

Tree-Planting on the Prairies

of Manitoba, Saskatchewan and Alberta

By

Norman M. Ross, B.S.A., B.F.

Forest Nursery Station,
Indian Head, Saskatchewan

Dominion Experimental Farms,
E. S. Archibald, B.A., B.S.A., LL.D., D.Sc., Director

DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE
BULLETIN No. 144—NEW SERIES

Published by direction of the Hon. Robert Weir, Minister of Agriculture,
Ottawa, 1933

630.4
C212

B 144
new ser.

DOMINION EXPERIMENTAL FARMS BRANCH

PERSONNEL

DIRECTOR, E. S. ARCHIBALD, B.A., B.S.A., LL.D., D.Sc.

Dominion Field Husbandman E. S. Hopkins, B.S.A., M.S., Ph.D.
Dominion Chemist
Dominion Horticulturist
Dominion Cerealist L. H. Newman, B.S.A.
Dominion Botanist H. T. Güssow, LL.D.
Dominion Animal Husbandman G. W. Muir, B.S.A.
Dominion Agrostologist L. E. Kirk, B.A., M.S.A., Ph.D.
Dominion Poultry Husbandman F. C. Elford.
Chief, Tobacco Division N. T. Nelson, B.S.A., M.S., Ph.D.
Dominion Apiarist C. B. Gooderham, B.S.A.
Dominion Bacteriologist Grant Lochhead, Ph.D.
Chief, Division of Extension and Publicity F. C. Nunnick, B.S.A.
Chief Supervisor of Illustration Stations..... J. C. Moynan, B.S.A.
Economic Fibre Specialist R. J. Hutchinson.

ALBERTA

Superintendent, Experimental Station, Lacombe, Alta., F. H. Reed, B.S.A.
Superintendent, Experimental Station, Lethbridge, Alta., W. H. Fairfield, M.Sc., LL.D.
Superintendent, Experimental Sub-station, Beaverlodge, Alta., W. D. Albright.
Superintendent, Experimental Sub-station, Fort Vermilion, Alta.

BRITISH COLUMBIA

Superintendent, Experimental Farm, Agassiz, B.C., W. H. Hicks, B.S.A.
Superintendent, Experimental Station, Summerland, B.C., R. C. Palmer, M.S.A.
Superintendent, Experimental Station, Windermere, B.C., R. G. Newton, B.S.A.
Superintendent, Experimental Station, Sidney, B.C., E. M. Straight, B.S.A.

MANITOBA

Superintendent, Experimental Farm, Brandon, Man., M. J. Tinline, B.S.A.
Superintendent, Experimental Station, Morden, Man., W. R. Leslie, B.S.A.

SASKATCHEWAN

Superintendent, Experimental Farm, Indian Head, Sask., W. H. Gibson, B.S.A.
Superintendent, Experimental Station, Rosthern, Sask.
Superintendent, Experimental Station, Scott, Sask., G. D. Matthews, B.S.A.
Superintendent, Experimental Station, Swift Current, Sask., J. G. Taggart, B.S.A.
Superintendent, Forest Nursery Station, Indian Head, Sask., N. M. Ross, B.S.A., B.F.
Superintendent, Forest Nursery Station, Sutherland, Sask., James McLean.

NEW BRUNSWICK

Superintendent, Experimental Station, Fredericton, N.B., C. F. Bailey, B.S.A.

NOVA SCOTIA

Superintendent, Experimental Farm, Nappan, N.S., W. W. Baird, B.S.A.
Superintendent, Experimental Station, Kentville, N.S., W. S. Blair, D.Sc.

PRINCE EDWARD ISLAND

Superintendent, Experimental Station, Charlottetown, P.E.I., J. A. Clark, B.S.A., D.Sc.
Superintendent, Experimental Fox Ranch, Summerside, P.E.I., G. E. Smith, B.A.Sc., D.Sc.

ONTARIO

Central Experimental Farm, Ottawa, Ont.
Superintendent, Experimental Station, Kapuskasing, Ont., S. Ballantyne.
Superintendent, Experimental Station, Harrow, Ont., H. F. Murwin, B.S.A.

QUEBEC

Superintendent, Experimental Station, Cap Rouge, Que.
Superintendent, Experimental Station, Lennoxville, Que., J. A. McClary.
Superintendent, Experimental Station, Ste. Anne de la Pocatière, Que., J. A. Ste. Marie, B.S.A.
Superintendent, Experimental Station, La Ferme, Que.
Superintendent, Experimental Station, Farnham, Que., R. Bordeleau, B.S.A.
Superintendent, Experimental Station, L'Assomption, Que., J. E. Montreuil, B.S.A.

CONTENTS

PART I

	PAGE
Planning, planting, and maintaining shelter-belts—	
Conditions and benefits of tree-planting.....	3
Preparation of the soil.....	6
Selection of species.....	8
Obtaining plant material.....	12
Formation of the plantation.....	13
Planting.....	15
Planning the plantation.....	18

PART II

Description of suitable species—	
Broad-leaved trees—	
Manitoba maple.....	30
Green ash.....	33
White elm.....	35
Cottonwood.....	37
Russian poplars.....	39
Willows.....	41
Paper birch.....	42
Bur oak.....	43
Basswood.....	44
Caragana.....	45
Conifers—	
General notes on nursery treatment.....	48
White spruce.....	53
Jack pine.....	55
Scotch pine.....	56
Lodgepole pine.....	58
Tamarack or American larch.....	58
European larch.....	60
Siberian larch.....	60
Swiss stone pine.....	61
Limber pine.....	61
Low-growing or shrubby evergreens.....	61
Hedges.....	62
List of botanical names of trees mentioned in the text.....	62

ILLUSTRATIONS

An average treeless prairie homestead.....	5
A sheltered prairie homestead.....	5
Six-year-old shelter-belt.....	7
Pile of Russian poplar cordwood.....	9
Prairie-grown fence-posts.....	10
Heeling in seedlings for winter storage.....	13
Ten years of tree-growth; residence at Indian Head Nursery station.....	15
Proper and improper ways of planting cuttings.....	16
White spruce hedge.....	18
Snow damage in a pure cottonwood plantation.....	20
Plantation of Manitoba maple, pruned and thinned.....	22
Plantation of Manitoba maple, unpruned.....	22
Model showing prairie farmstead without trees.....	23
Model showing prairie farmstead planted with trees.....	23
Plan for farmstead, southwest corner of section.....	24
Plan for farmstead, southeast corner of section.....	25
Wind-break of jack pine acting as snow barrier.....	26
Tree belts sheltering a vegetable garden.....	27

