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DEPARTMENT OF THE INTERIOR, CANADA

HON. ARTHUR MEIGHEN, Minister; W. W. CORY, Deputy Minister

FORESTRY BRANCH—BULLETIN No. 69

R. H. CAMPBELL, Director of Forestry

THE CARE OF THE WOODLOT

B. R. MORTON, B.Sc. F.

(This Bulletin supersedes Circular No. 10)

OTTAWA
THOMAS MULVEY
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1920

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(This Bulletin supersedes Circular No. 100.)

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THE CARE OF THE WOODLOT

1—INTRODUCTION

Throughout Eastern Canada nearly every farm has its woodlot or bush. In many cases this portion of the farm is indispensable to the owner's comfort and prosperity. He could not afford to buy the fuel, fence-posts and timber that are required about the place. The cutting of these gives him occupation at a season when there is comparatively little else being done on the farm, and the sale of an occasional load of fuel or posts brings him in ready money. The protection the woodlot affords against winds for dwellings, gardens, orchards, and live stock is often of great importance and one of its many values which cannot be readily expressed in dollars and cents.

Perhaps the greatest objection made to caring for the woodlot is the time it takes to produce large-sized timber. On the farm however there are many uses for small and medium-sized forest products and these take a comparatively short time to produce. On many woodlots a thrifty young growth already exists that will not require many years before it is sufficiently large to use. A little attention will shorten considerably the time required to produce marketable material.

The use of small dimension material is steadily increasing since the scarcity of wood in large dimension has forced the attention of manufacturers to the use of built-up wood. The war has done much to increase our knowledge regarding the possibilities in the use of laminated products, of which the airplane is an example. This use of wood in small sizes makes it possible to market the products of the woodlot, while the trees are comparatively young.

There are many reasons why it is good business to maintain a woodlot on the farm. Few farms are so small that it would not pay to maintain a small part under trees. The woodlot gives the farm as a whole a higher value. Even when it has been started artificially by planting and the trees have not yet reached merchantable size, they have value. Planting a woodlot is a sure and safe way of building up a bank account for one's old age or one's children.

On many farms there are one or more waste areas—patches that are not suited to agricultural crops. The soil on them is sandy or perhaps the surface is too rough, stony, or steep to allow its being cultivated. Why allow these areas to remain idle generation after generation when with a little initial cost they can be made to grow trees which will be increasing in value as you sleep? Each piece of ground should be used for the purpose for which it is best suited. A poor piece of soil should not be abandoned merely because it will not yield so large a return as the remainder of the tract. There is no part of the farm so poor that it will not produce tree-growth.

2—PROTECTION

GRAZING

The grazing of stock in the woodlot is one of the greatest causes of its deterioration. The same piece of ground will not serve as a pasture and remain a profitable woodlot for any considerable length of time. Goats, sheep, horses, and cows will all destroy hardwood seedlings by browsing on them. Goats and sheep are the worst offenders in this respect. They will eat many woody plants not touched by the others, and during the hot part of a midsummer day they stay in the shady part of the woods, nibbling at the small trees in preference to grazing on the grass growing in the sunny openings.

Cattle and horses not only injure seedlings but often destroy saplings of considerable size by straddling and walking them down in order to reach the leaves. Horses will kill young hardwoods by gnawing at the bark. Foals do most of their injury by running through the underbrush.

The seedlings of broad-leaved or "hardwood" trees are the ones most injured by browsing. Conifers, such as spruce, balsam fir, cedar, larch, and pine, are practically

An ungrazed woodlot. In the foreground of the picture a wire fence has been erected. The one side has been grazed clean, while on the other ungrazed side the good reproduction to be noted farther back has sprung up.

immune. Cattle will sometimes, however, bite off the tips of young pines. Maple, ash, basswood, elm, chestnut, and oak suffer the most; walnut, hickory, willow, and birch do so to a less degree.

The injury done by live stock in the woodlot is, however, not confined to the young trees. As a result of the destruction of the underbrush the soil is exposed to the sun and winds. These, together with the tramping about of the live stock, cause the earth to become packed, dry, and hard, and the rain, instead of being readily

absorbed and retained for the use of the trees, runs off the surface, carrying with it much valuable material. Shallow-rooted trees are seriously injured by having their roots exposed and barked. Much of the stagheadedness, i.e., dead tops, is caused by this form of injury.

FIRES

There are few woodlots of any size in which traces of fire-damage cannot be found. In many cases this has been the result of carelessness on the part of the owner. No precautions were taken when burning stumps or brush, and the fire was allowed to run through the leaves and underbrush. Some owners are short-sighted enough to believe that no harm is done if trees of marketable size have not been destroyed. They place no value on the seedlings and young growth which will be the trees of the future.

It is, however, not merely by the destruction of young trees that the fire in the woodlot does harm. Larger trees are also injured. This at first may not be apparent, for the results may not show for some years after. Fires, which at first sight do not seem to have done much harm to the older trees, will frequently scorch the bark at the base sufficiently to kill the living tissue beneath it. The bark on this scorched patch will drop off and the wood will be exposed to the organisms of decay. In one instance 30 per cent of all trees over six inches in diameter were found decaying at the butt as a result of a fire running through the place several years before.

The destruction of the leaves and twigs on the forest floor is also a serious loss. Not only does this litter decay and form a fertilizer for the trees, but it also acts as a sponge in absorbing the moisture. In woods on rocky situations this decayed litter may be practically the only soil in which the trees have to root. Burning this off can have only disastrous effects. Many trees will die as a consequence of having their roots scorched and exposed, and others will be overthrown by the wind. Fire should never be allowed to run through the woodlot.

WIND

Reference to the damage by winds has already been made. The injury done to the soil can be prevented by keeping the ground covered with litter and, in the open places, by encouraging the growth of young trees. The borders of the woodlot should be completely banked up with branches and foliage in order that the interior may be protected. Trees growing along the edge of the woodlot should be allowed to retain their branches right to the ground, and open borders and gaps should be closed by planting, if necessary.

The effect of strong winds on a stand that has been severely thinned is usually disastrous. When the thinning of a dense stand is necessary it should be made with the greatest of care, especially with shallow-rooted species on thin or swampy soil or in stands situated on exposed hillsides. It is best done a little at a time and spread over a period of several years. This method does not expose the remaining trees to the full force of the wind before they have time to develop bracing roots.

INSECTS

Insects doing damage to the woodlot trees are of many kinds. They include: those which bore in the trunks of living trees; those which tunnel under the bark of living trees; those which destroy foliage; and those which bore in logs and trunks of dead trees.

Insects working either in the trunk or under the bark usually make their presence known by the fine boring dust at the tiny openings or entrances in the bark, or by the little heaps of this dust at the base of the tree. In the case of living evergreens the gum, or resin, is usually found exuding from the small holes. Certain of these

Fire damage to roots. Repeated fires have destroyed the soil and bark about the roots of this tree

Damage done by fire to bark and trunk. The bark for a distance of two feet up has been destroyed

insects do the boring in the grub stage of their development, and working under the bark form numerous wavy galleries, or passages, which eventually girdle and kill the tree.

The spread of these insects should be prevented by removing and destroying the infected trees at a time and in a manner which will ensure the destruction of the insect with it. A comparatively few boring insects attack vigorous trees. They usually attack the weak ones, and it is therefore advisable to keep the woodlot free of sickly or dying trees.

Borers working in the trunks or in the cut logs do considerable damage by rendering useless, or nearly so, much valuable material. Not only do they honeycomb the wood with numerous galleries but these galleries afford an excellent means for various organisms of decay to establish themselves.

Leaf-eating caterpillars are a serious pest in some years. Repeated attacks of these insects will kill the tree.

Windfall, the result of an open border

Photo. 5558

Many insects confine their attacks to one or two species and to certain parts of these trees, as for example, the balsam bud-worm (sometimes called the spruce bud-worm), which destroys the buds of balsam fir and spruce, the larch saw-fly which destroys the leaves on the larch or tamarack, or the white-pine weevil which destroys the tops or leaders of young white pine trees and causes distorted growth.

Information regarding the methods of controlling any of these forest-damaging insects can be secured by addressing the Dominion Entomologist, Ottawa. If possible specimens of the insect and samples of their work should be forwarded with the inquiry.

DISEASE

Tree diseases are usually caused by parasitic fungi. The most common fungi ordinarily met with in the woodlot are those which cause decay. Discoloured wood, hollow trunks, or those shelf-shaped or hoof-shaped projections frequently found attached to the side of trees and logs are an indication of the presence of decay-producing fungi. The shelf-shaped projections, or "punks" as they are sometimes

called are merely fruiting bodies of the organism growing within the wood and causing its destruction. These bodies produce minute seeds, or spores as they are usually termed, which are carried by the wind or other means to infect other trees. For this reason decaying trees and logs are a source of danger to the other trees. The removal of the "punk" will reduce the immediate danger of the spores spreading, but it should not be assumed that it will eradicate the decay in the affected trees. The decay in the trees will go on spreading and sooner or later new bodies will be developed in that part or in some other part of the tree.

Many of these decay-producing fungi are not capable of attacking a tree except through a wound or where the bark has been broken, and therefore, to minimize the danger of the disease being spread, the needless blazing or cutting into the trunks of living trees should be avoided. The fruiting bodies frequently develop at a place where the tree has been injured and the fungus has obtained entrance.

3-Thinning

The conditions in woodlots are so variable that it is impossible to give anything but general advice in regard to proper thinning. It is possible, only, to point out some of the things which should be borne in mind when undertaking this work. Much depends upon the judgment of the person in charge.

In the woodlot containing many species, the relative value of each species must be considered. After due consideration has been given to the adaptability of each species to the local conditions, the owner must decide for himself what species he is going to favour. He is the one who knows best what he requires of his woodlot. Generally speaking, sugar maple, elm, white ash, hickory, white oak, beech, chestnut, red oak, and yellow birch are the preferred broad-leaved or "hardwood" species; while white pine, red pine, white spruce, red spruce, and cedar are the most desirable conifers or "evergreens."

In many woodlots which have been protected from cattle and fire a dense even-aged growth of young trees has sprung up in the more open places. This is a desirable condition. In their youth the trees should be close enough together to force a rapid height-growth and produce clear trunks. When about five years old they should number from 3,000 to 5,000 per acre. This number will gradually diminish until at ten years of age the stand will contain from 1,500 to 3,000 trees, and at maturity not more than 150 of the original trees will remain.

Left to itself this thinning would come about in a natural way. The more vigorous trees will get ahead of their weaker neighbours and sooner or later overtop them, causing them to die. Trees, even of the same species, differ in their rate of growth.

Nature, however, is slow, and a little assistance by way of artificial thinning will stimulate the growth and concentrate it into a smaller number of the most desirable trees. Proper artificial thinning will shorten the time required for the trees to reach marketable size by ten to fifteen years.

THEORY OF THINNING

The primary object in thinning is to stimulate growth by giving each tree sufficient light and space to develop and yet maintain a complete canopy over the entire area of the woodlot, so that there will be no deterioration of the soil.

The number of trees per acre or the spacing of the trunks in the stand are not guides to the proper amount of thinning to be done. To understand the principles which underlie the process of thinning, one should know something of the physiological growth of a tree.

GROWTH OF THE TREE.—The materials which make up a tree are carbon, various mineral matters, and water. The carbon is derived from the carbon dioxide gas which

PHOTOGRAPHS TAKEN WITH THE CAMERA POINTED VERTICALLY
UPWARD IN ORDER TO SHOW DIFFERING DENSITIES
OF CROWN COVER.

