking back. If the hive is afterwards carried to a new location on familiar ground less than a mile away, the older bees do not usually notice the change, but return from flight to the exact spot where they first marked their home, there to die as homeless martyrs, unless there are other hives near at hand to receive them. There are occasions, however, in the lives of bees when the memory of the home site seems to be subordinated. These are occasions of great excitement, as in swarming or of long confinement, as in winter. In neither of these cases is the memory of the old home site entirely lost; but when first taken out of the cellar they usually orient themselves, as in their first flight as young bees. The impulse to guard the hive against strange bees is also subordinated on both of these occasions.

An additional factor in the return of bees to the hive on such occasions is the "homing call." Each worker is provided with a small gland located just above the tip of the abdomen. Under the excitement of a first flight or swarming, bees alighting on the entrance of a hive raise the tip of the abdomen, exposing this gland, and fanning with their wings to drive off a scent which attracts others. They also utter a peculiar hum, which has been called the "homing call." Whether it is the scent or the sound which attracts other bees we need not discuss here; but this call causes numbers of bees to alight near the callers and enter the hive, even though it is not their own. When conditions in the apiary are favorable with warm sunshine, still air and not much excitement of the bees, the call from the various entrances is about the same, and no confusion results. The bees, in flying out, have taken note of the location of their hive, much as on the occasion of their first flight as young bees, and return mostly to their own hives; but where the excitement is great they do not orient themselves well on going out, and if a strong wind strikes up it drives the "homing call" across the yard, so that bees are called to the windward side and drift in large numbers up against the wind to the hives on the far side. The result of this drifting is a large number of weak colonies, and a few colonies which have more bees than they should have at this season. Under the excitement colonies sometimes swarm out and leave their hives entirely.

That bees do not entirely forget the old location of their hives is indicated by the following observation reported by different beekeepers with variations. On the first flight of bees after the hives are removed from the cellar, it has been noted that numbers of bees sometimes hover about stands which were occupied in the fall, but are now vacant. These are believed to be workers from hives which formerly stood here and now stand elsewhere. It is inferred from this that a general interchange of bees occurs where all stands are reoccupied, but not by their former hives. If this occurs to any extent, and the evidence that it does is fairly conclusive, several dangers are incurred by not getting each hive back on its former stand. An infectious disease existing in a few hives of the apiary is liable to be spread to other hives, queens may possibly be killed by strange bees, and the defence of each hive against robber bees may be reduced by the confusion. It seems important, then, that hives should be carefully returned to their original stands, even though many successful beekeepers do not consider the advantage worth the extra trouble.

Another matter of importance is the robbing impulse which must be guarded against until nectar is gathered regularly from flowers. The impulse to defend the entrance is at a low ebb during the first general flight and there is danger that bees from hives which have been wintered out of doors, or have been set out previously, will rob the ones which have just been brought out. As far as possible all the hives of one apiary should be carried out on the same day.

A few days before setting out it is good practice to go through the cellar, and mark the hives where bees are restless, or where many dead bees are accumulated on the bottom board. As the hives are carried out all light ones should also be marked. The percentage of such abnormal colonies in a well-regulated cellar will be small, and, after they are set out, only these need be disturbed by changing bottom boards, giving feed, or examining for queen condition. The danger of robbing and exposure to cold in giving immediate attention to the apiary will thus be greatly reduced.

As the flight of bees is very subject to temperature, light and wind, the weather for setting out must be carefully considered. In fact, the beekeeper needs to be a student of the weather at all times, also of the daily reports of the Weather Bureau. One of the best means of forecasting the weather is to study sunsets. It is not easy to describe the sunset which forecasts a bright or stormy day; but, by taking note of the general appearance of the evening sky and noting the sort of day which follows it, one soon becomes a rather good weather prophet.

Birdseye view of O.A.C. Apiary in summer. Note hives in background left in single cases. Some consider summer packing a factor in swarm control. Supers are added within the case.

The usual time for taking bees out is the evening before or the morning of the day which promises to be fine and still, but not too hot. When such a day is expected the doors and windows are opened at sunset to cool the cellar. The hives may at once be placed on their stands by moonlight, or in the early morning, while the air is still frosty. If the day fulfils the beekeeper's expectation it will be still, bright and moderately warm, about 60° to 70° F. The bees will have a splendid flight, and everything will go well.