	PAGE
Examples of successful prairie farm planting.....	28-29
Manitoba maple in nursery rows.....	30
Manitoba maple as an avenue tree.....	32
Green ash seedlings in nursery rows.....	33
White elm seedlings in nursery rows.....	35
White elm as an avenue tree.....	36
Russian poplar pruned and injured by sun-scald.....	38
Russian poplar unpruned and healthy.....	38
Russian poplar plantation showing bad results of pure planting.....	40
Avenue of Russian poplar killed out.....	40
Birch plantation ten years old.....	42
Caragana hedge seven years old.....	44
Starting a caragana hedge.....	45
Broad-leaved plantation supplemented by evergreens.....	46
Ash and oak: growth attained in natural woods, southern Manitoba.....	47
Lodgepole pine in natural forest, Alberta.....	47
Rolling seed-beds immediately after sowing.....	49
General view of shaded seed-beds.....	49
Seed-bed of Scotch pine during second season.....	49
Scotch pine in nursery rows.....	51
White spruce in transplant rows.....	51
White spruce seedlings.....	52
Scotch pine seedlings.....	52
White spruce plantation in southern Manitoba.....	54
Newly planted Scotch pine plantation, Indian Head.....	56
Same plantation at 20 years of age (side branches removed).....	57
Tamarack and white spruce plantation: first season.....	59
Tamarack plantation, 18 years planted.....	59

TREE-PLANTING ON THE PRAIRIES

PLANNING, PLANTING, AND MAINTAINING SHELTER-BELTS

CONDITIONS AND BENEFITS OF TREE-PLANTING

Natural conditions on the prairies affecting tree growth—Benefits to be derived from tree-planting—Difficulties in raising trees—Economic tree-planting on the farm

Natural Conditions.—The subject of tree-planting on the western prairies is one of general interest to the settlers. Although certain portions of Manitoba, Saskatchewan, and Alberta are naturally timbered, the larger part of the settled area is practically treeless. It is impossible to say what the exact causes are which, operating for centuries, have produced this result but it is generally thought by those who have given some attention to the subject that a large part of what is now prairie was not originally so; in fact, there is direct evidence to show that some districts, at least, that are now treeless were originally well timbered. Undoubtedly the chief agency which, little by little, caused the prairies to encroach on the timbered area was the frequently recurring prairie fire. It is well known to those familiar with the country that, if fires are kept out of a district for a number of years, small bluffs of poplar spring up all around the sloughs and low places which, if not disturbed, gradually extend till eventually a formerly treeless district becomes well timbered. This is very noticeable on the east and south sides of the Moose mountain in Saskatchewan, and may be seen in almost any locality where fires have not run over the prairie for some seasons. From this it would seem that, had fires not been so prevalent in the past, the timbered areas would be much more extensive than they are at present. The fact still remains, however, that there are immense tracts of land absolutely treeless which can be utilized to their fullest advantage only after a certain measure of protection is afforded by the presence of belts or plantations of trees.

Benefits of Plantations.—There are several ways in which plantations of trees benefit the prairie settler, the most important of which are the following:—

1. They afford shelter from the wind to crops, buildings, and stock.

In this connection the following statement made by the late Dr. Wm. Saunders, then Director of Dominion Experimental Farms, at the fourth annual meeting of the Canadian Forestry Association is of some interest:—

“I happened to be passing Indian Head some years ago in the spring after a very violent storm. Mr. Mackay, the superintendent, and I went over the ground and we found the protective influence of the forest growth on the plains there was about fifty feet for every foot in height that the shelter-belt grew; that is to say, a shelter-belt ten feet high protected about 500 feet wide of field. We had a field of barley that was sown alongside of one of the belts and other fields of grain at other points. The protective influence of the belt was very marked. The storm had been a very violent one, and the trees were about fifteen feet high and for 750 feet out the grain was green and well protected and in good condition, while beyond that it began to get thinner and thinner, and for a few feet it was entirely obliterated. There the whole crop was wiped out by the force of the wind blowing the plants out of the ground. We measured this at several points and we found that for each foot of growth there was about fifty feet of protection. I referred to this in our next annual report, but this is a thing that I think should be widely known—the advantage that tree growth is on the northwest plains in affording protection to the ordinary field crops of the country.”

2. They collect and hold the snow during the winter, preventing it from banking up around buildings.

3. They preserve and retain the moisture in the soil by breaking the force of the hot winds in summer, thus retarding evaporation. Further, the snow held by them in the winter, melting in the spring, furnishes a great deal of moisture to the land in the immediate vicinity which otherwise it would not retain.

4. Plantations will supply fuel, fencing material, and wood for repairs. This is a very important point to many settlers who live so far away from any natural supply of timber that it often requires three or even four days to make a round trip for a load of poles. If settlers would only realize that they can grow their own fuel and fencing material, as they undoubtedly can, many more plantations would be set out, as this would mean to them a great saving in time and labour.

5. They are of aesthetic value, beautifying the landscape and making life on the prairie much more pleasant and less monotonous.

6. They add greatly to the money value of the farm. There is not the slightest doubt that a farm which has on it a well managed and productive woodlot of a few acres would, other conditions considered equal, sell for far more than one without trees.

Difficulties.—Undoubtedly there are more difficulties met with in raising trees on the prairies than are to be found in the Eastern provinces. In the first place, the rainfall is very limited; secondly, the trees have to withstand a great deal of exposure to storms and extremes of temperature; thirdly, the prairie soil as we now find it, after years of exposure to the elements, is so compact and hard that it needs to be specially prepared before it is fit for tree growth. None of these conditions is, however, of such a nature as to make the raising of trees an impossibility, and by following out certain methods which are indicated by results already obtained, tree growing on the prairies can be made just as successful as, and, perhaps, even more certain than, wheat raising.

Economic Tree-Planting.—With the exception of setting out trees for shelter and ornament practically nothing has been done in the way of tree-planting on the prairies of Canada for producing wood material. The question of economic tree culture has not yet received sufficient attention to furnish enough absolutely reliable data upon which to base reliable conclusions. There seems to be little doubt, however, that tree-planting would pay in many cases. There are on almost any farm certain portions of land which are not utilized for grain-growing, and which, if pastured, do not really give the returns they should do, such as steep slopes or odd corners cut off from the main cultivated fields, which might well be put to profitable use by planting with trees of some quick-growing species. It is true that for a few years after planting no revenue can be obtained from a plantation, but the initial expense is not very great, and as an investment such planting would pay good interest in the future.

Important Points.—There are four main points which must be observed if success is to be hoped for. It is safe to say that at least ninety per cent of the failures in tree-planting are due to the fact that the importance of one or of all of these features has been overlooked. The four points are these:—

1. The soil must be most thoroughly prepared before planting.

2. Only such species of trees should be used as are known to be hardy in the district and suited to grow in the particular kind of soil and in the situation where it is desired to plant them.