When thinning or making improvement cuttings make a practice of looking up into the crown of the trees and noting the size of the opening which will be caused by the removal of any particular tree. Unless there are younger trees below try to avoid making a gap which will take considerable time to fill. Keep the tops touching and the ground shaded.

is everywhere present in the air and is taken in by the leaves. The mineral matters are taken in by the roots and conducted to the leaves, dissolved in water. In the leaves a large part of the water is evaporated and given out to the air, leaving the mineral matter. A portion of the mineral matter remains deposited in the leaves and returns to the earth when the leaves drop off. The remainder is acted upon by the sunlight, which strikes the leaves and a process corresponding to digestion in animals takes place. In the leaf the various minerals and the carbon are combined, or assimilated, to form food for the tree. The food is then carried down from the leaves through the outside layers of the tree, and new wood is formed immediately under the bark all along the branches, trunk, and roots.

The minerals which make up the food of a tree really form a very small part of its mass. This can best be realized by comparing the weight of a stick of wood with the weight of its ash after it has been burnt. The ash left is largely the mineral substance which was taken in by the roots. The carbon taken in by the leaves, and any moisture in the wood have passed off as gas, smoke, and steam.

EFFECT OF CROWDING.—It will therefore be seen that a very large proportion of any tree has been derived through the leaves from the air and that sunlight and foliage are very necessary agents in its growth. Shading or crowding, which interfere with the development of the leaves, must necessarily check the growth.

To keep trees too long in crowded stands is not advisable, since, other things being equal, the tree receiving the most light will produce the most wood. We must be careful, however, not to go to the other extreme and grow our trees in stands which are too open, for our object in growing wood is not merely to secure it in quantity; we also desire quality. We require the wood in a form in which we can make best use of it. Ordinarily the form we most desire it in, is long, straight trunks, clean of stubs and branches, which can be sawn into clear, sound lumber.

It is well, therefore, to bear in mind that trees grown in the open do not have desirable trunks, since it is characteristic for a tree when young and vigorous to spread out and take all the space it requires, and to develop a large, low, bushy head on a short trunk.

To secure tall, clear trunks we must prevent the crown or head becoming too large and spreading. We must cause the lower branches to be pruned off while comparatively small so that they will leave no large stubs to form knots in the sawn material.

The most practical way of bringing about the desired result is to crowd the trees in stands and thus limit the quantity of light which can reach them. By crowding them from the time that they are quite small and from time to time thinning them as they require it we can retain a side shade of the proper density, which will cause the pruning to take place but at the same time will not prevent the tree from maintaining a good rate of growth.

DENSITY GOVERNED BY LIGHT REQUIREMENTS.—A woodlot composed of only a few species is very much easier to thin intelligently than one composed of very many kinds of trees, and especially if they are of different ages. The different species have not the same shade-enduring qualities and each must therefore receive special consideration. Trees which endure much shading require to be kept crowded for a longer time to clear their trunks than those which demand much light and, therefore, are readily pruned by crowding.

Foresters class the different species according to their shade-enduring qualities. Spruce, beech, and maple, for example, are very good shade-endurers and are spoken of as "tolerant" trees. Red pine, ash, and poplar will not endure shading to any great extent, and if crowded will prune their trunks when comparatively young. Such trees are classed as "intolerant" or light-demanding species. Between the two classes mentioned above comes the intermediate class or group, including the birches and white pine, for example.

Mixed stand of white pine, white spruce, and balsam fir before thinning

Mixed stand of white pine, white spruce, and balsam fir after thinning

In the following list the trees have been grouped according to their light requirements. This order is not absolutely fixed, but will be found to vary somewhat in different localities. The site upon which a tree grows and its age influence its ability to endure shade. Young trees, as a rule, will tolerate more shading than those nearer maturity, while a tree growing on a site not best suited to it—too wet or too sandy, for instance—will endure less shade than if it had proper soil and moisture conditions.

<i>Shade-Endurers</i>	<i>Intermediate</i>	<i>Light-Demanders</i>
Sugar Maple	Chestnut	Black Ash
Beech	Birch	White Ash
Hemlock	White Pine	Jack Pine
Balsam Fir	Black Walnut	Norway Pine
Spruce	Sycamore	Cottonwood
White Cedar	Black Cherry	Poplar
Silver Maple	Oak	Tamarack
Red Maple		Hickory
Elm		Locust
Basswood		

In the case of a young stand of mixed species it is desirable to have some knowledge of the requirements of each species in regard to light and shade. Take for example a stand containing a mixture of young white pine and hemlock, coming up together. The white pine being the more valuable is the one we desire to encourage the more, and it is therefore well to know that the hemlock will both endure and produce more shade than the white pine. We must favour the white pine in thinning and encourage it to keep ahead of the hemlock, for should the hemlock become the dominant tree the white pine would soon be shaded out.

It is a characteristic of species which are intolerant of shade to have rapid growth in early life, and because of this quick growth when young they can in a measure compete with the more shade-enduring species on the same ground.

Species which are intolerant of shade are also those which produce very little shade, and shade-enduring species coming up under them are therefore not seriously hindered in their growth unless the overhead stand is very dense.

WHAT TO THIN

As pointed out elsewhere, trees, even of the same species do not all grow at the same rate. And, although a stand of trees may start up together, sooner or later certain individual trees will get ahead of their neighbours. These more vigorous ones will gradually crowd and overtop those surrounding them, until many have been weakened and killed. Upon examining such a stand we will find trees grading from the most vigorous to those which are dying and dead. Foresters have divided these trees into four classes: dominant, intermediate, suppressed, and dead. The vigorous ones, those with the large, full crown, standing well up into the light, are the dominant. Those which are crowded at the sides but still receive considerable light from above are the intermediate. The suppressed trees are those which are slowly dying. They have been overtopped by the others and have lost in the race.

In a stand of this kind the removal of the more closely crowded intermediate trees would be considered a moderate thinning. It might in some instances be found advisable to remove certain trees of the dominant class; this, however, depends upon the judgment of the person in charge. Suppressed and dead trees can be removed at the same time, but their removal is ordinarily spoken of as "improvement cutting," since it is not for the primary purpose of stimulating growth. Improvement cutting is discussed on another page.

In thinning, select the trees you desire to retain and then decide which trees should be cut to help the ones that are to remain. It is well to thin on the side and take

out too little rather than too much. One can always come back later and remove a few more trees if necessary, while it is a much more difficult matter to overcome the evil of too severe thinning.

It is a good general rule not to cut a tree if its removal will leave an opening which cannot be closed by the branches of surrounding trees in three or four years. For this reason light thinnings made every five or six years are better than severe thinnings made at longer periods.

WHEN TO BEGIN THINNING

Foresters in Europe have a rule which says: "Thin early, often, and moderately." This means to begin when the trees are still small, as soon as the lower set of branches have been killed, and then to repeat the thinning every four or five years. It is a very good rule and, if possible, should be followed. In this country, however, the average woodlot owner will probably find it most convenient to begin thinning when the material to be removed is of sufficient size to make firewood or be used for some other purpose. In a well stocked conifer stand the first thinning is rarely needed before the trees are from ten to fifteen years old; with most broad-leaved trees it is not needed before the twenty-fifth year. This depends, of course, upon the density of the stand.

4—IMPROVEMENT CUTTINGS

The typical woodlot of today does not contain the quality of material that it might, had it not been neglected. The careless removal in the past of the sound and vigorous trees of the better species and the leaving of overmature and decaying ones, as well as the inferior kinds, have resulted in its present poor composition. Inferior species are occupying space that should be growing more desirable trees. Poplar, willow, hawthorn, ironwood, hemlock, and juniper have taken the place of maple, ash, hickory, elm, and pine. Old trees, long overmature, have been left standing; in many cases their wide-spreading tops shutting out the light from younger trees and preventing their proper development.

Such undesirable conditions should be changed and all future cuttings should be directed with this object in view. Unsound, crooked, broken, and dead trees should be removed. They are merely acting as a breeding place for the organisms of decay, which from them may be transmitted to the sound trees. All inferior species which are either interfering with the growth of better species or acting as seed-trees should be cut.

It is not advisable, however, to remove such "weed trees" where they are necessary for the protection of the soil and where their removal would permit grass and brambles to establish themselves. When removing a tree consider the size of the opening which will be left in the tree tops and the probable effect of this opening on the soil and growth below. The appearance of grass is a sign that no more cutting should be done until it has been shaded out. It is, therefore, not always best to weed out the inferior species all at one time; if necessary it should be extended over a period of years.

The removal of many dead, crooked, and unsightly trees tends to improve the appearance of the woodlot, but one should not forget that this is not the real purpose of improvement cutting. Do not attempt to make the woodlot "look neat," especially if this necessitates the cutting of the underbrush composed of young trees of a desirable species, and, more particularly, if this underbrush is coming up in the more open places where the overhead canopy is thin or under older trees which will be removed within the course of a few years. The young trees are required to replace the old ones, and in the more open places and around the border of the woodlot they are required to protect the soil from the drying effect of the wind and sun.

In practice it is not always possible to draw a distinct line between improvement cutting and thinning. The one partakes of the other, and both may be carried on at the same time.

LIBERATION CUTTINGS AND CLEANINGS

When improvement cuttings consist in the removal of old, spreading trees which are shading and holding in check valuable young growth they are sometimes spoken of as "liberation cuttings," since they liberate or free the young trees from the shade.

Natural broad-leaved reproduction coming in under older trees. Proper thinning here would benefit both the old and young trees.

In dense stands of young saplings, where the desirable species are comparatively few and scattered throughout the less desirable kinds, the cutting out of the poorer species immediately surrounding each one of the better species is termed "cleaning." Young pine coming in under sapling birch or poplar is often benefited by this cleaning. Completely cutting out the crowding trees is not always necessary; lopping off the top of a few will often serve the purpose and in some cases will be better than completely cutting them out. The lopped trees will still continue to protect the soil and produce sufficient side shade for forcing the favoured tree.

5 DEVELOPING STRAGGLING YOUNG GROWTH INTO MARKETABLE TIMBER BY PRUNING

On many farms, especially in the more outlying agricultural districts of Eastern Canada, are to be found patches of uncultivated clearings. These are areas which are too stony or shallow for ploughing or they are situated on hillsides too steep to be profitably worked. They have, therefore, been lying abandoned or neglected for many years, and a growth of young pine, spruce, balsam fir, or cedar has sprung up on them. This new growth has originated from wind-blown seed of neighbouring stands or from seed of a few trees which have escaped the axe during the clearing. This new growth should be encouraged since it occupies land unsuited for cultivating.

In some places the growth may be quite dense and if permitted to come ahead will soon be sufficiently crowded to produce desirable clear straight timber. On other areas,

however, especially on those at some distance from the seed-trees, the growth will be found very open and scattered. The trees are so far apart that their branches will never meet to form a close stand, or at least not until the trees have reached a large size.

Where the trees are still small, two or three feet high, the proper density for producing good material may be obtained by artificial seeding or planting among them. Or it may happen that an exceptionally good seed crop will bring about a thickening of the new stand. Seed years are uncertain and, therefore, planting is recommended.

There are many such open stands, however, in which the trees have reached the height of ten to fifteen feet or more, and are now too far advanced to be overtaken and effectively crowded by any later growth that may come in either naturally or artificially. Growing under these open conditions the trees will always remain branchy and when cut will produce only inferior material, since each branch which has been allowed to develop on the main portion of the trunk will result in one or more knots in the lumber. The strength and value of the material is thereby greatly reduced.

HOW TO PRUNE

It is apparent, then, that if these larger open-grown trees are to produce valuable timber they must be artificially pruned. The following plan is suggested: The pruning should begin, if possible, before the lower branches have died or become over one-half an inch in diameter and before the trunk is over four inches in diameter at

Scattered growth which can be made to produce useful material by systematic pruning

stump height. In order that best results may be obtained the branches must be cut off right at the trunk. No projecting stubs must be left. To leave long stubs will obviously have the same effect as leaving branches. They become imbedded in the body of the tree as the new wood is formed around them, and the result is a loose knot in the sawn timber.