Unfortunately, however, spring weather is uncertain, and if, when the air is full of flying bees, the sky becomes overcast and the temperature begins to drop and a stiff breeze strikes up, much drifting will result and many bees may be blown on the ground to chill and die. In small apiaries this danger is reduced to a minimum, but where there are many colonies it is safer to select a time when indications are for dull weather for two or three days. Then, at sunset, start carrying out the hives and continue until they are placed on their summer stands, even if it takes until after midnight.

In either case the entrances should be contracted to from one to four inches, according to the strength of the colony, covers properly adjusted, combs of honey given to colonies which are light, bottom boards which are much dirty changed, and other such adjustments made at once. By morning the bees will have been quietly clustered and will not leave the hives to any extent until the weather warms up and favorable flying conditions prevail. This usually comes gradually and prevents the excitement and drifting which occur under the unfavorable conditions previously described.

No particular ceremony is needed in carrying hives out, particularly at night. The only precaution is to work quickly and avoid disturbance as far as possible. Do not allow unnecessary light in the cellar, and do not jar the hives. If there are many hives there should be two or three persons to carry. Let each man pick up a hive in his arms in a comfortable position, carry it gently and quickly to its stand, set it down and come back for another. If the carrying out is being done in daylight, it is best for one to attend to the cellar door, standing right there to open and close as the others pass in and out, thus avoiding unnecessary light and disturbance in the cellar. Even then if the morning is inclined to be warm, the bees in the cellar may become restless, and in that case the door should be left closed for some time after every period of fifteen or twenty minutes carrying out, while the bees in the cellar become quiet and the operators are adjusting entrances, covers, etc., on the hives which are out.

In case cellar conditions have been very unfavorable, so that these ordinary precautions will not keep the bees from flying from the hives or coming out to sting the operator while they are being carried out, the entrances can be closed with a cloth, wet with cold water, and some smoke blown into the hive to quiet the bees. This use of a wet entrance closer and smoker is advised also for timid persons; but under normal conditions of bees and beekeepers is quite unnecessary.

It is well known that bees, in their first flight, discharge the fæces which has been retained in the intestines during the winter, and care should be taken that nothing in the way of clothing or the like be left exposed in the apiary or neighborhood. It is very annoying to a neighbor who has put out a fresh washing on the line to have it stained by the droppings of bees, so as to make rewashing necessary. Where there are near neighbors they should be warned of this danger. It has been one of the most serious causes of trouble between beekeepers and their neighbors.

In conclusion, I would emphasize the importance of favorable cellar conditions for wintering, then leaving the hives in just about as long as the bees can be kept quiet or until near the opening of soft maple bloom. Then, in carrying out, disturb them as little as possible, pack them up snug and warm, see that they have sufficient stores and let them alone for some time.

Spring Protection of Cellar-Wintered Bees.

Once upon a time there were two farmers living side by side. Both had equally large farms, with heavy crops of grain. The one had an adequate staff of harvesters ready when the grain began to ripen, and saved his whole crop. The other did not think much about securing help until the first field was ready to cut. Then he began scurrying about getting a man here and another there; so that by the time the last field was harvested and most of the early grain had spoiled in the field, he was boarding a full gang of harvesters who were no longer needed.

Another time there were two beekeepers, each in a good location. The one took good care of his bees and had the hives full to overflowing with workers when the honey flow started. At the end of the season he had a large crop. The other neglected his bees, and the spring weather being unfavorable, they were just about as weak on the 10th of June as they had been in April. Of course they built up during the honey flow and were in good shape for winter that fall; but another season's crop had been lost, owing to lack of proper care at the right time.

There are several things that have to be taken into account in the spring management of bees. They may "spring" poorly because they have wintered poorly, leaving the hive with only a few bees of weak constitution. The hive may be in an exposed place, where persistent winds keep the inside temperature down and compel the nurse bees to huddle together, thus restricting the size of the brood nest; or the cover of the hive may be thin and open, allowing the heat to pass up

A commercial apiary wintering in quadruple cases. Note windbreak made of lath nailed on frames 6 feet by 8 feet. These may be removed and stacked in summer, and are easily transported in case of moving an apiary.

and out. On the other hand, the brood-chamber may be crowded with old honey, depriving the queen of laying space, or feed may be so scarce that the bees have a job to keep themselves, let alone feeding the brood. They may have a poor queen. Any or all of these conditions are liable to prevail, and cause the beekeeper heavy loss where he goes entirely on the "let alone" plan.