3. A certain amount of cultivation of the soil after planting is absolutely necessary. This cultivation must be carried on until the trees are well established and able to grow without further care.



PLATE 1.—AN AVERAGE TREELESS PRAIRIE HOMESTEAD.

(F.S.C. Photograph 18933)



PLATE 2.—A SHELTERED PRAIRIE HOMESTEAD

This picture shows what can be done on the prairie by the private owner. Thorough cultivation is the secret of this tree growth. Farm home of E. L. Craggs, Yellow Grass, Sask. Trees planted in 1916. (F.S.C. Photograph 18204)

4. Where a plantation has become established and cultivation between the rows is no longer possible owing to the spread of branches it is advisable, and in drier parts of the prairies practically necessary, to keep a strip of soil about 16 to 18 feet wide continually cultivated all around the belt both along the inside and outside edges.

PREPARATION OF THE SOIL

Soil in the forest—New land—Root land—Summer-fallow—Stubble land—Manuring—Spring ploughing

Soil in the Forest.—If the texture of the soil on the open prairie is compared with that of the forest a vast difference is found. In the former case the ground is covered by a tough, compact sod, and the soil beneath this is so hard as to be almost impenetrable for the roots of plants.

In the forest, however, there are found on the surface several inches of loose, decaying vegetable matter, with a subsoil rendered comparatively open and porous, owing to the action of the tree roots. Under such conditions as these there need be no difficulty at all in planting and successfully raising young trees, but unfortunately these are not the conditions which have to be dealt with, as in most places where tree-planting is resorted to, as on the prairies, the soil is more or less compact, and not suited to the growth of deep-rooted plants.

In raising trees, as well as other crops, it is always advisable to follow nature's methods as closely as possible. If this is done one may confidently expect a very fair measure of success to attend his labours. In nature, as above noted, trees require a fairly loose, porous soil, and it is therefore necessary to bring the land which it is desired to plant up with trees into a condition as nearly like this as possible. Under ordinary circumstances, it would be absolutely foolish to plant trees on the freshly broken sod of the prairie and expect them to make a successful development.

New Land.—In most cases trees will be found to do best on land that has been under cultivation for some years previous to planting. But a *very thorough cultivation* of the soil of new land during one season, in an ordinary year, may bring it into a fair state for setting out the young trees. In a very dry year one season may not prove long enough to sufficiently rot the sod, and in such cases it will be more satisfactory to defer planting until the land is in a suitable condition, as upon this practically depends the future success of the plantation.

To prepare sod land for planting it should be broken about two inches deep as soon as the frost leaves the ground in the spring. When the sod is fairly well rotted, it should be backset two or three inches deeper and thoroughly worked up with disk harrows. After the second ploughing the soil should receive frequent cultivation. Later in the fall a third ploughing should be given, working up the ground eight or ten inches deep. In the following spring no further ploughing will be necessary except when the trees are being planted, and then a plough should be used to open up a deep furrow in which the young trees are to be set.

Planting on breaking and backsetting is not recommended. Much better results will be secured by treating the ground as a summer-fallow the year following breaking.

New land has one great advantage over old land in that it is much freer from weeds, and the cultivation after planting will require less labour. *This does not mean that because no weeds grow cultivation is unnecessary.* In the Prairie Provinces the supply of moisture is extremely limited, and what little there is must be preserved in the ground as long as possible. This can be done only by keeping the surface of the soil in a loose, friable condition, as then evaporation of soil moisture is at a minimum. As soon as the surface becomes hard and baked, evaporation is very rapid, and the effect of allowing the soil to remain in this condition will be evident in a very short time.

Root or Garden Land.—Where such soil contains plenty of moisture and is clean, trees may be planted with a fair degree of success. The average farm garden and potato plot, however, is as a rule very well stocked with weed seeds, and generally it would be advisable to clean the plot thoroughly by summer-fallowing before planting.

Stubble Land.—Planting trees on stubble land is not recommended for two reasons: first, the grain crop takes a considerable amount of moisture out of the soil instead of conserving it; and second, when the stubble is ploughed under, the soil is left so open that, when the season is hot and windy, it rapidly dries out around the roots of the young trees soon after planting. This does not apply in cases where irrigating can be done.

Manuring in most cases is not at all necessary, and if practised at all should be done at least a year previous to planting. The soil on the prairie is, as a rule, extremely rich. What the trees desire most is a good supply of moisture; thorough cultivation is the only way to maintain this. On very heavy gumbo or clay soil, such as is found in the Regina district, manuring may be advantageous in improving the mechanical texture of the soil by making it more porous and increasing its capacity for holding water, but even on these soils it is not advisable to apply the manure at the time of planting.



PLATE 3.—A SIX-YEAR-OLD SHELTER BELT

View of shelter-belt of broad-leaved trees planted on the farm of D. Lawson, Hussar, Alberta, in 1916. The illustration shows growth in six years. (F.S.C. Photograph 14713).

Cases are not at all uncommon where trees die out owing to the fact of the soil being too rich, and a great mistake is usually made in manuring around trees, as they do not require a particularly good soil. At Indian Head on the Nursery Station there have been certain spots where it has seemed impossible to grow tree seedlings. The ground was originally used as a corral for cattle and horses, and after ploughing, the manure turned under made the ground too rich, and it is not likely that trees can be successfully grown on these spots until the excess gets worked out.

Spring Ploughing.—In cases where there are no irrigation facilities spring ploughing is not recommended, as a general rule, for the reason that in a dry spring any deep working of the soil tends to dry it out. Another thing to be taken into account is that spring is the busiest season of the year on a farm and it is a great advantage if any preparation can be accomplished at some other time when work is not so pressing.

SUMMER-FALLOW AS PREPARATION REQUIRED BY THE FOREST SERVICE

Properly worked deep summer-fallow is the only preparation that can be absolutely relied upon to give uniformly good results in all seasons on the prairies. In seasons of extreme drought trees planted on stubble, root land, or backsetting are often complete failures. In order, therefore, to ensure as far as possible the success of the trees sent out by the Department of Agriculture, trees will be granted for planting only on land prepared by summer-fallowing unless in very exceptional cases of specially well cultivated garden land or backsetting. Under no conditions will trees be given to plant on spring- or fall-ploughed stubble.

SELECTION OF SPECIES

Selection to be governed by the natural habits of the trees—List of trees adapted to various soils—Slow and rapid growers—Long-lived and short-lived trees—Light-demanding and shade-bearing trees—Mixed plantings—Main points to be considered.