The branches should not be removed too many at a time. They should be cut gradually, that is, two or three whorls of the lowest branches to be taken off every three or four years. The top or green portion of the tree should always be maintained not less than one-half to one-third of the total height of the tree. If too little top is left the growth of the tree is seriously retarded. No more green branches are removed

after the trunk has been cleared to the height of 19 feet above the ground, since the object is to produce only one sound, clear, 18-foot log per tree above the one foot allowed for stump height. The branches above the 19-foot mark are left to flourish and extend as they will until such time as the trunk may have reached the diameter required by the owner and the tree is finally cut down.

Removing the branches above the 19-foot mark is, however, not recommended, largely because it necessitates a ladder of such length and weight being used that it cannot be readily handled by one man. Another reason for not removing the green branches above the first log length is the fact that the greater green top a tree has the more rapid is its trunk diameter growth. To reduce the size of the top further would mean the lengthening of the time required to produce merchantable-sized material.

PROBABLE COST

This is a simple method of obtaining good material from trees which would otherwise produce little better than fence-posts or firewood. It is not a costly method when one considers that the work can be done during the winter when there is comparatively little work being done on the farm. The total value of the labour when the pruning has been completed would probably not amount to more than ten or fifteen cents per tree.

6—REPRODUCTION

Reproduction may be secured by seeding or planting or by sprouts.

NATURAL SEEDING.

The woodlot which is in greatest need of restocking often is the one in which it is most difficult to secure a natural reproduction. Such a woodlot contains many open grassy patches, and any seed shed by the surrounding trees has a poor chance of reaching the soil and germinating. Even if it did germinate, but a small percentage of the seedlings would survive in competition with the grass.

In many woodlots practically all the desirable species have been cut out. Undesirable species such as hawthorn, ironwood, blue beech, poplars, willows, grey birch, and hemlock form the greater part of the stand. These are of small commercial value and as a result have not been kept in check by past cuttings. They are, therefore, able to produce seed in greater quantities and thus have an advantage over the other trees.

Although trees of desired species may be present in large numbers they may be either too young or too old to produce good seed. Trees which are overmature will go on producing seed, but as the quantity is small and the quality poor only a small percentage will germinate.

Again, as a result of past cuttings, one part of the woodlot may contain the most desirable species and the other contain none. Under such circumstances it may take a long time to secure a full stand of the more valuable trees. Some trees produce seed only at long intervals and others produce some seed every year, but it is only every third or fourth year that there is a heavy crop.

For these, and many other reasons, it is not always advisable to wait for the trees to seed up a woodlot. Natural seeding is, however, the cheapest method of securing a new crop of young trees and, as a general rule, unless the woodlot is in a very open and park-like condition or desirable species are not present, it is best to try this method before adopting any other.

Under certain conditions it may be an advantage to turn sheep and goats into the woodlot, as is the case in a woodlot in which the young growth is composed of unde-

sirable species. The sheep and goats will assist to clean it out and make it possible for better species to get started. Conditions may also arise when it is an advantage to run hogs in the woodlot for a time. If turned in just before the seed begins to fall they may have the soil well turned up and in good condition to receive the seed. Hogs, however, are very fond of the seed of some of our heavier-seeded species, such as beech and oak, and should therefore not be permitted to remain too long after the beechnuts and acorns have begun to fall.

Under some conditions it may be advisable to prepare the soil in the neighbourhood of desirable seed-trees after the manner described for broadcast sowing.

ARTIFICIAL SEEDING.

By "artificial seeding" is implied the sowing of seed by hand or some mechanical device. For this purpose seed may be gathered where it is most abundant or it may be bought from a dealer. It can be sown where most desired and in this way one becomes, to a certain extent at least, independent of the seed-trees. New species can in this way be introduced into a woodlot.

BROADCAST SOWING.—There are several ways of sowing seed. Broadcast sowing is the simplest of these. It consists in scattering the seed over the area to be restocked by hand, or in the case of small seeds like those of the conifers, a hand-seeder can sometimes be used to advantage. When the seed is very small mixing it with sand, sawdust, or bran will be of assistance by adding bulk to it.

It is not advisable to use the broadcast method where there is a heavy growth of grass and weeds or where litter on the forest floor is deep. It is better to break this sod by disking. Heavy litter need only be well stirred up. This can often be done by dragging a heavy bundle of brush over it after the seed has been sown. Where the forest floor is known to be in favourable condition, and where there is little danger from birds and rodents, the sowing is sometimes done early in the spring on the snow.

A table of the quantities to be sown per acre for different species is given elsewhere.

SEED-SPOT SOWING.—Where the area to be seeded is stony, grassy, covered with brush, located in the side of a steep hill or, in general, too rough to permit the use of horses in preparing the soil, a method known as seed-spot sowing is sometimes used. By this method small spots or areas, varying in size from a foot to two yards square, are cleared and worked up to the depth of several inches. These spots are spaced at more or less regular intervals depending upon the nature of the ground. The more overrun the place is with undesirable growth the larger the spots should be. Spots two feet square and spaced six feet apart will be found satisfactory under many conditions. Twenty to forty seeds are raked into each spot. Some spots will be failures and others will produce many seedlings. When one or two years old the superfluous seedlings may be transferred to the "fail places," that is, places where the seeds sown have failed to come up, or where the seedlings have died.

This method has the advantage of requiring only from one-tenth to one-quarter the quantity of seed required in broadcast sowing.

PLANTING NUTS.—Acorns, beechnuts, hickory-nuts, butternuts, walnuts, and chestnuts are better planted than sown. The planting consists in removing a square of sod, making a hole with a pointed stick and, after dropping in the nut, covering it a couple of inches deep with earth and pressing it down firmly. The nuts may be planted in the autumn if there is no danger of their being found by squirrels and mice; otherwise they should be planted in the spring.

DRAWBACKS TO SEEDING

Although seeding is often very successful, the success of any seeding method depends upon many contingencies. A large number of the seeds and seedlings are

destroyed by birds, mice, and squirrels. To a certain extent this can be overcome by coating the seeds before sowing with a mixture of ordinary red lead and linseed oil. This makes them distasteful, but will not entirely prevent the birds from pulling them up after they have sprouted.

On unshaded sites a dry spell of a few weeks during the summer following the sowing would result in the destruction of a large percentage of the seedlings. Warm humid weather is also undesirable since it favours a disease known as "damping off" which kills many seedlings when they are but a few days or a week old.

With some species the high price of seed is one of the great drawbacks to broadcast sowing. On large areas it almost prohibits the seed being used in sufficient quantity to ensure a stand of proper density. However, when the seed can be obtained at a low cost and there is little or no preliminary preparation of the soil required seeding is considerably cheaper than planting.

Photo 5588

A good place to plant. Open grassy places within the woodlot should be planted.

Planting is more certain of success than seeding on swampy sites, on shifting sand, or on hillsides and other places where the seed is in danger of being washed away. It is also better to plant on areas overgrown with grass or weeds or where the grass and weeds are likely to come in before the young trees can get themselves established.

PLANTING

Planting is the best method of establishing a forest growth. It must not be imagined, however, that planting a forest is like planting an orchard and that the same time and labour are necessary to plant a forest tree as is required in setting out a fruit or ornamental tree. By "forest planting" is implied the setting out of small trees from three to eighteen inches high, which have either been raised in the nursery especially for this purpose or have been collected from places where they have sprung up from natural seeding. The cost in time, labour, and money is very much less than that required to set out an equal number of orchard trees.

WILD STOCK VERSUS NURSERY STOCK.—Wild stock is sometimes used for forest planting. By "wild stock" is meant seedlings which have sprung up in the fields or woods as the result of natural seeding. Nursery-grown stock, however, is far superior

Photo 16218
Heeling in pine seedlings. The tiny plants are carried from the seed-bed with their roots immersed in water and temporarily set in rows as shown above

Photo 16236
Plants must be carried with their roots immersed in muddy water

as a rule, because of its better root-system. The roots of wild stock are much spread and not compact. In some species they extend deep into the earth, and it is almost impossible to dig them out without causing serious injury. Another objection to wild stock is its lack of uniformity in size, unless it has been carefully selected.

It is sometimes cheaper to gather wild stock than to buy or raise nursery stock, but it is not advisable to use it for extensive plantings. When it is to be used care should be taken to obtain little trees with good root-systems and of vigorous, open-grown growth. Avoid the temptation of taking large-sized trees, however. The trees from four to eighteen inches in height will endure transplanting better than larger ones.

WHERE TO SECURE NURSERY STOCK.—Nursery stock suitable for forest planting may be obtained by buying it from a dealer, by raising it in a home nursery or, in the case of those living in the provinces of Ontario and Quebec, from the provincial government nurseries. Those desiring to reforest within the provinces of Ontario or Quebec should apply for planting material to the Forester, Department of Lands and Forests, at Toronto and Quebec, respectively when they will receive full information as to the conditions under which the material is distributed.

Those who are interested in raising their own nursery stock will find elsewhere in this publication a description of the method of collecting tree seed and propagating it in the home nursery.

The demand for forest-planting material in Eastern Canada has, in the past, not been sufficiently large or steady to encourage commercial firms to raise it in great enough quantities to enable them to sell at prices low enough to encourage planting. Those who are not in a position to raise their own stock or who do not live in a province supplying the material must, therefore, depend largely upon dealers in the United States. This is unfortunate because it is always advisable to secure planting material which has been grown from seed produced as near home as possible, or at least under climatic conditions as rigorous as those to which the tree will finally be exposed.

The Dominion Government encourages reforestation by permitting planting material for this purpose to enter Canada duty free. The importation of certain trees however is prohibited. White pine, or any of its related five-needled pines, may not be brought into Canada, because of the very great danger of spreading the white pine blister rust, a disease which is menacing the white pine of both Canada and the United States. The importation of chestnut trees (i.e. the edible chestnut) from the United States is prohibited because of a disease. Coniferous trees such as spruce, pine, hemlock, fir, etc., are not permitted to enter Canada from the States of Vermont, New Hampshire, Massachusetts, Connecticut, and Rhode Island, because of certain insect pests.

Those intending to import nursery stock should write for Circular 4, issued by the Entomological Branch of the Department of Agriculture, Ottawa, which will furnish them with the instructions and regulations governing the importation, fumigation, and inspection of such stock.

SEEDLINGS VERSUS TRANSPLANTS.—Nursery stock may be bought at prices ranging from \$3 to \$25 per thousand, depending on whether the little trees are seedlings or transplants, and upon the species and size.

"Seedlings" are young trees which remain in the nursery beds for one or more years; until they are taken up and planted directly in the permanent plantation.

"Transplants" are those which have been taken out of the seed-beds and transplanted one or more times into other parts of the nursery before being finally set out.

Trees which have been transplanted in this manner have more abundant and compact roots. They endure adverse conditions better than seedlings. It is best to use transplants where there is a likelihood of their having to endure a summer drought or having to compete with grass and other vegetation on the planting site.

Seedlings, however, are less expensive to purchase, raise, and plant. They are less likely to be injured in lifting, transporting, and setting out, and, except under unfavourable conditions as mentioned above, it is usually best to use them.

Conifers or "evergreens" are best for planting when from three inches to one foot tall, and from two to four years old. Broad-leaved or "hardwood" species are ordinarily set out when one or two years old, and because of their more rapid growth when seedlings they are usually somewhat higher than the conifers of the same age.