The queen condition of the colony should be watched during summer, and although queens brought from the South can be introduced in April or May, it is much better to have a good queen in the hive to start rearing brood earlier than that. Stores sufficient for winter and spring should be given in the fall, but can be given in spring if necessary.

It is frequently stated that the life of the worker bee is anywhere from six weeks to six months, depending on the amount of work that it does. Bees do not build up strength and increase their powers of endurance by healthful food and exercise as animals do, but each bee arrives in this world supplied with about the amount of energy it will expend during its life-time. We have compared bees to small, dry cell batteries, with just so much energy stored. This energy can be saved by having ideal conditions in the hive; but where conditions are not ideal for brood-rearing, the worker bees must improve them by an expenditure of energy which shortens their own lives. The temperature at which a broodless colony remains quietly clustered is about 57° F. When the outside temperature drops below that, as it does on frosty nights, heat must be generated by the bees themselves within the hive. The temperature at which brood is reared is between 93° and 95° F. It will be seen that on a frosty night this is at least 60° F. above the temperature of the atmosphere outside the hive. The heat necessary for maintaining this temperature is generated by the muscular activity of the worker bees, and is the result of a consumption of food. In other words, the hive might be compared to a dwelling-house, and the colony of bees to the furnace. With this comparison in mind it is easy to understand why a hive needs to be warmly protected, especially in spring during the time that brood is being reared, and when we consider how difficult it is to heat the house on a windy day, the importance of sheltering hives from the wind will be evident. But bees do not attempt to heat the whole interior of the hive to the brood-rearing temperature. A spherical cluster is formed of bees, not closely crowded within the cluster, but forming a very compact shell by the bees on the outside crowding closely together in such a way that their bodies form a non-conducting surface to the sphere. When the difference in temperature between the inside and outside of the cluster is great, more bees are required to form the non-conducting shell, and the diameter of the sphere must be accordingly reduced. Where the walls and ceiling of the hive are non-conducting, retaining heat which escapes from the cluster, the difference in temperature is reduced, and the sphere can be accordingly enlarged. The quantity of brood which can be cared for at any one time depends entirely on the size of this sphere, and the size of the sphere depends on three things: the population of the hive, the temperature outside the hive, and the extent to which the hive itself retains the cluster heat. It is the last with which we have to deal in this chapter, and it does not seem that further explanation is necessary to show the importance of having the hive warmly protected and sheltered from cold winds during the spring building-up period.

The method of applying these principles is a matter of detail, which any beekeeper will work out for himself once he fully realizes the importance of having colonies warmly protected and sheltered from cold winds during the spring building-up period. Bees wintered out of doors should not be unpacked before settled warm weather—the latter part of May or early in June. Some are never unpacked. If wintered in the cellar they should receive protection and shelter when they are brought out. The apiary should not be a windy site at any time. The shelter of evergreens or buildings is very desirable. If such shelter is not available, it is advisable to erect an 8 foot board or lattice fence, placing the boards fairly close together. Where colonies are quite strong and the hives are sound with good, tight, warm covers, the shelter from the wind may be sufficient, provided the entrances are contracted to about one or two inches by three-eighths of an inch. Single board covers are not sufficient. In fact I do not consider them satisfactory at any time. There should be some warmer material, such as cork, felt or shavings in the cover.

One beekeeper describes his method of packing, after taking out of the cellar, somewhat as follows: He puts chaff or straw on the ground for the hives to rest on to keep the bottom dry and warm, sawdust cushions on top, straw piled up around the sides and backs, boards leaned against the straw to hold it in place, and large telescoping covers placed over each hive. If any colony is weak and does not cover the required number of combs when set out, he removes unoccupied combs, crowding the bees to the side of the hive with a division board, putting packing in behind the division board. The bees are left with this packing around them until they are strong enough to need room and ventilation.