After it has been decided where the plantation is to be located it will be necessary to select such trees as from their natural habits of growth are best suited to thrive in that particular spot. There are several species of trees suitable for prairie planting, but they are not all adapted to live and grow under similar conditions. Some grow best on heavy land, others on light soil; some require a large amount of moisture, and others, again, would soon die if planted on land which is continually wet and swampy. It is impossible to lay down any hard and fast rules as to what species are best suited to the different kinds of soil, as so many other questions have a bearing on this subject. The exposure (that is, whether the ground is level or slopes to north or south), the rainfall (which varies in different parts of the West), the difference in range of temperature, the difference in altitude, and many other questions must be taken into consideration. From this it will be seen that the kind of soil alone does not determine the species of trees to be planted, so that the following table can serve only as a general guide: —

TABLE OF TREES SUITED FOR PLANTING ON CERTAIN SOILS

Heavy clay	Moist, sandy loam	Dry, sandy loam	Sand or gravel	Low, wet land
Manitoba Maple	Manitoba Maple	Manitoba Maple	Russian Poplar	Ash
*Silver Maple	*Silver Maple	Poplars	White Spruce	Elm
*Bur Oak	Green Ash	Scotch Pine	Scotch Pine	Cottonwood
*Basswood	*Basswood	Jack Pine	Jack Pine	Black or Balsam
Green Ash	Elm	White Spruce	Caragana	Poplar
Elm	Cottonwood	Caragana		Tamarack or Larch
Cottonwood	Poplars	Colorado Spruce		Black Spruce
Poplars	Willow			Willow
Willow	Birch			
Tamarack or Larch	Tamarack or Larch			
Scotch Pine	Scotch Pine			
White Spruce	Jack Pine			
Caragana	White Spruce			
Colorado Spruce	Caragana			
	Colorado Spruce			

Trees marked thus * are suitable for planting only in portions of southeastern Manitoba.

In planning a plantation the natural habits of growth of the species to be used must also be considered. If a mistake is made in selecting the species and in mixing them in the plantations, it will not be realized before several years, at least, when it will very probably be impossible to alter the plantation in order to make it as productive as it should be, without a great expenditure of labour, to say nothing of the loss of time.

As a general rule the prairie settler requires first a shelter-belt or wind-break around his buildings. The establishment of a plantation to produce fuel and fencing material is either of secondary consideration or is not given a moment's thought, the popular idea being that it takes trees too long to grow, and that it is not much use doing work the benefits of which will be reaped by some one else. This, however, is a mistake, as has been clearly shown by actual plantations set out on the western experimental farms, on the Dominion Forest Service Nursery Station at Indian Head, and by private individuals scattered throughout the West, especially in the Mennonite settlement in the southern part of Manitoba. In this district, which was settled about 1883, there were absolutely no trees growing at that time. Numerous plantations, principally of cottonwood and Manitoba maple, were set out, and now most of the people in this settlement can secure all the fuel they use without going off their own farms.

Many of the species which can be used on the prairies are very rapid growers, for example, cottonwood, willow, Russian poplar, and Manitoba maple. It is safe to say that wood large enough for fuel can be grown from any of these trees within six years. After that time a plantation will increase in value and productiveness year by year and will prove one of the best investments on the farm.



PLATE 4.—PILE OF RUSSIAN POPLAR CORDWOOD.

The two cords of wood in the illustration were produced from a plantation of eight seasons' growth. Indian Head Forest Nursery Station. (F.S.C. Photograph 6500).

On the Nursery Station at Indian Head a plot three-quarters of an acre in extent was planted out to Russian poplar in 1906, trees spaced four feet apart each way. In 1913 the average height of these trees was twenty-three feet. In the fall of 1913 half the plot was cut down and yielded six and three-quarter cords of fuel of fairly good quality. This is at the rate of about eighteen cords per acre in eight years. The soil was a medium clay loam. The labour cost of planting was \$5.86 per acre and cultivation for two years about \$6 per year.

On the Indian Head Nursery Station fairly extensive plantations of all the hardy varieties of trees were set out soon after the nursery was established, for the express purpose of finding out definitely just what fuel and other wood material could be produced in cultivated tree-belts. The trees in all these test plantations were spaced 4 by 4 feet, in some cases even closer. They were cultivated for three or four years, or until such time as the plantation was well established and a heavy enough growth to choke out all grass and weeds had been formed. Most of these plantations, which in the aggregate cover some 75 acres, have made very encouraging progress, and clearly demonstrate that fuel, fencing material, and useful wood for other farm purposes can be practically grown under average prairie conditions in a reasonable space of time.



PLATE 6.—PRAIRIE-GROWN FENCE-POSTS

These fence-posts of willow, birch, maple, pine, and other species were cut from trees planted about 19 years. Indian Head Forest Nursery Station. (F.S.C. Photograph 18553).

A plantation of alternate Scotch pine and white spruce, planted in 1906, with trees spaced 4 feet by $3\frac{1}{2}$ feet, was thinned during the winter of 1925-26, after 20 years' growth. In this thinning only suppressed or dead trees and those with injured tops or of bad shape were cut out. This plantation covered three-quarters of an acre. The thinnings produced $4\frac{1}{4}$ cords of good fuel and left the remaining trees standing at an average spacing of 5 feet 6 inches apart. Several other plantations have been thinned in the same way, producing fuel and fencing in about the same quantities. Good fence-posts averaging from 3 to 5 inches at the top and 7 feet in length have been cut out of these plantations, of such species as maple, birch, cottonwood, Russian poplar, willow, Scotch pine, tamarack, and European larch; the average age of the plantations was from 17 to 20 years. Maple, ash, and elm in the same time will provide material suitable for double-trees, single-trees, and implement poles which can be used in an emergency.

In setting out a shelter-belt, species which will produce the most rapid growth are naturally the ones which will be chosen. There is, however, a point which must not be lost sight of in this connection and that is that the most rapid growers, namely, the cottonwood, Russian poplar, and willow, are comparatively short-lived trees, so that in setting out a wind-break it would not be altogether wise to plant only these species; a fair proportion should consist of elm, ash, or maple, which, though they do not grow quite so fast, have a much longer life and would eventually remain as the wind-break after the faster-growing kinds had been cut out.

In setting out a plantation to supply fuel and fence-posts, what is looked for is an early return and a continuous supply. In order to obtain this, rapid-growing trees may be planted with slower-growing kinds. In nearly all cases mixed plantations are preferable to those containing only one species. With some varieties of trees it would be very bad policy to set them out in a pure stand, as, for instance, the green ash, birch, or poplars. These trees all have comparatively thin crowns, allowing a great deal of light to penetrate to the ground beneath them, which encourages the growth of grass and weeds, and permits a great deal of evaporation of moisture from the soil, allowing the surface to become hard and compact. Such are not the conditions under which trees thrive best, as the ground should always be kept well shaded and porous.