TIME TO PLANT.—The best time to plant is in the spring before the buds begin to open. It may be done as soon as the frost is out of the ground. Fall planting, especially with seedlings in wet soil, may result in the plants being injured by "heaving," as a result of alternate thawing and freezing of the ground. Broad-leaved trees "hardwood" should never be transplanted when in leaf, unless it is in the fall just when the leaves are beginning to drop.

Two-year-old pine seedling, compared with four-year-old pine transplant

Dull quiet days are better for planting than hot, sunny or windy days, since there is less danger of the young trees having their roots dried out.

DISTANCE APART TO PLANT.—The closer the trees are planted together the sooner their branches will meet and shade the soil, thus destroying any grass and weeds and preserving the moisture. This crowding also produces the tall, straight, limbless trunks, which are most desired. However, no specific rules can be laid down for spacing trees in the plantation. It depends largely upon the site and the species being used. The spacing generally used is 5 by 5 ft., that is, each tree is set 5 feet from its nearest neighbour. Any spacing greater than 6 by 6 ft. is considered too wide for most species. On poor soil, or where there is considerable other vegetation which it is necessary to kill by shading, spacing 4 by 4 ft. or even closer may be advisable. The spruce, hemlock, balsam fir, sugar maple, beech, basswood, white oak, and hickory, being species which endure considerable shade, are best planted 4 by 4 feet; while others like the white pine, red pine, jack pine, chestnut, white ash, red oak, and black walnut may be spaced 5 by 5 ft. or 6 by 6 ft. according to the site.

The spacing, as far as possible, should be kept uniform in order that each plant will have the same amount of growing space. Sometimes, however, owing to rough ground, stumps, rocks, etc., the spacing will have to be very irregular.

HANDLING YOUNG TREES.—The young trees when shipped from the nursery are usually done up in bundles of twenty-five, fifty or one hundred and packed in baskets or crates. Their roots are kept moist by layers of damp moss. When properly packed and handled they will endure this condition for several weeks.

The trees, however, should not be kept packed for a longer time than is necessary. Immediately upon their arrival from the nursery they should be taken out of the crates and their roots immersed in water. The bundles should then be opened and the plants heeled in. The heeling in consists in digging a shallow trench about eight or nine inches deep with one sloping side, then spreading the small trees in a thin layer along the sloping side and covering the roots with five or six inches of moist earth. This will keep them from drying out and they can readily be lifted as they are required for setting out. The heeling in should be done in a cool place that is continually shaded and as near as possible to the place where the trees are to be planted.

Four-year-old pine transplants heeled in

During the planting the planter draws his plants from a pail which he carries about with him as he moves along. This pail contains a mixture of fine clayey earth and water of the consistency of ordinary paint, and not deeper than will just cover the roots. This muddy mixture coats the small rootlets and aids in preventing their being dried out.

It is very important at all times during the taking up, heeling in, and planting of the trees, that the roots be not permitted to become dry. This is particularly important in the case of conifers. Once dry, wetting them again is of little avail.

PLANTING THE TREES.—In actual planting it is usual for the men to work in pairs, one going ahead and making the holes for the plants and the other following with the pail of plants and setting them in the ground. A strong boy will often be found suitable for setting the plants. The man who makes the hole estimates the approximate distance between holes and need not waste time in actually measuring, although he should check himself from time to time by using a stick of the proper length to determine whether he is keeping the spacing approximately correct. He keeps the

rows straight by facing back and lining himself with the trees already set. He should not permit himself to get too far ahead of the planter because of the danger of the holes becoming dried out.

The planting holes are made with either a spade, long-handled shovel, grub-hoe or mattock, depending upon the nature of the ground, the size of the planting material, and the choice of the user. Many special tools have been devised for planting, but the average woodlot owner will find that those above mentioned will answer his requirements.

The holes should be of sufficient depth and width to permit the roots of the plants being spread out in a natural position and all pointed downward. They should not be so shallow that the roots will be doubled in the bottom. Also, the tree must not be set too deep. That is, the earth must not be banked up around the stem. It is however, permissible to set them about half an inch or so deeper than they originally stood in the nursery. This is to allow for the settling of the earth. Care should be taken not to overdo it, especially in clay soils which do little settling.

In setting out large-sized material, such as four-year-old conifer transplants, it will be found convenient for the "hole-maker" and the planter to work close together. The hole-maker retains on his spade the earth he has just dug up while the planter places the tree and holds it. The earth is then thrown back into the hole covering up the roots. The planter immediately tramps the soil firmly into place while the hole-maker moves on. The tramping must be well done and it is advisable to use the heel, not the sole of the foot, for it is very important that the plants be set solidly. If properly set it will require considerable effort to pull the tree out of the ground.

When using small material, such as two-year-old conifer seedlings, in sandy soil, or soil that has at one time been cultivated and is still fairly loose, it may not be necessary to dig holes. By thrusting a spade into the ground and moving it back and forth a few times an opening will be made into which the planter can insert the roots of the plant, and the spade is then withdrawn. The soil must then be firmly stamped about the tree.

On stony or wet ground, or in other places where the use of a plough as described below is not practical, all sod or other growth should be removed in a patch a foot or more in diameter where the tree is to be set and the tree planted in the centre. These patches are not made in advance but at the same time as the holes are made. In practice this merely amounts to making a hole somewhat wider than would otherwise be required. However, do not use pieces of sod to fill in the holes around the roots. The grass will start to grow again even if planted upside down. At best, sod does not make a firm filling and it is hardly possible to pack the roots too firmly.

PLANTING IN FURROWS.—On open sites where it is not too steep or stony to use a plough it is advisable to plough furrows, especially if the site is grassy and the planting material is composed of small seedlings. The furrows need not be deeper than will just turn the sod, but should be as wide as possible. They are ploughed at the regular interval at which it is intended to space the plants, and along each furrow the plants are set in holes at the proper distance apart.

On hill-sides the furrows should run across the face of the hill, not up and down. This will prevent heavy rains from washing out the small trees. Otherwise it is well to run the furrows in an east-and-west direction. Furrows ploughed in this manner are more or less shaded from the sun during the hot part of the day, and therefore not so readily dried out. In planting, especially if using small seedlings, the plants should be set close to the south side of the furrow in order that they may benefit by the shade. By turning the furrows so that the soil will fall to the south, the south side of the furrow is increased in height by the thickness of the turned sod and the trees are thus afforded greater shade. In very light soil, however, planting the trees next

the sod side of the furrow may have this disadvantage that the sod will sometimes crumble or wash back into the furrows and partially bury seedlings. However, this is rarely serious.

The ploughing should be done as the planting is going on and the ploughman should not be many furrows ahead of the planters, otherwise the furrows will become dried out.

It should not be necessary to water a plantation either immediately after it is set out or at any time afterwards.

SUMMARY OF IMPORTANT POINTS. The important things to observe about planting are:

(1) Always keep the roots moist. While planting carry the plants in pails of muddy water. Never expose roots needlessly to wind or direct sunlight.

(2) Set the trees firmly. Be sure the roots are in close contact with the soil and have not merely the soil sprinkled over them or lying lightly upon them. Stamp the soil well.

(3) Where there is heavy sod plant the trees in furrows, or if this is not practical remove as much sod as is practical when setting the trees.

SPROUT OR COPPICE METHOD

The third method of securing reproduction on the woodlot is to encourage the growth of sprouts which spring from newly-cut stumps. This method is, however, not applicable to all species. It is only with some of the broad-leaved trees that it

Planting pine transplants in furrows. The planter holds the tree in place while the hole-maker throws the earth back on the roots. Photo. 10231

can be used. Conifers, with the exception of pitch pine, do not sprout. Some of the best sprouters are chestnut, basswood, willow, cottonwood, red oak, and black locust. Others are elm, soft maple, birch, beech, hickory, and ash.

In Europe, and to a less extent in the New England States, the coppice method is much used. It is also applicable to the more temperate parts of Canada. The trees in northern forests sprout comparatively little, neither do the sprouts develop as well

Planting seedling pines in furrows. In light soil a crew of planters, as shown, can set out five thousand seedlings a day. Photo. 10210

Two-year-old pine seedling set in furrow. Arrow indicates the seedling. Photo. 10238

as those in forests further south. Sprouts in the north frequently keep on growing late into the fall and the new wood is not properly ripened before they are frozen back by early frosts. Sprouts, as a rule, are more tender than young seedling trees.

One of the chief disadvantages of the coppice method is the small size of the material produced. The growth at first is very rapid, much greater than that of a tree growing from seed. However, this rate lasts only for a few years and then gradually slows down until the tree growing from seed has overtaken it. It is, however, the quickest method of producing small dimension material, such as rails, fence-posts, firewood, etc. For larger timber it is not to be recommended.

POSITION OF SPROUTS—Sprouts which spring directly from the upper edge of the bark where the cut has been made are, as a rule, not so vigorous as those which come off farther down the stump. The best shoots are those which occur at a point where the root joins the trunk.

MANNER OF CUTTING STUMPS—To encourage low sprouting the stumps should be cut close to the ground. In river-bottoms, where it is likely to be flooded, it is sometimes advisable to cut somewhat higher in order to keep the shoots out of the water. The face of the cut should slant in order to shed the rain. Care must be taken not to strip or tear the bark.

TIME OF CUTTING—The cutting should be done late in the winter or early in the spring. If done in the winter the live tissue, which lies immediately beneath the bark, is in danger of being killed by exposure. If left till late in the spring or summer the new wood, which has formed beneath the bark by this time, will not be old enough or have sufficient vigour to sprout.

AGE—Very old trees are poor sprouters. Healthy vigorous trees are the best. Repeatedly cutting the shoots off the same stump will eventually destroy it. Oak and chestnut will stand repeated cuttings for a longer time than most species. Beech and birch will endure it only once or twice. Sooner or later all forests managed under this system have to be replaced by trees grown from seed.

SITE—Trees on the better soils are better sprouters. On lands frequently flooded there is danger of the shoots and stumps being killed.

CUTTING SPROUTS—A great many shoots will sprout from each stump. All should not be allowed to grow. At first only five or six of the most vigorous ones at the base of the stump are permitted to remain. After the first or second year these should again be thinned out, leaving only two or three of the healthiest to develop.

7—COLLECTING TREE SEED

For those who desire to collect their own tree seed the following information may be useful:—

TIME FOR COLLECTING

The time for the ripening of tree seed varies, according to the species, from early summer to October. No fixed date for collecting can be set for any species, as the time of ripening will frequently differ by two or three weeks from one year to the next, according to the season. A warm season will hasten the ripening while a dull wet season will retard it. Those intending to collect should examine the seed from time to time as the ripening season approaches. It will not do to gather the seed before it is ripe, nor will it do to wait too long, because it is impossible to collect the seed of

some species after it has been shed on the ground. The approximate time for collecting the seed of the individual species is mentioned later when dealing separately with each tree.

HOW TO COLLECT

In the case of most species of forest trees the seed must be collected from the standing tree. Sometimes it is possible to obtain it from felled trees when felling is going on during the time the seed is ripe and still attached to the trees. It is more often necessary to climb the tree and either pick the seed into a bag by hand or dislodge it by means of a long-handled pruning fork or rake. In the case of a few trees, like the elms, maples, and ashes, it may be possible to secure much of the seed by spreading canvas sheets or blankets under the trees. In the case of trees with heavy seed, like the oaks or walnuts, the seed can be picked off the ground. The method to be employed in each case can best be determined by the collector after he has located his seed.

SEED-TREES

Seed should not be collected from stunted, diseased, or sickly trees. Seed from such trees will not as a rule produce as good plants as that from healthy trees. The seed from trees just beginning to bear is often poorly developed and will not sprout well, so it is advisable to confine the collecting to older trees. Flourishing, well developed, open-grown trees are the best from which to gather seed. Having more branches they produce more seed, and it is usually easier to collect. Seed on open-grown trees matures earlier than that on trees in close stands.