A beekeeper writing from Northern Ontario, has a collapsible winter case, which he puts on each hive, packing with two or three inches of shavings on sides and top, practically giving the colony as much protection as many beekeepers give for outdoor wintering in Southern Ontario. The main point is to see that the hives are warmly protected and sheltered from cold winds during the period of spring building up. This seems like a little extra labor, but will be well repaid in the additional amount of honey gathered during the honey season.

SPRING FEEDING OF BEES.

Success in beekeeping depends on having the hive boiling over with workers just at the beginning of the main honey flow. This condition is obtained by conserving the strength, and thus prolonging the life of the workers which have wintered over; also, by making conditions as favorable as possible for rearing young workers. We have seen how the rapid breeding of young depends on cluster temperatures. There is another factor of equal importance which must now be considered; that is, the productivity of the queen and the nutrition of the larvæ.

Aside from cluster limitations, which depend on population and temperature, the queen's laying is affected by her vigor and the way she is fed. Her vigor depends on her original vitality and the amount of work she has done. Age and breeding are important factors here, also wintering. A vigorous queen, after her winter's rest, will lay eggs in the spring as fast as a colony can care for them, provided she is well fed. Her food is obtained from the younger workers of the hive, and is a milk-like substance produced by glands, located in the head, which pass the food down into the mouth, where it is handed out to a hungry queen or larva, as the case may be. The production of this food is quite involuntary, and depends on the amount of honey and pollen consumed by the worker bees. As the queen is producing eggs at the rate of hundreds daily, she requires frequent nourishment, and must seek it from workers about her in the hive. To a great extent her egg-laying will be in proportion to the ease or difficulty with which she is able to obtain food in this way, and that will be in proportion to the number of young bees in the hive and to the extent to which they are producing this food; and that, again, will depend on the supply of honey and pollen in the hive and the extent to which it is available. Honey which is sealed in the combs will be used by workers in the preparation of this food; but unsealed honey, or that which has just been brought in, is used more freely. It will be seen from this chain of statements, that for rapid brood-rearing in spring, it is important not only to have plenty of stores in the hive, but to have part of them not sealed and close to the cluster, so they will be handled and consumed by the workers. The handling of honey, either from the field or from feeding, must stimulate the production of milk food by young workers. A supply of pollen in the hive is quite as important at this time as honey.

An equally important factor for the upbuilding of the colony is the proper feeding of the larvæ. This depends on the same conditions as the feeding of the queen, and if neglected would cause greater loss, as the queen can go about and look for food in the hive, but each larva remains in its cell waiting for food to be brought, and a lack of attention at the right time may result in starved brood or workers without their share of vitality.

Much as has been said and written on stimulative feeding to induce the queen to lay in the spring during the last fifty years or more, the late Wm. McEvoy, the first apiary inspector of Ontario, is about the only one to mention the importance of having the brood well fed. In the Annual Report of the Ontario Beekeepers' Association for 1892, he is reported as follows:—

"Between fruit bloom and clover I see that there is plenty of unsealed honey in the combs. If not, I feed in the evenings until there is, because the larvæ are never so well fed when all the unsealed stores are used up. In favorable weather the bees will gather abundance from fruit bloom and dandelions to feed the brood well and keep a large quantity of unsealed honey on hand. Then, right in the middle of it all we sometimes get a frost, followed by rainy weather, which cuts off the honey flow so suddenly that the bees have to use up the unsealed stores at once to feed the larvæ. Then, when the unsealed stores are used up and no honey is coming in, with a large quantity of larvæ to feed, the bees will not at such times uncap the sealed stores fast enough to keep pace with the large amount of larvæ that needs feeding. If the weather keeps backward after that, so that the bees get little or no honey, they will begin to drag out some of the larvæ, and a little later on we find starved brood. The larvæ that are lost at such times are the very life blood of the honey business."

It is particularly important that this condition should not be allowed to occur in an apiary affected with European Foul Blood, because the larvæ need the very best care to enable them to resist the disease germs which may be present. Italian bees, well looked after at this time, will usually get through to the main honey flow all right, and after that they are safe.