Light-demanding and Shade-bearing Trees.—Trees are divided into two classes by foresters according to the amount of light required by them in order to make healthy growth. These are known as light-demanders and shade-bearers. In early youth all trees are more or less shade-enduring, that is, they will grow under the shade of other trees; many species require a certain amount of shade when seedlings, but cannot live under the same conditions after they are a few years older. There can be no hard and fast line drawn between these two classes, as the one merges very gradually into the other. In the group of trees generally classed as shade-bearers, some are more shade-enduring than others, and the same is the case with the light-demanders, some requiring more light than others. The white spruce and black spruce are instances of very heavy shade-bearing trees, that is, they will continue to grow under very dense shade. The birch and poplars are samples of light-demanders. The Manitoba maple, elm and ash will bear a fair degree of shade, but require plenty of light for their best development. As a rule, light-demanding trees should never be set out in pure plantation, for reasons already given, unless it is intended that after a few years the trees should be underplanted with some other variety capable of maintaining a suitable soil-cover. Shade-enduring varieties may be safely planted without mixture so far as keeping the soil in good condition is concerned. There are other considerations, however, which might make it advisable always to set trees in mixture in preference to pure plantations. A mixed plantation suffers less from insects and fungous attacks, because as a rule each particular insect and fungus has a preference for a certain kind of plant or tree, and unless extraordinary conditions exist does not attack other species. A mixed plantation of rapid and slow growers or light-demanding and shade-bearing trees will, in most cases, give far more satisfactory results than one made up of only a single species.

The main questions, then, to be considered before planting are these:—

1. What trees are hardy in the district?
2. Of these, which are adapted to the particular locality?
3. What species are most suitable for the purpose for which they are to be planted, namely, wind-break, snow-trap, fencing or fuel?
4. Will these if planted alone form a suitable ground-cover?

After it has been decided which species are to be planted, the next thing is to procure the seedlings. These may be obtained from the natural woods or from a commercial nursery, or they may be grown by the planter himself.

Trees for planting farm wind-breaks can be secured from the Department of Agriculture. Applications for circulars and forms should be addressed to the Forest Nursery Station, Indian Head, Saskatchewan.

OBTAINING PLANT MATERIAL

Naturally grown seedlings—Seedlings from commercial nurseries—The farm nursery

Collecting Seedlings from the Woods.—If the area to be planted is small and a natural supply of seedlings can be found in the immediate vicinity, it may be the most economical method to obtain the young plants in this way. In the sand-hills where spruce and jack pine grow, and in tamarack swamps, comparatively large numbers of even-sized plants can often be obtained, but with such trees as Manitoba maple, green ash, and elm, the seedlings are usually difficult to find in large numbers, and are not as a rule of very uniform size and shape. In taking plants from the woods, those growing only in the most exposed situations should be dug, and most success will be obtained in using small seedlings from one to two feet high rather than larger trees. Seedlings taken from the protection and shade of the parent trees, and at once set out in exposed situations are almost sure to die, as they are not hardy enough to stand the fierce winds or the glare of the hot sun to which they are likely to be subjected in their new position.

Nursery Plants.—When nursery stock can be secured at reasonable rates it may be more economical to buy seedlings than to spend much time hunting them in the woods. Nursery-raised plants will probably prove more satisfactory than those grown naturally, as they are raised under conditions more similar to those they will experience when planted out; they usually have a much better developed and more compact root-system and large numbers of a uniform size and shape can be secured.

The Farm Nursery.—Where seeds of native trees can be obtained the cheapest method of getting seedlings is for the planter to grow them himself. Most of the hardy species are very easily raised from seed, the labour and expense in this connection on a farm amounting to very little.

Seed should always be procured, if possible, from mature trees growing under climatic and other conditions similar to those which the seedlings will be expected to endure. The Manitoba maple has a very wide range, and seed might be procured almost anywhere in North America. It would be found, however, that that picked in the Southern States or even in Eastern Canada would not produce seedlings hardy in the Prairie Provinces. The growing season is much longer in the East than in the West, and it has been found that seedlings from eastern seed do not ripen up or mature early enough to escape the fall frost on the prairies, and are consequently cut back. The greater the difference there is between conditions of growth affecting the parent trees and those experienced by the seedlings, the greater the difficulties the latter have to contend with. This shows that many characteristics are acquired by the seed from the parent trees, so that it would always be wise to get seed from the best individuals and to avoid, where possible, taking it from dwarf or stunted trees. Seed from young trees does not generally have so good a germinating percentage as that borne by mature ones.

The amount of land a farmer would require for his nursery is very small; in fact, one-quarter of an acre or less would be more than sufficient in the ordinary case. Any land that is in a suitable condition for growing garden crops and is at the same time moderately protected from the high winds would do for this purpose. The best soil for the nursery is rich, sandy loam. It should be located near the house so that the work may be done in odd moments. It is not necessary here to go into the details of nursery work, as in the second part of this bulletin the best method of raising seedlings and cuttings is fully described for each species.

The only time to plant trees in the West is in the spring. In exceptionally wet autumns trees have been planted and have come through the following winter without dying, but fall planting cannot be generally relied upon. The seedlings for spring planting can be dug either in the fall or the spring. If a large plantation is to be set out, it is advisable to take trees up in the fall, count them and then heel them in on some well drained piece of ground near the site of the proposed plantation, so that they will be ready for immediate planting in the spring. Heeling in for the winter merely means digging a shallow trench, throwing all the earth to one side, so that there is a gradual

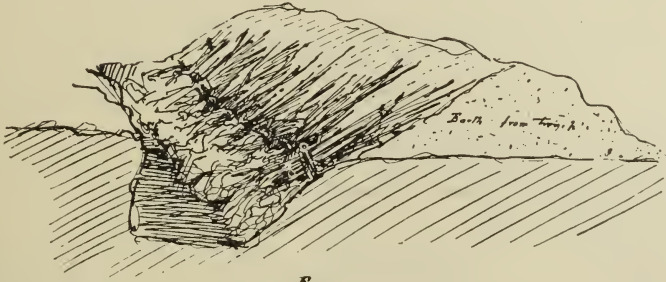


Fig. 1

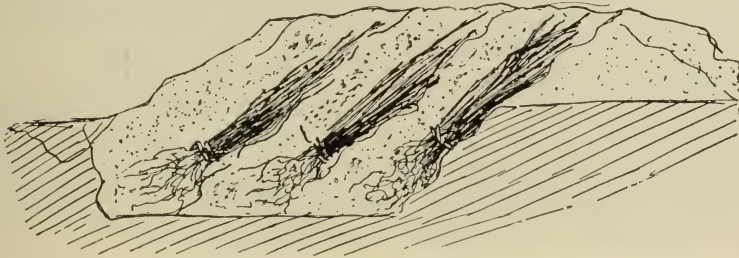


Fig. 2.