SEEDS OF BROAD-LEAVED TREES

The seeds of broad-leaved ("hardwood") species vary greatly in size and appearance. Some are quite large like those of the walnut and hickory, others are tiny like those of the birch and alder. Again certain species, like the black cherry, have their seeds covered with a fleshy fruit, while others, like those of the elm, are surrounded by a dry, papery wing.

By examining the seeds of the broad-leaved species, as later described for conifers, one can determine whether they are ripe. As a rule, however, the colour and general outward appearance of the fruit enable one to determine the condition of the seed.

The seeds of many species may be stored or sown just as they are gathered, without any further treatment. Fleshy fruits, however, like the wild cherry or plum, should be dried in the sun before storing for the winter; or they may be placed in water and washed about until the pulp is loosened and floats to the top, and can then be poured off. The seeds are left in the bottom. Walnuts and butternuts are sometimes stored in their husks, but it is usual to remove them. This can be done when they are still fresh by using a hammer or mallet and driving them through an auger hole in a plank or block of wood, which will cut off the husk and permit the nut to pass through. The husks of hickory nuts frequently come off in the handling. When they do not come off readily they may be left on.

SEEDS OF CONIFERS

The seeds of our conifers (also called "evergreens" or needle-leaved trees), as indicated by the name which means "cone-bearers," are borne in cones which in most species hang at the top of the tree. While the red juniper (sometimes called red cedar or pencil cedar) would seem at first sight to be an exception to this rule it is not so, because the dark-blue berry which contains the seed is really a cone covered with pulp or flesh. While tamarack or larch is not an evergreen it is a true conifer, as it bears its seeds in cones.

Upon examining a fresh cone it will be found to be made up of woody scales attached to a central stem or axis. Pressed to the inner side of these scales are the small seeds in pairs, each attached to a papery wing. When the cone scales open the seeds drop out. In collecting, therefore, care must be taken not to gather open seedless cones. In most of our conifers the seed has been shed before the cone drops to the ground, therefore, to collect good cones, it is necessary to gather them from the tree.

HOW TO DETERMINE WHEN SEEDS ARE RIPE.—The seeds within the cone are sometimes ripe a week or more before the brownish colour of the cone-scales would indicate it. Their condition, however, can be determined by cutting through the cone and seeds with a sharp knife and examining the cut seeds. If the seeds are watery or slightly milky the cones are not ready to pick, but if they are firm and the coat of the seed is brownish the collecting may commence. As the time for ripening approaches the seed should be tested occasionally in the above manner.

Screen-bottomed drying trays in rack

Photo 911

In this connection it is well to know that all pine trees require two years to mature their cones. The cones formed in one spring will not be fully grown until a year from the following autumn. It is, therefore, possible to forecast the probable crop of pine seed a year before it is ripe. All our other cone-bearing trees mature their cones the same year they are formed.

DRYING CONES BEFORE STORING. Cones may be gathered in sacks. Fresh cones, however, should not be stored in sacks for two or three days after they are collected. They should first be partly dried by being spread upon sheets in the sun, otherwise they may become heated or mouldy and the vitality of the seed be reduced. After this they can be stored in a cool, dry place in sacks until the seed is extracted. It is best, however, to start the extracting as soon as possible, and to store the seed rather than the cones. Most cones are more easily opened shortly after they are gathered than they can be later on. It is almost needless to say that at all times it is necessary to protect cones from squirrels and mice.

EXTRACTING SEED.—Air-drying.—To extract the seed the cones are further dried by being spread in a thin layer on a tight floor indoors. As they dry the seeds drop out, and if the floor is not tight the seed drops through the cracks. Eight or ten bushels of cones can be conveniently spread on 168 square feet. If the floor is not large enough trays of open lath construction or with bottoms of wire screen can be constructed. The trays are placed one above the other in tiers in a wooden frame, which will permit the trays to slide in and out like drawers. The open character of the bottoms of the trays will allow the seed to drop through and be caught below. Enough space should be left between the trays in a tier to permit the cones to be stirred from time to time.

From three days to two weeks are required to open cones in this manner. The rapidity of drying depends upon the species and the weather conditions. Some cones, like those of the spruce and white pine, will open readily by air-drying, others, like the jack pine and red pine, require artificial drying.

Apparatus used to thresh dried cones and shake out the seed.

Photo 212

This drying may be done out of doors in the sun, provided it is possible to protect against rain, wind, and rodents. Sun-drying will shorten considerably the time required to open the cones.

Artificial Drying.—Drying the cones as described above requires considerable time. In fact, a large number of cones may only partly open and others will not open at all. It therefore often is necessary to dry them artificially. This can be done by using a stove to heat the drying room and keeping it heated until the cones are practically all open. A temperature of 100 degrees Fahrenheit will not hurt the seed.

The time required to open cones by artificial heating depends upon the species and the temperature, as well as upon the previous air-drying the cones have had. For most species it runs from one to fifteen hours.

Threshing.—After the cones are open they should be thoroughly stirred to shake out the seed, after which they can be threshed on an open floor or in a bag with a

flail. They are then sifted through a screen of large enough mesh to let the seed go through, but retard the bulk of the chaff. A second sifting through a still smaller mesh is often given to break off the seed wings, and finally they are cleaned by running through an ordinary cleaning mill.

In breaking cone-bow taken not to overdo it for fear of injuring the seed by crushing. For this reason and because the seed is difficult to clean afterwards, some authorities do not recommend the heavy flailing of small cones like those of the hemlock, spruce, and white pine.

STORING SEED

To keep seed through the winter for spring sowing care must be taken that it does not become dried out. Leaving seed in bags is not a satisfactory method for most species, unless the bags can be kept in a cool place where the ventilation is good and the moisture in the air fairly constant. Damp, unventilated cellars are not good places, neither are dry furnace rooms.

One of the best methods of storing is to use glass fruit sealers, or earthenware or tin receptacles which have very tight-fitting lids. The seed, however, should not be placed in them immediately after gathering or extracting or while it is damp. A partial drying is necessary to prevent heating and moulding. Heavy seeds like those of the oak, beech, hickory, walnut, butternut, cherry, basswood, and chestnut are best stored by stratifying them in a mixture of moist sand and leaves. Two inches of sand should alternate with a single layer of nuts, and after protecting them from rodents the whole mass may be left to freeze during the winter without injury to the nuts.

The seed of the elm, of silver (or white) maple, and of red maple should not be stored at all. It should be sown as soon as gathered.

8—THE FARM NURSERY

The growing of many of our tree species from seed is little if any more difficult than raising vegetables. The professional nurseryman, it is true, with his better equipment will doubtless secure better results than the amateur, just as an experienced gardener will get better results than a beginner. Using ordinary care, however, there is no reason why the average farmer should not obtain results quite satisfactory for his purpose.

The coniferous trees, as a group, require a little more care and attention than the broad leaved species. They are more tender and demand a certain amount of shading during their first year. They also require a longer time in the nursery than broad leaved species. The difficulties in growing them, however, are not sufficiently great to prevent an amateur from undertaking the work on a small scale.

For those who are not in a position to secure their planting material in any other way or who may for other reasons be sufficiently interested to undertake to grow their own trees from seed, the following brief directions are given for conducting a small nursery.

SOIL AND LOCATION

A well drained, deep, fertile, sandy loam is best suited for growing nursery stock. Any good friable garden soil free from stones will serve.

In locating the nursery beds it is advisable to have them as near the house as possible, so that the work on them may be done in odd minutes. They should be near a well or other source of water, since it may be necessary to water them daily during a hot, dry spell. The beds should also be so placed that they will be protected from

sweeping winds which cause their drying out in summer and the removal of the protecting snow from them in winter.

The site should be level or nearly so. A slight inclination is an advantage in draining, but a steep one will cause a too rapid run-off during a heavy rain and will wash out the seedlings.

SIZE OF THE SEED-BEDS AND PREPARATION OF THE SOIL.

The most convenient size for seed-beds is six or twelve feet long by four feet wide. If wider they are difficult to weed. Any necessary paths between the beds should be at least two feet wide. On heavier soils it is an advantage to have the paths three or four inches below the surface of the beds since it causes a more rapid run-off during very wet weather.

The soil in the beds is prepared in exactly the same way as would be done for a vegetable garden. Well rotted manure should be spaded into it in the fall before it is intended to sow. In the spring the soil is thoroughly worked over and the surface gone over with a rake until it is well pulverized. It is then smoothed off, leaving the bed slightly higher in the centre and ready to sow.

SOWING

The seed may be sown either broadcast or in drills. Both methods have their advantages. On heavy soils where cultivation is desirable the drills are preferable. Drills also make weeding easier, although good seed sown broadcast often produces such a dense growth that much weeding is not necessary. More seedlings can be grown in a bed sown broadcast than if sown in drills. It is usual, however, to sow conifers and small-seeded broad-leaved species broadcast, and the larger-seeded species, like oak, chestnut, maple, ash, and hickory in drills. Drills, for most species, are spaced from four to eight inches apart. Their depth depends upon the size of the seed and the character of the soil. Seed, as a rule, need not be covered deeper than its own thickness. On dry, sandy soil it may be covered somewhat deeper than it need be on heavier, moist soil. The best method of covering seed, either in drills or broadcast, is to sift earth over it to the required depth through a strong screen of about one-quarter inch mesh.

When sowing seed broadcast it should be distributed as evenly as possible over the surface of the bed. This can best be accomplished by sowing a small section of a bed at a time.

The quantity of seed required for sowing broadcast or in drills is dealt with further on when discussing the requirements of the individual species. It is better as a general rule in sowing broadcast to sow too thickly than too thinly. It is not a difficult matter to thin a bed if the crop of seedlings is too dense.

TIME TO SOW

It is the usual practice to sow the seed of most species in the spring. There are certain species, however, whose seed should be sown as soon as gathered and no attempt made to hold the seed for spring sowing. This class includes the elm, soft maple, and white oak.

COVERING BEDS AFTER SOWING

After the beds have been sown and the seed covered with soil they should be rolled or patted lightly, and then watered. During the period of germination the soil should be kept uniformly moist. To prevent too rapid drying out, at this time, it is well to cover the beds with old sacks or burlap, or else to use a mulch of leaves. Straw or hay should not be used for this purpose because of the weed seeds they contain. The burlap or mulch must be removed as soon as the seed begins to sprout, in order that the young plants may receive the necessary light and air.

SHADING SEEDLINGS

Seedling conifers during their first year should not be exposed to the direct sunlight for any considerable length of time. They should receive partial shade as they would in nature, if growing under the protection of the parent or neighbouring trees. This partial shading can be produced by covering the beds with a lath screen, as shown in the accompanying photograph, which can be lifted on and off the beds as required. The space between each two laths is about equal to the width of a lath. On cloudy, moist days these screens are better left off the beds. On dry, bright days during the first summer they should always be in place. To support these lath screens and to prevent the destruction of the seed and seedlings by birds and rodents it is advisable to build a frame of boards about the beds, as shown in the photograph. When this frame is not necessary stakes driven into the ground at the corners of the beds will serve to support the screen at a height of twelve to eighteen inches above

The farm nursery. Three seed-beds, four feet by twelve feet. Note the screens of lath used to shade the seedlings during hot weather. To prevent the destruction of seeds and seedlings by birds, and by rabbits and other rodents it is sometimes necessary to build a frame about the beds as shown above. This frame also serves to support the screens. Photo, 2009

the bed. Screens supported above the beds in this manner permit the sun to strike the young seedlings growing along the south border of the beds. To overcome this branches of conifers or other brush may be placed along the south side.

WEEDING AND WATERING

The seed-beds should be kept free of weeds. Small hand cultivators such as are on sale for gardening purposes will be found suitable for this purpose where the seeds have been sown in drills.