A favorable locality provides a continuous supply of nectar and pollen from natural sources throughout the spring, except in cases of adverse weather, as mentioned by McEvoy above. The beekeeper will need to understand his own locality fairly well to know whether this continuous supply is available. It takes five or six weeks from the laying of the egg for the worker to become a field gatherer. Active brood-rearing should begin then, at least six weeks previous to the opening of the main honey flow, and should be continuous, without any break, until the honey flow starts.

The impulse to collect dust of some kind and carry it to the hive as pollen in the spring seems very strong. When warm days come early, so that bees are active before any pollen-bearing flowers are in bloom, they will be seen collecting sawdust, coaldust, and have even been known to collect black earth and embryo cheese mites. For fifty years or more, writers have advised feeding flour or meal of various kinds to the bees at this time, considering that it stimulated brood-rearing. Some placed it in the cells of combs which were put in the hive, others in shallow boxes, where the bees could have access to it. To keep bees home in rough weather, it was advised to make soft candy of meal, pulverized sugar, honey and water, knead it into a stiff dough and put into an open-work sack. This was first dipped into hot water and out again quickly, then laid over the frames where the cluster could reach it. It supplied both sweet and pollen substitute.

Cheshire mixed pea flour with syrup and spread it over the surface of an empty comb, which he placed in the brood-chamber, and found that the bees used it as pollen, and whereas they had been neglecting their brood previously, the brood afterwards assumed a well-fed appearance, and they even resumed comb-building, which they had stopped for lack of pollen in their feed.

It is quite likely, however, that opening hives for such experiments so early in the spring, will do more harm than good. It is better to see that there is some pollen in each brood-chamber in the fall, and depend on the colony collecting from natural sources early enough in the spring. The practice of placing meal out for bees to gather on early warm days is also of doubtful value. It causes considerable excitement, and must use up colony vitality rapidly.

It is probably true that where the spring pasturage is poor and the main flow comes early, spring feeding is unavoidable. It was an old rule in some parts of Europe that every beekeeper must have three years' store of bee feed in advance, and this used to be stipulated in the marriage settlement.

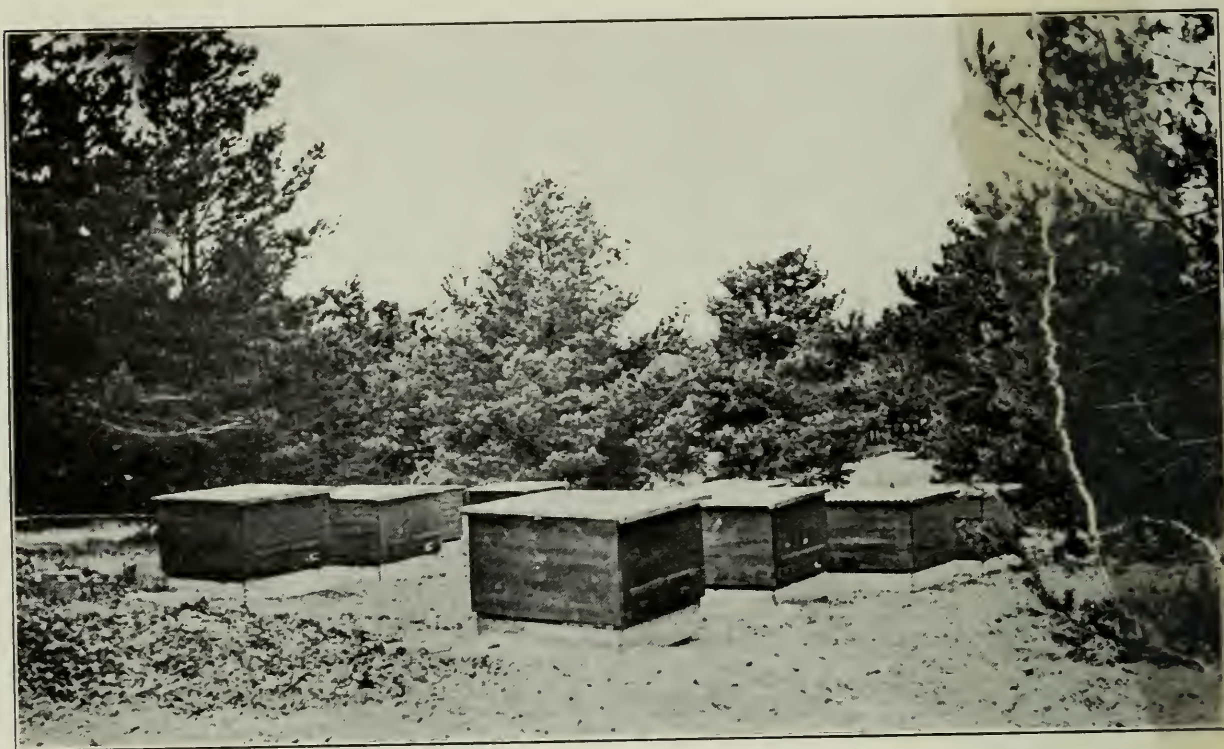
When once begun stimulative feeding must be kept up until the honey flow starts. One objection that has been raised to early feeding is that it excites the bees to rush out, and if the weather is too cool for them to fly normally, they become chilled and do not get back to the hive. This can be obviated by always giving the feed in the evening, when it is getting dark and bees are settling down for the night. It is a safe rule in Ontario not to start this until a check comes in the flow from fruit bloom. Then, where practicable, it might be taken up and continued until the clover flow starts.