Figures 1 and 2.—Heeling in seedlings for winter storage (seedlings tied in bundles of about 25)

slope from the bottom of the trench to the top of the earth thrown up. The seedlings are then placed close together with their roots in the trench and the stems lying on the sloping earth. (See Fig. 1.) After the trench is filled with seedlings, soil is put on them, and is well worked in among the roots, the tops being slightly covered. After the first layer is covered, a trench should be left similar to the one first made. This is filled with seedlings, which are in turn covered with earth, and the work continued in this manner till all the plants are heeled in. (See Fig. 2.)

FORMATION OF THE PLANTATION

Spacing—Composition of the Shelter Belt—Number of rows—Pruning—Use of Evergreens

Spacing.—The question of spacing has always led to considerable controversy. Those who advocate wide spacing make the seemingly logical claim that there is not sufficient moisture under prairie conditions to support a close planting of trees. It must be remembered, however, that even if the trees are spaced eight to ten feet apart as soon as the crowns meet and develop a complete ground cover there will be just as large a leaf development on any given area as where the trees are set close together and consequently there will be practically the same amount of moisture required in both cases.

Wide spacing means keeping up cultivation between the trees for many years and if for any reason this cultivation is neglected, the ground quickly grows up to grass and weeds and the shelter belt will soon deteriorate. Generally speaking a 4 feet by 4 feet spacing has given excellent results and at such spacing cultivation between the rows need be carried on only for about three and at most four years. If the outside edges of the belts are then kept cultivated, there is little danger of grass working in among the rows.

It is of course desirable to produce a shelter which can be developed as quickly as possible and with the least expenditure of labour. One must always recognize the fact that where small plants are originally widely spaced it will be a number of years before the branches grow closely enough together to make an effective windbreak, whereas with close spacing a reasonably good shelter may be secured in three or four years. Where wider spacing is thought advisable it would be best to compromise by planting close in the rows and spacing the rows further apart, say six to eight feet.

In the drier areas it is not advisable to plant more than four or five rows at four feet apart and under no condition should belts of more than 12 to 15 feet wide be set out unless a snow break is planted at the same time about twenty to twenty-five yards further back. This will be referred to again later on.

Mixing the Species.—A mixture of different kinds of trees in a plantation will give better results than if only one kind is used. A good arrangement for a four row belt of broad leaf varieties would be:—

Outside Row—Caragana.

Second Row—Maple—Poplar—Maple—Elm—Maple—Poplar, etc.

Third Row—Ash—Maple—Ash—Maple—Ash, etc.

Fourth row—Ash—Elm—Ash—Elm, etc.

Or the Fourth or inside row could be all Ash.

In this arrangement, after from six to eight years, many of the poplar and perhaps also some of the maples would be large enough for fuel, and could then be cut out, care being taken not to cut so heavily as to expose the soil too much. The elm and ash should be helped as much as possible, since they are more valuable than the others, by cutting out the maple or poplar if these species interfere with the growth by excluding too much light. The poplar and maple, after being cut, would sprout again from the roots so that a good undergrowth of stool shoots could be maintained where the ground was not sufficiently shaded by the elm and ash. After the elm and ash reached a suitable size they could also be gradually cut and would grow up naturally again from the stump. In this way a plantation well established and carefully managed would produce a continual supply of wood without any subsequent expense for planting. A good mixture for conifers (evergreens) would be—planting four feet apart—spruce in every alternate row, the remaining rows to be made up of Scotch pine, jack pine, or tamarack. It can be easily seen that a plantation may be made up of many species mixed in various proportions and in many combinations. The rates of growth of the different trees should, however, be taken into account, also their requirements as regards light, and the mixture be arranged accordingly. There are several native species of shrubs which will no doubt prove very valuable for under-planting or mixing in a plantation to obtain a good soil-cover. The native hazel, saskatoon, choke cherry, and dogwood are found to serve this purpose in all our natural timber-belts, and will probably be equally good in artificial plantations. Economic tree-planting on the plains, however, is not yet well understood, and there is still a great deal to be done in the way of discovering the best mixtures to be set out in order to obtain the largest yield.

Evergreens in the Shelter-belt.—The hardy coniferous evergreens such as spruce and pine are the ideal varieties for prairie wind-breaks. It is not advisable, however, to mix these among the broad-leaved kinds. In order to get the best results these species should be planted in one or two rows on the inside or outside of the main shelter-belt and not nearer than 10 or 12 feet to the broad-leaved species.



PLATE 7.—TEN YEARS OF TREE GROWTH: RESIDENCE AT INDIAN HEAD FOREST NURSERY STATION. This picture was taken in 1914; in 1904 the land was unbroken prairie. (F.S.C. Photograph 7012)).

PLANTING

Care of plant material—Planting seedlings—Planting cuttings—Cultivation after planting—Mulching

Before planting commences, when the seedlings arrive from the nursery they should be lightly heeled in, that is, the roots should be covered with moist earth, and if possible they should be shaded from the sun by covering the tops with bags or anything that will check evaporation. Planting should be done as early in the spring as possible in order to take advantage of the moisture left in the soil after the melting of the snow.

Planting of Seedlings.—The quickest and best way to plant young seedlings in large numbers is to plough out a furrow as deeply as possible, hold the seedling by the top, with the end of the root resting on the bottom of the furrow, and then draw in the soil from each side with the feet, tramping it solidly around the roots.

If the furrow is not deep enough, carry a dibble or sharpened stick to make a hole in the bottom, in which the end of the root should be placed.

Seedlings of cottonwood, ash, elm, and maple are almost sure to die if not planted at least as deep as they originally stood in the nursery. It is best to set them about one inch deeper, as the soil will probably settle in the course of a few days after planting.

The furrow should not be ploughed out far ahead of the planters, as the soil dries out very rapidly.

After the trees are all set the furrow should be filled in at once with the plough; if, however, the horses cannot be kept from tramping the young seedlings, a shovel or hoe should be used.