The seedlings should be watered daily during very dry weather. The quantity of water required depends upon the soil and the season. The soil should be moist but not wet. Too much watering produces tender plants and, among coniferous seedlings especially, favours a disease known as "damping off."

COMBATING THE DISEASE CALLED "DAMPING OFF"

"Damping off" is a disease caused by a parasitic fungus which frequently attacks the seedlings before they are quite above the ground. More often it appears a few days after they are up. It is most dangerous during the time of germination and for a period of two or three weeks following, while the stems of the seedlings are still very tender. The trouble appears on the young stem in the form of a watery spot, usually just above the surface of the ground. A day or two later the seedling falls over and wilts.

Damping off is a very difficult disease to control. However, by carefully regulating the watering and shading of the beds, the loss from this disease can be greatly reduced. The screens should be removed at night and in cloudy weather, particularly if the weather is warm and moist. Sprinkling wood ashes or dry sand between the drills is recommended by some nurserymen as a means of checking the disease. The sterilization of the soil with formalin has produced satisfactory results. This, however, must be done several days before the beds are sown. A solution of one part of formalin to 200 parts of water is used and applied at the rate of a gallon and a half per square foot of the seed-beds.

WINTER COVERING

During the first winter it is best to protect coniferous seedlings with a mulch of leaves or straw. The covering should be done in the late autumn, usually after the ground freezes. Brush, old carpets, or canvas, or the shade screens used during the summer can be used to hold the mulch and prevent its being blown away.

Broad-leaved species are not usually protected in the seed-beds. A light mulch covering will, however, reduce the danger of "heaving" by frosts.

TRANSPLANTING

BROAD-LEAVED SPECIES.—The seedlings of most broad-leaved ("hardwood") trees are large enough when one year old to be planted in the permanent site. Many broad-leaved species produce heavy tap-roots which extend deep into the ground and make the removal of the plants difficult if left two years in the seed-beds. If they are not to be planted into their permanent site at the end of the first year it may be advisable to transplant them. The seedlings are termed "transplant beds" and allow them to remain during the second year. In the transplant beds the seedlings are set from six to eight inches apart in the rows, and the rows are placed far enough apart to permit cultivation. In transplanting, those with long tap-roots should have a portion of the tap-root pruned off. This will encourage a more fibrous and branched root-system to form. When the seedlings have been grown in drills sufficiently far apart this root pruning may be done without transplanting. It is done by pushing a spade, held at an angle of 45 degrees into the ground a short distance away from the row of seedlings in such a manner that the ends of the longer roots are cut off. Two men working together on opposite sides of the row get better results than one man working alone.

CONIFERS.—Seedlings of the conifers, ("evergreens"), are rarely set out in their permanent site when they are one year old. They are usually much too small and tender. They are allowed to remain from two to three years in the seed-beds, as a rule, and then, if conditions permit, are set out in their permanent site or into transplant beds for further development. In the transplant beds, they are set from two to four inches apart in the row, with from six to eight inches between rows. This transplanting, as with the broad-leaved species, compacts the root-system and develops a tree capable of withstanding adverse conditions. Conifers are left for one to two years in the transplant beds, during which time they should be kept cultivated and free from weeds.

TIME TO TRANSPLANT AND NECESSARY CARE.—Spring is the best time for planting on seed-beds into transplant beds. Broad-leaved species should never be transplanted after the foliage has begun to develop. Conifers may be transplanted after the new growth has started but it is not advisable to delay this work longer than necessary. Seedlings should be taken up with care. The soil should first be thoroughly loosened by means of a spade or digging fork and the young plants then gently pulled out or shaken free. The seedlings should immediately be placed in pails with their roots immersed in muddy water. At no stage in the operation, particularly with conifers, should the roots be unnecessarily exposed to the sun and wind. It is important that they be kept constantly wet and never become dry even for a second. Unnecessary delay in setting them into transplant beds should also be avoided. If a delay is necessary the seedlings should be heeled in as described under "Planting."

FINAL TAKING UP

In the spring when the young trees in the farm nursery are finally old enough to set out in their permanent site, and the planting is all ready to begin, they should be carefully lifted, after first loosening the earth with a spade, and their roots gently shaken free of earth. They may then be heeled in or packed for transportation, as circumstances may dictate. If the site to be planted is not far distant it may be possible to carry the plants, with roots immersed in muddy water, in pails or a tub (see picture on page 23). If this cannot be conveniently done the plants should be carefully packed in boxes, crates, or baskets in such a manner that they will lie in layers with their tops to the outside and their roots to the centre. To keep the roots moist it is necessary to pack wet sand or moss about the roots from time to time, as the layers are built up.

9—NOTES ON VARIOUS SPECIES

Trees are divided into two general classes to which have been given the following names:—

Hardwood	Evergreen
Decid. (as-leaved (falling in season))	Needle-leaved
Broad-leaved	Conifers (cone-bearers)
Softwood	

Owing to the fact that some so-called "hardwood" trees are softer than some so-called "softwood" trees, and because some trees called "evergreen", as the tamarack or larch, lose their leaves in winter it has been pretty generally agreed by those who write on trees to call these two classes "broad-leaved" and "conifers", or "needle-leaved". In this book the terms used are "broad-leaved trees" and "conifers".

CONIFERS

WHITE CEDAR, OR ARBOR-VITAE (*Thuja occidentalis*)

The white cedar cones are ready for collecting about the first of September, sometimes before that date. They are easily picked on open grown trees and in a good seed year, with the aid of a step-ladder, it is usually not difficult to obtain large quantities.

The seed is sown thickly in drills in the nursery bed and covered lightly about one quarter of an inch deep. It is very light, about 175,000 seeds to the pound, and four or five ounces will be sufficient to sow a bed 12 by 4 ft. in size and to produce 6,000 or 7,000 seedlings.

The cedar, like the tamarack, spruce, and balsam fir, is well suited for planting on wet sites but it will also do well on drier grounds. It requires to be planted in close stands to ensure the development of single, clear trunks.

BALSAM FIR (*Abies balsamea*)

The seed of balsam fir ripens about the first of September. The cones must be gathered early and when slightly green, for they fall to pieces shortly after they are ripe. The seed, which is about the same size as that of white pine, requires to be sown quite thickly in the drills. Three-quarters of a pound of seed will sow a bed of 48 square ft. and, if of good quality, will produce approximately 7,000 seedlings.

The balsam fir is suited for planting on wet sites, but makes its best growth on well drained but moist soils. It may be planted in pure stands or mixed with spruce, hemlock, or tamarack. It is very tolerant and therefore should be planted in close stands about 4 by 4 ft.

HEMLOCK (*Tsuga canadensis*)

The seed of hemlock is usually ripe during the early part of September. It is sown in the nursery beds in the spring and takes approximately twenty-one days to germinate. One pound contains about 400,000 wingless seeds, and eight ounces is sufficient to sow a seed-bed 12 by 4 ft. If the seed is fresh and of good germinating quality, one bed should produce about 7,500 seedlings. One-year-old seedlings are from two to three inches high.

Jack pine transplants set out in sand to prevent drifting

Photo. Special

The hemlock can be planted on almost any soil which is not too dry. It is not a tree to be recommended for forest planting, however. There are other trees such as red pine or white pine which are well suited to the same soil as the hemlock, and will produce a better quality of timber. It is a good shade endurer and producer, and is therefore a valuable tree for underplanting in stands composed of species which do not produce sufficient shade for the protection of the soil under them.

JACK PINE (*Pinus Banksiana*)

The jack pine ripens its seeds in October, but owing to the fact that the cones remain on the tree for a number of years without opening, the collecting can be done at almost any season. However, only fresh, bright cones should be picked, for the older, dark-grey cones are likely to have poor seed and they are also more difficult to open as a rule.

The seed of the jack pine is very difficult to extract but by exposing the cones to a steady fairly high temperature, they can be made to open. At a temperature of 150 degrees Fahrenheit they will open in from three to four hours. It is advisable, however, for fear of injuring the seed, to use a lower temperature for a longer time.

The seed should be sown in seed-beds as described for other conifers. Six ounces is sufficient to sow one bed 4 by 12 ft. and to produce approximately 7,500 seedlings. One bushel will contain approximately 2,500 cones. One pound contains 100,000 or more seeds.

The sowing is best done in the spring. The seed will require two weeks or more to germinate. Shading is not always necessary, but is often advisable to check evaporation. One-year-old seedlings are from two to three inches high.

Jack pine, like the Scotch pine, is well suited for growing on very dry, sandy or gravelly soils. It will grow on dry soils better than will the white pine. It does well in pure stands, but should only be planted where the soils are too dry for the satisfactory development of the other more valuable pines. It is largely planted to hold in check shifting sands, for which purpose it appears to be well suited.

RED PINE—(*Pinus resinosa*)

The cones of the red pine should ordinarily be collected in the early part of September, since they begin to shed their seed toward the end of that month. Like the jack pine cones they frequently require considerable drying before they are completely open. The seed is not abundant in the cones, about one-quarter pound to the bushel, and is therefore expensive to collect. It is, however, very small, about 60,000 to 70,000 to the pound, and will pass through ordinary mosquito netting.

Broadcast sowing with red pine seed requires about five pounds per acre. Seed spots two feet square with spots placed six or eight feet apart are much cheaper. They require only about one pound of seed per acre, sowing 35 or 40 seeds per spot.

Sown in seed-beds six ounces will sow a bed 12 by 4 ft. and will produce approximately 7,500 seedlings. They require about two weeks or more to germinate. When one year old the seedlings are from two to three inches high.

The red pine, like the jack pine and Scotch pine, is suited for planting on very dry, sandy or gravelly sites. It will grow on poorer soil than will the white pine. It may be planted pure or mixed with other pines.

SCOTCH PINE—(*Pinus sylvestris*)

The Scotch pine is not a native of this country, but because of its hardiness and indifference to soil requirements it has been used considerably in this country and the United States for planting on very dry, sandy and gravelly areas. It is a native of Europe and the seed can, therefore, not be collected here except in places where trees have been planted and are now of seed-bearing age.

Seed of the Scotch pine can be purchased through dealers in tree seed, who import it from Europe, or it may be imported direct. It is well, however, in ordering this seed to specify that it be collected in northern Europe as that from southern countries is not so hardy nor will it produce so good a quality of timber.

The seed is sown in the nursery beds in drills at the rate of 25 to 30 seeds per foot, and covered lightly one-quarter of an inch deep. One pound will sow about 2,500 feet of drill and produce approximately 30,000 seedlings if the seed is fresh.

One-year-old seedlings are from two to four inches high and like other conifers require partial shade during their first year. When one year old they may be transplanted into nursery rows and left there one or two years before setting out into the field.

Scotch pine may be planted pure or mixed alternately with such light-demanding trees as the red pine, white pine, jack pine, and tamarack.

WHITE PINE. (*Pinus Strobus*)

The cones of the white pine are usually ready for collecting during the latter part of August or the early part of September, but the exact time depends upon the season.

One bushel contains about 600 or 700 cones and will yield from one-half pound to one pound of clean, wingless seed. The seed is sown in drills in the nursery beds at the rate of one pound to 500 ft. of drill. This is equivalent to 200 square ft. of bed with drills, six inches apart. Approximately 10,000 plants will sprout from one peck of fresh seed. About three weeks are required for it to germinate, but often a considerable proportion of seed will lie over until the next spring and then sprout.

White pine plantation four years after setting out as transplants

One-year-old seedlings are from two to three inches high, and require shading during their first year. They are left two years in the seed-beds and then, if conditions for planting seedlings are favourable, may be set in the field. Otherwise they are taken up and transplanted again into transplanting beds in rows 12 to 18 inches apart, and three inches apart in the row. After one or two years in the transplanting beds they are set out in the permanent plantations.