The simplest plan, where there is a plentiful supply of sealed honey in the hive, is to visit each hive once in three or four days and scrape the cappings of one comb of honey, placing it next to the brood. The bees will immediately move this leaking honey, storing it around the brood, and the process will stimulate the production of milk food and result in a better feeding of both brood and queen. If combs of capped honey are not available, empty combs may be filled with syrup, made of sugar and water in equal proportions. The filling of these combs presents a difficulty which Doolittle has overcome in a very simple way. He takes a common milk pan, punches the bottom full of holes, places this in a board having a hole cut out of it, so that the pan will stand in the hole. Nail the board to the work-bench, having the ends projecting out; set a wash-tub underneath to catch the drip. An assistant now pours the syrup into the pan, while the comb is held horizontally underneath to catch the numerous small streams of syrup.

Another simple method of stimulative feeding is to tip each hive back a little, so the rim of the bottom board forms a shallow container. Half a pint of syrup is poured in the entrace by means of a funnel. This must, of course, be done in the evening to avoid robbing.

Numerous feeders of considerable merit are sold by supply dealers, such as the Division Board Feeder, Atmospheric Feeder, Boardman Feeder, Alexander Feeder, etc.

There is no doubt that colonies may be stimulated to more rapid growth by skilful feeding, but the beginner will do well to experiment carefully, and the extensive beekeeper usually considers that it is too much work and travel to give feed to hundreds of colonies in different apiaries every evening for a few weeks. The labor required in preparing bees for successful wintering will simultaneously prepare them to reach the next harvest in prime condition. Fall conservation of vitality and stores is productive of better results than spring stimulation, and without the latter's cost in time, labor and risk. Much depends on colonies being in prime condition in the fall. This includes not only plenty of stores, but a vigorous queen and populous colonies. By careful management practically every colony in the yard can be in such condition, and then there is very little need of stimulative feeding, unless very unfavorable weather comes between fruit bloom and the opening of clover; but the man who takes it for granted that because he fed his colonies in the fall until all had a certain quantity they will need no feeding in the spring, may meet with great losses. It is just another illustration of the fact that a man's success does not depend on the amount of manual labor he does, but on the amount of skill and carefulness with which that labor is performed.



Ontario Agricultural College Apiary in Winter.

CONCLUSION.

Bees may be wintered successfully in any part of Ontario either in cellars or out of doors. Where the cellar has given good results its use may well be continued, but the beginner is advised to pack his bees on summer stands.

Beekeeping requires less financial investment than other branches of agriculture in comparison with the returns. Expense should, therefore, not be spared in equipment, especially for winter protection.

Preparations for winter and spring should begin early in the honey season by looking after the queen condition of each colony during the honey flow. Ample fall feeding, to avoid all chances of starvation in winter or spring, will be well repaid.

Usually spring feeding is better done in autumn. Where a large number of colonies are winter packed, however, it will do no harm and will usually be beneficial to place a ten-pound feeder of syrup on each colony in the packing case in April. This can be done by means of the feeder-boards and style of packing case described in this bulletin, without losing any of the cluster heat. The bees should then be disturbed as little as possible until queen clipping time in May.