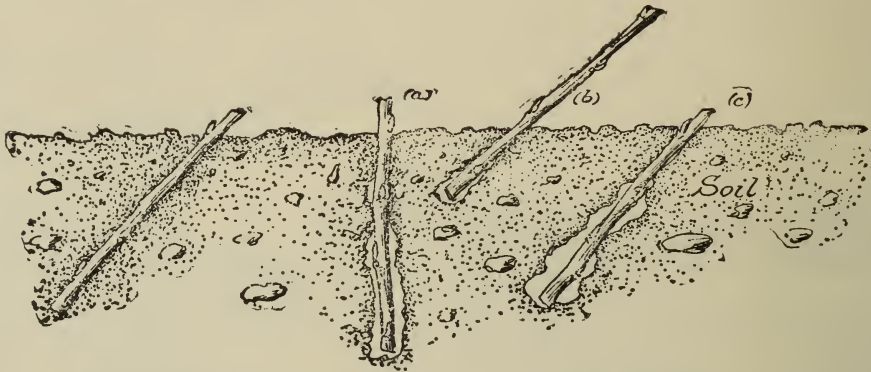
The soil should not be hilled up around the stems of the trees.

While planting is being carried on, the seedlings and cuttings should be carried in pails half filled with muddy water.

Care should be taken to prevent the roots from drying out. The seedlings should never be left exposed to the sun or wind.

Seedlings with a single tap-root may very easily be planted with a dibble.

The best time to plant is on a dull cloudy day, or in the evening, after the sun commences to get low.



Correctly Planted

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.

Improperly Planted

- (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

FIGURE 3.—PROPER AND IMPROPER WAYS OF PLANTING CUTTINGS.

Points to be carefully observed:—

1. Never allow the roots to become dry.
2. Plant seedlings of broad-leaved trees one or two inches deeper than they originally stood in the nursery.
3. Pack the soil firmly around the roots. If a tree is properly planted it should be difficult to pull it out with the hands.

Planting Cuttings.—Cuttings are small twigs taken from the new growth of the previous season, made into lengths of about ten inches, the average diameter being half an inch. The trees usually grown from cuttings are cottonwood, Russian poplar, and the various kinds of willows.

They should be planted as soon as possible after they are made, as they commence sprouting if they are heeled in for any length of time. These sprouts are very delicate and are sure to be knocked off during planting operations.

The following points must be carefully attended to:—

1. Cuttings must never be allowed to dry out.
2. It is advisable to soak them in water for one or two days, but no longer, immediately before planting.
3. The soil for planting must be mellow and contain plenty of moisture.
4. Most failures result from too shallow planting. Never allow more than an inch or an inch and a half to project above ground.
5. Cuttings should be planted on a slant.

6. The cutting must be set with buds pointing upward.

7. The soil *must be well firmed* and in close contact with *the whole of the portion below ground*. Very frequently when the hole is made with too large a stick or dibble, the soil when tramped, closes around the neck of the cutting, but the lower part is left in a kind of pocket. As a consequence the cutting dries out and fails to root.

8. In fairly loose soil a hole may be made with a dibble or suitable stick, but the hole must not be much larger than the diameter of the cutting. Perhaps the best results will follow the use of a spade. The spade is thrust into the ground in a slanting direction, the handle lifted and the cutting put in under the spade, which is then drawn out, the soil being thus allowed to fall back into place. *The soil must then be firmly tramped.*

9. Never push the cutting into the soil without first making a hole.

10. Plant deeply and always make the soil firm around the cutting.

Caution.—Do not push the cutting into the ground without first making a hole with the dibble, as in doing so the bark is liable to be separated from the wood at the end of the cutting, and it will then most likely fail to root.

Cultivation after Planting.—As before stated, after the trees are all set out constant cultivation is absolutely necessary until the tops of the trees grow together sufficiently to choke out all growth of weeds and grass. The rainfall in the prairie districts is so small that every means must be employed to preserve what little soil-moisture there is. Surface cultivation is the best method of accomplishing this, as it keeps a loose covering of soil, which acts as a mulch, retaining the moisture in this way. The single-horse scuffer or cultivator is the best implement for this purpose. The hoe is of little use by itself, except to cut off the larger weeds and for working close around the roots of the trees, as it does not stir the soil sufficiently unless a great deal of time is spent on the work.

The number of times it will be necessary to go through a plantation depends a good deal on the season. After a heavy rain, when the ground is dry enough, the cultivator should be always run through in order to prevent the formation of a crust. After the third season cultivation should no longer be necessary. *In any case, cultivation should always cease before the end of August in each year* so that the trees will not be encouraged to grow too late in the fall, as the early frosts would then be liable to cut back a large portion of the new wood.

Mulching.—It is often recommended that as a substitute for cultivation a mulch of straw or manure be spread amongst the trees, the idea being to choke out grass and weeds and conserve moisture. It is claimed that this practice will save a great deal of labour in hoeing and cultivating. Careful observations of many plantations which have been wholly or in part mulched indicate that under average prairie conditions, where land has been properly prepared before planting and the trees well cultivated for three or four years, such cultivated plantations are better than those that have been mulched. It has not been found that there is any saving in labour by mulching. In fact to properly spread a mulch in a large belt of trees is a very tedious process, while half an acre can easily be cultivated with a scuffer in two or three hours.

There are several objections to mulching:—

(1) It makes the belts look unsightly and untidy;

(2) The mulch is very inflammable and several cases have been reported where trees that were mulched were destroyed by fire;

(3) Many cases have been reported of serious injury by mice girdling the trees underneath the mulch;

(4) In dry seasons a mulch tends to prevent any precipitation other than very heavy rains from reaching the soil;

(5) Certain weeds, such as Canada thistle, seem to thrive on a mulch; in fact it has been found that after the second season mulched plantations get very weedy and cannot be readily cleaned up.

As previously stated, where a plantation is properly handled it will do much better without mulching and at a less expenditure of labour. Under no conditions should a mulch be applied during the first three or four years after planting.



PLATE 8.—WHITE SPRUCE HEDGE.

The hedge is about six feet high and is kept trimmed. Indian Head Forest Nursery Station. (F.S.C. Photograph 12485).

In certain exceptional cases mulching may prove beneficial:—

(1) In cases where the soil is very light and subject to drifting, sometimes the roots of trees are blown bare. A mulch here will serve to prevent the soil being blown away.

(2) Where older plantations, owing to neglect, have become overrun with grass and weeds a heavy mulch properly applied may be the only means of saving the trees.

PLANNING THE PLANTATION

Guiding principles—Convenience—Prevailing winds—Space around buildings—Snow-traps—Ornamental planting—The woodlot—Pruning—Thinning—Suggested plans—Cost of establishing shelter-belts—Rates of growth.

It is presumed that all those who apply to the Department of Agriculture for assistance in tree-planting desire to establish a shelter-belt or plantation that will give the best results in the shortest time and at the least expense.