The white pine for good development requires a fair amount of moisture in the soil and while it grows on light sandy soils it is not so well suited to very dry places as are the red pine or jack pine. It may be planted in pure stands or mixed with other pines, red oak or sugar maple.

The white pine is fairly tolerant and therefore requires close planting, about 5 by 5 ft., to produce a clean stem early in its development.

NORWAY SPRUCE (*Picea excelsa*)

The Norway spruce, like the Scotch pine, is not a native of this country, and the seed cannot be collected here except where trees, now of seed-bearing age, have been planted. It has been used in this country largely for ornamental and wind-break planting, because of its graceful form and its rapid growth. It is much more rapid

in growth than any of our native spruces, and beyond this we do not know that it is much to recommend it in preference to our white spruce or our red spruce. Where the trees have been planted in this country it will be found that the cones mature sometime in September or early October. They should be collected and the seed extracted and stored as described for other conifers.

In sowing, one-half of a pound of seed will be sufficient for about 750 feet of drill, with the seed sown at the rate of 40 to 50 seeds per foot.

One-year-old seedlings are from one to two-and-a-half inches high, and when two years in the bed may be planted in the permanent plantation if they will not have to compete with grass and weeds. Otherwise they should be given a year or two in the transplanting beds before setting out.

The Norway spruce may be grown in pure stands or planted alternately with white pine, red pine, tamarack, birch, ash, or other species which produce little shade.

It grows best on a light, porous, fresh soil and is not suited to very dry sites.

Interior of a white pine plantation twenty-five years old. The trees in the foreground are spaced ten by ten feet. Those behind are five by five feet. Note the ground is clear of grass, weeds, and other undesirable growth due to the complete shade produced by the tops.

WHITE SPRUCE AND RED SPRUCE (*Picea alba* and *Picea rubra*)

The seed of the spruces ripens in the early part of September as a rule, but in some seasons is ready for collecting as early as the middle of August.

Green or undried white spruce cones expand in drying so that one bushel of green cones equals two bushels of dry cones. This quantity yields about one and one-half quarts or nearly two pounds of seed.

The seed may be sown in the spring or fall in the same manner as described for other conifers. Half a pound of spruce seed is sufficient to sow a bed 12 by 4 ft. in size and will produce approximately 7,000 seedlings. One-year spruce seedlings are from 1½ to 2½ in. in height.

They require shading during the first year and may be left two or three years in the seed-beds before being transplanted as seedlings into the permanent plantation or into the transplant beds.

The spruces are suited for planting on a wide variety of soils. They are well adapted for wet sites but do best on moist, well drained soils. They are very tolerant and therefore should be spaced about 4 by 4 ft. to ensure a clean stem.

TAMARACK, ALSO CALLED HACKMATAK OR LARCH (*Larix laricina*)

The seed of the tamarack is produced abundantly only every three or four years. It ripens in August or early September, and should be gathered as soon as possible, as it drops early.

In the nursery beds the seed is sown in drills (so thickly that the individual kernels touch) and covered lightly one-quarter of an inch deep. Like most of the other coniferous species they require to be partially shaded during the first year. One-year-old seedlings are from two to three inches high. It is best to leave them two years in the seed-beds before transplanting. They may be set out in the field or woods when two years old but it is often best to give them one year additional in the transplant bed, and then set them out when they are three years old.

The tamarack is suited for planting in very wet or swampy situations, but it develops very well in any moist site. It may be planted in pure stands or mixed with the spruce or black ash.

BROAD LEAVED TREES

WHITE ASH (*Fraxinus americana*)

The seed of the white ash ripens in October and may be sown in the fall or spring. It is sown in drills so thickly that the kernels will touch each other, and is then covered about one-half inch deep. One pound of seed contains about 10,000 seeds and will sow about 100 feet of drill. One pound of seed will produce from 3,500 to 5,500 seedlings.

One-year seedlings are from six to twelve inches in height. For planting it is best to use one-year-old or two-year-old stock, ranging in height from six inches to two feet.

The white ash develops best in fresh, loamy soil and will not do as well in wet sites as the black ash. It will not do well on pure sand even if the moisture content is suitable.

Because of its poor shade-producing qualities it usually is better to grow it mixed with certain other species than to grow it in pure stands. On well drained sites which are not too dry it can be grown with white pine, red oak, sugar maple, or beech in alternate rows. On soils that tend to be wet it may be mixed with silver maple, cottonwood or white pine. The two former species are able to over-throw the ash and should be mixed sparingly, that is, in the plantation where the trees are spaced 5 by 5 ft. or 6 by 6 ft. every third or fourth row should be silver maple or cottonwood.

Very good results have been obtained by sowing white ash in the woodlot, especially in the seed-spot method. By sowing ten or twelve seeds to a spot a pound or two will sow an acre.

BLACK ASH (*Fraxinus nigra*)

The black ash is better suited for the very wet and swampy sites than is the white ash. On such sites it can be grown mixed with spruce, tamarack, and elm, or, on the spots somewhat better drained, with white pine.

The seed of the black ash is heavier than that of the white ash and there are fewer seeds per pound, about 7,000 as a rule. It is also slower to germinate and requires from one to two years.

The method of growing in the nursery is much the same as described for white ash.

BASSWOOD (*Tilia americana*)

The basswood ripens its seed in September or early October. It may be sown at once or stored in the same manner as described for nuts until spring. The seed is separated from its wing or bract before sowing and is sown in drills one inch deep.

One pound of seed contains about 6,000 seeds and will sow about 200 feet of drill. Some of the seeds may lie dormant for a year. One-year seedlings are from six to twelve inches high.

The basswood is best suited for fresh, loamy situations and can be planted pure or in mixed stands. It may be planted with oak, white elm, sugar maple or hickory. The basswood is one of our best sprouting trees and can be propagated as described in discussing the sprout or coppice method of reproduction. In planting it should be spaced about 4 by 4 ft.

BEECH (*Fagus grandifolia*)

The seed of the beech ripens in October and may be planted in the fall or stored for planting in the spring. It should be planted in seed-spots in the field or woodlots if there is little danger of its being destroyed by squirrels or other rodents. The beech has very long roots and is difficult to transplant if left more than one year in nursery beds. One-year seedlings are from three to six inches in height.

The beech requires about the same soil conditions as the sugar maple, white ash, basswood, and black cherry, so the extensive planting of this tree is hardly justified where the more valuable ones will grow. It should be planted 4 by 4 ft.

THE BIRCHES (*Betula*).

The seed of the birches is very small and light, there being approximately 800,000 seeds to the pound. It occurs in small cones or catkins which ripen about the middle of August. The seed is often ripe while the cone is still green in colour. Ripe seed has a light brown colour. Unless they are exposed to violent winds the catkins will often be found hanging from the tips of the branches late into the fall.

After a little drying the catkins may be broken by rubbing between the hands. This drying is not always necessary for most of the cones become broken in the picking. No attempt need be made to separate the chaff-like cone scales from the seed; it is almost impossible. They are sown together.

The sowing may be done either in the fall or spring, thickly, in drills or broadcast in the nursery beds. If they come up thickly in the drills they can later be thinned out. In the case of fall sowing the beds are covered with a mulch which is removed in the spring.

The young seedlings like those of the conifers are best shaded in the hot weather during their first year. In the fall they may either be taken up and heeled in ready for transplanting in the spring or left in the beds over winter. In the spring they are set out in nursery rows about two or three inches apart, the distance between the rows depending upon whether they are to be cultivated by hand or by horse cultivator. After one year in the nursery row they will be from 18 to 24 inches high and ready for setting out.

Although the birches produce very useful wood the extensive planting of them in the woodlot is not recommended unless it is for the purpose of producing firewood. They make more rapid growth than many of our more valuable broad-leaved trees but are short-lived.

BLACK CHERRY (*Prunus serotina*)

The fruit of the black cherry ripens in August or early in September. When unripe the fruit is green in colour and as it ripens it takes on a reddish tinge, and finally becomes quite black.

The seed may be sown in the fall or spring. It is stored in moist sand as described for nuts. In sowing, the seeds are planted three inches apart in drills and covered one inch deep. One pound of seed contains about 4,000 seeds and will sow about 300 feet of drill. The drills are eight to twelve inches apart for hand cultivating or two to three feet for horse cultivating.

One-year-old seedlings are from eight to twelve inches in height and large enough to set out in the field or woodland.

The black cherry develops best on well drained bottom-land soils, but it is not exacting as to soil and moisture. It is better suited for growing in a mixture than in pure stands, but should be mixed only with species which are not heavy shade producers, such as the white ash or black walnut.

CHESTNUT (*Castanea dentata*)

The chestnuts ripen in October and should be gathered as soon as they begin to drop. The first touch of frost usually opens the bur and the nuts are easily taken out. They may be planted either in the spring or fall. When grown in the nursery they are planted in rows ten or twelve nuts per linear foot and about one inch deep, leaving enough room for cultivating between rows. One bushel of chestnuts contains from 6,500 to 8,000 nuts, will plant 650 feet of nursery row, and produce about 1,000 plants.

The chestnut will develop well on fairly dry, light, sandy soils, but it is at its best on deep, loamy, well drained soils, which are often too dry for sugar maple or beech. It may be planted in pure stands five feet apart each way or it may be mixed with white pine, red pine, or red oak, and on more moist sites with sugar maple, white oak, beech, or white ash.

The chestnut sprouts, or coppices, with remarkable vigour from cut stumps and it can be reproduced in that manner.

This is the chestnut tree that produces the edible nuts, and should not be confused with the horse-chestnut which is not a native but has been widely planted for ornamental purposes. For economic planting, in Canada, the chestnut is practically confined to the Niagara peninsula and the counties adjoining the lakes Erie and St. Clair.

At the present time there is a fungous disease, the chestnut bark blight, attacking and killing the chestnut in large numbers in many of the northeastern United States from Maryland and Pennsylvania to Massachusetts. As yet no practical means of overcoming it has been discovered, and as there is a possibility of the disease spreading into Canada it would not be advisable to set out extensive plantations of this tree.

RED ELM ALSO CALLED SLIPPERY ELM (*Ulmus fulva*)

The seed of the red, or slippery, elm ripens in May or early June. Like that of most elms it retains its vitality only a short time and therefore should be sown soon after gathering.

Sow in drills about 25 or 30 kernels to the linear foot and cover from one-eighth to one-quarter of an inch deep. Thin out to about one inch apart if they come up too thick. One ounce of wingless seed will produce about 2,000 plants.

One-year-old seedlings average from ten to eighteen inches in height and may be set out in pure plantations or mixed with white ash, white pine, white oak, sugar maple, or black cherry.

WHITE ELM (*Ulmus americana*)

Seed of the white elm ripens in May. Care should be taken not to pick it too soon. Only plump and well filled seed should be taken. If milky and not firm the picking should be delayed for a few days.

The sowing should be done as soon as possible. Before sowing, however, the seed should be dried for a day or two and the wings rubbed off between the palms of the hands. The seed should be sown in drills at the rate of about 60 to 80 kernels per linear foot, and covered lightly one-quarter of an inch deep. Leave from twelve to eighteen inches space between drills for cultivating.

One pound of seed will sow about 1,200 feet of drill and produce approximately 25,000 seedlings. With eighteen inches between drills, one pound will sow 1,800 square feet of nursery. If seedlings come up too thickly they may be thinned to one inch apart.

One-year-old seedlings are from five to ten inches high; two-year-old seedlings are about twenty inches high.

The white elm when planted out will do well on heavy clay, fairly wet soil, such as is found in river bottoms or flats.

In planting, one-year-old seedlings are suited for setting out under ordinary conditions. They may be planted in a pure stand or mixed with sugar maple, white oak, red oak, white ash, or basswood. The spacing of 5 by 5 ft. or 6 by 6 ft. will be found satisfactory.

TWO HICKORIES (*Carya*)

Hickory seed ripens in October and may be planted either in the fall or spring. Because of the deep tap roots of hickory seedlings and the difficulty of transplanting them it is often advisable to plant them in their permanent site. In planting in this manner two or three nuts are placed in the same spot.

In the nursery they are planted in rows two or three inches apart and about an inch deep. One pound contains from 60 to 90 nuts. One-year-old seedlings are from three to four inches high.

The shagbark hickory (*Carya ovata*) produces the most valuable wood. It may be planted pure or mixed with white ash, or birch, provided these latter are kept in check and not allowed to overcome the hickory. In planting the spacing is usually about 1 by 1 ft. The shagbark hickory is a good sprouter.

MANITOBA MAPLE, OR BOX ELDER (*Acer Negundo*)

The seed of the Manitoba maple is produced abundantly each year. It ripens in the fall, but since it hangs on the trees well on into the winter it can often be gathered very late in the season. One pound of seed contains about 13,000 individual seeds. One bushel of seed weighs about eleven pounds. It has a germination percentage of from 50 to 60 per cent, and one pound will produce approximately 6,000 plants. Before sowing it is well to flail it in order to break off some of the wings.

It may be sown in the fall or spring. Some seed may be dormant for one year. Sow thickly in drills so that seeds touch one another, and cover one-half to one inch deep. One pound of seed will sow about 400 feet of drill. The drills should be 30 inches apart if a horse cultivator is to be used. Seedlings should be cultivated during the first year. One-year-old seedlings are from twelve to sixteen inches in height, two-year-old seedlings, from 24 to 36 inches. They may be planted out in the permanent plantation when either one or two years old.

The Manitoba maple is very hardy and will grow under a wide variety of conditions. It has a rapid growth but is short lived and is not recommended for forest planting in Eastern Canada, where many more desirable species can be grown. It is very tolerant of shade, however, and is therefore useful in underplanting or mixing with more valuable species which do not grow well in pure stands. It can be mixed with the black walnut, or white ash, but these trees, particularly the walnut, should have several years' start before the Manitoba maple is introduced into the plantation.

SUGAR OR HARD MAPLE (*Acer saccharum*)

The seed of the sugar maple ripens about the first of October and has a low germinating proportion—from 30 to 50 per cent. One pound of seed contains approximately 7,000 seeds and will produce about 2,500 seedlings.

It may be sown in the fall or spring in drills at the rate of about twenty seeds to the foot. One pound of seed will sow approximately 320 feet of drill.

Cypress shoots or sprouts of slashbark for kory
Photo 218

Tamarack plantation, 25 years old showing five feet by five feet
This is a suitable tree for planting on low wet, if drained
partly of the farm or woodland

One-year-old seedlings are from six to twelve inches in height.

Sugar maple will make its best development in well drained, fresh, loamy soil. It may be planted in pure stands or mixed with other species such as white pine, white oak, red oak, elm, white ash, basswood, shagbark hickory, beech, or basswood.

One-year-old seedlings are suitable for forest planting and should be spaced about 4 by 4 feet or 5 by 5 feet if in pure stands. Even if they are intended for a sugar grove it is well to space them at approximately that distance. It is a mistake to plant them too far apart, even though they will require considerable thinning before they have reached tapping size. The sugar maple makes best growth under forest conditions. While it is known that the quantity of sap a tree yields is in direct relation to the size of the crown, sugar-makers claim that forest-grown trees will produce more than those grown in an open, orchard-like grove. This is probably due to the fact that trees under which there is good covering of forest litter and humus are more vigorous as a rule than trees grown so far apart that they are surrounded by sod. It is well to plant the trees close enough to ensure proper ground conditions at the start, and when they are about ten feet high and begin to crowd seriously commence to thin them gradually. These conditions of growth produce long trunks which afford a storage place for the sugar contained in the sap, and the yield of sugar is thus increased.

THE SOFT MAPLES (SILVER OR WHITE MAPLE (*Acer saccharinum*)
(RED OR SCARLET MAPLE (*Acer rubrum*))

The seed of the soft maples ripens early in the summer, about May or June. It should be sown as soon as ripe and not stored for fall or spring planting. It will sprout in a few weeks and the seedlings will make good growth during the first season.

Both of the soft maples thrive on wet places and are suited for planting where the drainage is uncertain. They may be planted with elm, ash, or tamarack. The soft maples have little value except for firewood and are not particularly good trees to plant if a more valuable tree will grow on the place.

WHITE OAK (*Quercus alba*)

The acorns of the white oak ripen in September and October, and germinate soon after they fall. For this reason it is advisable to plant them as soon as they are gathered, and not to attempt storing them. Like all oaks they develop a deep root so that transplanting them is difficult. They can be raised in the nursery but if conditions are favourable it is well to set them out where it is intended they are to remain permanently.

In planting in the nursery they are spaced three inches apart in drills, and covered one and a half inches deep. One pound of acorns will plant about 25 feet of drill. One bushel of acorns contains about 8,000 seeds and will produce about 7,000 seedlings. One-year-old seedlings are from five to nine inches high.

Planting in the field or woods in seed-spots the spots should be about six feet apart each way and four acorns planted in each spot. Like the sugar maple the white oak does best on a fresh, well drained, loamy soil. It may be planted in pure stands about four feet apart each way or mixed with sugar maple, beech, red oak, hickory, white elm, basswood, chestnut, white ash or white pine.

RED OAK (*Quercus rubra*)

The acorns of the red oak ripen in September and may be planted in the spring or fall. The planting should be done as described for the other oaks. The acorns are larger than those of the white oak and run approximately 3,000 to the bushel. One-year-old seedlings are from six to twelve inches high.

The red oak will grow in dry, light, sandy, or gravelly soils, but should not be planted on very dry, shifting sands. It may be planted in pure stands or mixed with white pine, Scotch pine, red pine, chestnut or hickory. Spacing should be about 5 by 5 ft. or 6 by 6 ft., according to the condition of the soil.

POPULARS, COTTONWOODS, AND WILLOWS

Poplars, cottonwoods, and willows may be grown from seed or cuttings, but, as the seed of these trees is very difficult to collect and soon loses its vitality, growing them from cuttings is the more convenient method.

Cuttings are made from well ripened wood, generally of the previous year's growth. They can be made almost any time in the fall after the leaves drop, or in the spring before the growth commences. The best time is probably early in March.

The cuttings should be from ten to twelve inches long and cut from smooth,

Photo. 6500
Results of tree-planting. Two cords of poplar cut from a plantation set out by the Forestry Branch which yielded at the rate of eighteen cords per acre eight years after planting.

healthy branches or shoots, from one-quarter to three-quarters of an inch in diameter. Cut the twig off squarely at both ends with a sharp knife or hatchet, making the upper cut, preferably, just above a bud. Then tie them in bundles of from ten to twenty-five, and completely cover them with moist soil or sand in some cool place where they will not sprout before it is time to plant them. They must never be allowed to dry out. Freezing will not injure them.

As early as possible in the spring they should be set out in well prepared soil in nursery rows. Before planting it is often advisable to soak them a day or two in water. In planting they are set in holes made with a suitable pointed stick, but the hole should not be made much larger than the diameter of the cutting. By making the holes slanting better contact can be secured with the soil. A firm close contact with the soil of the whole portion below ground is very necessary. The planting must be deep and with buds pointing upwards. Completely bury the cutting except for the uppermost bud. Never leave more than an inch or an inch

and a half above ground. The cutting itself is not intended to become the trunk of the tree. A new shoot will spring from the bud and become the upright main stem. Always use a pointed stick or dibble, never push the cutting into the soil without first making a hole. The dibble, here referred to, is a gardening tool of wood or iron, pointed at one end and with a suitable handle at the other. In its absence a sharp-pointed stick will generally be found satisfactory for planting cuttings.

In the nursery rows the cuttings may be spaced from three to four inches apart and the rows should be far enough apart to permit their being cultivated. If 75 per cent of the cuttings sprout the planting may be considered successful. They should be transplanted to the permanent plantation in the following spring.

Proper and improper methods of planting cuttings.

This one is correctly planted because

- 1 Set in ground on slant.
- 2 Soil well firmed and in close contact with the whole length below ground.
- 3 Only one bud above ground.

These three are improperly planted because

- (a) Too upright—soil loose, only in contact with cutting at surface of ground.
- (b) Much too shallow. Soil too loose.
- (c) Cutting at right depth and correct slant but soil not in contact with lower part of cutting which would dry out before roots could form.

On sites where the cuttings will not have to compete with grass and other growth, and the soil is light and in good condition, the cuttings may be set out directly in the plantation or, where desired, without first rooting in the nursery rows. Any failures or blank places may be filled in the following spring. In setting out they may be spaced 6 by 6 ft. or 7 by 7 ft.

BLACK WALNUT (*Juglans nigra*)

The nuts of the black walnut ripen in September or October and may be planted in either the spring or fall. Under favourable conditions they are best planted where they are to remain permanently. The deep tap-root of walnut seedlings makes their transplanting from the nursery difficult. In the nursery they are planted in rows six inches apart in the row, and three feet between rows. There are about 800 husked nuts to a bushel. One-year-old seedlings are from twelve to fourteen inches high.

The black walnut will make good growth on heavy clay soils, but they must be well drained. The foliage is very thin and open, and it is therefore not a suitable tree for growing in pure stands. It should always be mixed with species producing a heavier shade but of slow growth, since the black walnut is of slow growth and very intolerant of shade. If fast-growing species are used in the mixture they should not be introduced until the walnuts have several years' start, and should then be

watched to see that they do not overtop the walnut trees. Red oak, white spruce, or white pine should prove suitable for this mixture. The walnut trees are spaced about 6 by 6 ft. or 7 by 7 ft. and the other trees planted between. For economic planting in Canada this tree is confined to the southwestern part of Ontario.

THE BITTERNUT (*Juglans cinerea*)

The butternut (sometimes called the white walnut) should be propagated in the same manner as the black walnut. The nuts are ripe about the same time. It can be grown throughout the older settled parts of Ontario and Quebec as well as the southern parts of New Brunswick and Nova Scotia, and has therefore a wider range than the black walnut. It is however not a desirable tree to plant extensively. It rarely grows without a number of crooks and croches, and is much given to decay when old. It makes fairly rapid growth when young but is not a long-lived tree.

10—TABLES OF DISTANCES AND QUANTITIES

TABLE 1—NUMBER OF POUNDS OF SEED PER ACRE USED IN BROADCAST SOWING

<i>Species</i>	<i>Quantity</i>
Ash.....	15 to 30 pounds.
Balsam Fir.....	20 to 35 "
Beech.....	50 to 125 "
Birch.....	15 to 25 "
Elm.....	15 to 25 "
Maple.....	20 to 50 "
White Pine.....	6 to 10 "
Red Pine.....	5 to 6 "
Tamarack or Hackmatack.....	6 to 8 "
Spruce.....	6 to 8 "
White Oak.....	10 Bush.
Red Oak.....	8 "
Black Oak.....	8 "

TABLE 2—NUMBER OF PLANTS REQUIRED TO PLANT AN ACRE AT VARIOUS DISTANCES

<i>Planting Distance</i>	<i>Number</i>
1 foot by 1 foot.....	43,560
2 feet by 2 feet.....	10,900
3 " 3 ".....	4,850
4 " 4 ".....	2,725
5 " 5 ".....	1,750
6 " 6 ".....	1,210
7 " 7 ".....	889
8 " 8 ".....	681
9 " 9 ".....	538
10 " 10 ".....	436

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