The following remarks are intended to lend suggestions to such prospective tree-planters, and not to advocate any rigid set of rules or propose a universal plan. Every individual has his own ideas regarding the arrangement of his home and he can construct his plan to comply with these ideas as long as the existing conditions, amount of ground available, etc., will permit. However, there are certain factors to be kept in mind when establishing wind-breaks on the prairies, and it is these factors which will be dealt with in order that those

who are not familiar with conditions on the prairies may have the benefit of years of experience of the department and the older-tree-planters throughout the three Prairie Provinces.

To obtain the best results it is essential that there be a definite plan in mind before any actual work is begun in the way of tree planting. The majority of farmers on the prairies have the intention of planting trees at some time or other, but very few stop to consider what would be the best location and arrangement for the proposed plantation. Too often this lack of any definite plan of planting results in inconvenient and unsatisfactory home surroundings. Where there is an initial plan drawn up, a portion of it may be completed each year, or as often as conditions will permit. It is known just where each belt will ultimately be established and the ground can be broken a season or two before planting and put into the best condition possible. It may take a number of years to complete the plan, the length of time depending upon the extent of the plantation and the time and planting material available each planting season.

The department cannot promise to furnish sufficient planting material to carry out any plan, but will lend all possible assistance in the way of making suggestions and will supply as many trees as are available for distribution.

Caution.—A great number of farmers do not consider the amount of labour necessary to properly care for a thousand or more trees under prairie conditions, and very often plant a larger number than they have time to properly attend to. If the trees are planted and then cultivation is neglected, there is a loss of both time and money. A few hundred trees well planted and thoroughly cultivated for the first three or four seasons will produce a better shelter than several thousand trees poorly planted and neglected.

A common mistake made on the prairie is the planting of trees on land which is insufficiently cultivated. Perhaps a piece of ground has been broken for a fireguard, then at a later date it is decided to plant trees. Frequently this old fireguard is chosen for the plantation without any thought as to the condition of the soil or the effect the plantation will have if located on that site.

GUIDING PRINCIPLES IN FORMULATING A PLAN

1. Make convenience the first consideration in arranging the farm buildings and grounds.
2. Establish the shelter-belt to protect the home and stock against the prevailing winds.
3. Allow sufficient room between the buildings and the shelter-belt for the extension and addition to buildings, threshing space, and the formation of snow-drifts in winter.
4. Allow space for lawns and ornamental planting.
5. Allow for the extension of the plantation for woodlot purposes.

Convenience.—Convenience should be the principal thought when erecting the farm buildings and laying out the grounds. There is nothing which decreases the efficiency or value of the farm more than a cramped and inconvenient arrangement of the home and its surroundings. With every farm there is an approach to the road allowance which is used more than any other, and this should be kept in mind when locating the driveway in order that there will be no time lost when leaving or entering the premises. The same will apply to the entrances from the barns to the adjoining fields or vegetable garden. In nearly every case on the prairie farm there is a sufficient amount of ground which will

allow the tree plantations to be so located that they will not interfere with the convenience of the place and yet will provide shelter for the home and barnyard.

Prevailing Winds.—In every locality there is generally some one direction, or perhaps two directions, from which the severest storms approach. It is on these sides of the buildings that the shelter-belts should be established first. On the prairies the most protection is needed from the north and west, as the prevailing winds come chiefly from these directions. The principal belt, then, should be on these exposed sides; four or five rows on the east and south will be found sufficient. Many tree-planters in the West endeavour to plant their trees so that they will serve as a wind-break and at the same time provide shade for the buildings. It should be remembered that the main object of a wind-break is to afford shelter for the buildings and stock, and therefore it should be established on the sides which are subjected to the prevailing winds. Later, a few standard trees, such as the ash, elm, and maple, may be planted individually or in groups near the buildings to provide shade.



PLATE 9.—SNOW DAMAGE IN A COTTONWOOD PLANTATION
Indian Head Forest Nursery Station. (F.S.C. Photograph 2943).

Space between Buildings and Shelter-belt.—There seems to be a strong tendency for those planting trees on the prairie farms to crowd them too close to the buildings. This is a great mistake, as they will collect large banks of snow in the winter-time, which will prove a great nuisance, and perhaps cause extra labour in digging out paths and roadways. Then, too, plenty of room should be allowed in case it may be desired to extend the buildings at some later date. A minimum distance of thirty yards should be allowed between any building and the shelter-belt.

Protecting the Belt from Snow.—In making a shelter-belt, if it is to be more than a rod wide, an extra row or two of trees should be planted outside this at a distance from the main belt of 20 to 25 yards, the space between to be left free from trees. This space is to act as a snow-trap in which the snow, drifting through the outer row, will be caught. If the snow is not held in this way it will lodge in the centre of the belt, and will be liable to break down the tops of the

small trees. This is likely to occur year after year, practically destroying the trees, which in all probability will never attain any size, but always remain stunted and bushy. The land kept for a snow-trap need not be wasted, but will answer splendidly for a garden or root ground. The outside belt on the north and west may consist of one or two rows of such trees as maple or caragana. Trees like cottonwood or poplars, which do not grow thick at the bottom, should never be used for this outside belt. A single row of caragana makes an ideal snowbreak.

Ornamental Planting.—That the attractiveness of a place can be greatly increased by the planting of shrubs and flowers is known to all. But on the prairies there are certain conditions which determine success in growing ornamental plants. It has been demonstrated at the Experimental Station at Indian Head that many shrubs which winter-kill in the open are quite hardy when sheltered by a belt of trees. Therefore, it is advisable to defer the ornamental planting until sufficient shelter has been established by the wind-break. On the ordinary homestead or new farm in the West there are many things, such as erecting buildings and fences, which are of more importance than ornamentation. But as the farm develops there will be greater opportunities to plant shrubbery and improve the appearance of the place. That these conditions will arise at some future time should be kept in mind when arranging for the planting of trees.

The Woodlot.—There is no expanse of territory where the scarcity of fuel and small timber is felt so keenly as on the plains. If properly managed, two or three acres of land planted with the proper species and in proper mixture will furnish a portion of the fuel used on the farm and will supply a quantity of posts and small poles. The area to be used as a woodlot should be included in the initial plan and at least a season in advance a portion of this area could be prepared to accommodate the planting material available. Trees planted in blocks should be protected by a snow-trap on the sides of the prevailing winds.

Pruning.—There seems to be a strong tendency on the part of inexperienced tree-planters to start pruning their trees at the earliest opportunity. This is a great mistake. Pruning will not in any way hasten the growth of the trees and is likely to cause a great deal of harm.

A shelter-belt, to be most effective, must be thick and dense from the ground up. Any general pruning of the lower branches necessarily lessens the value of a belt as a wind-break, and also opens up the soil to light, encouraging the growth of grass and weeds, and increases evaporation of moisture. Species such as Russian poplar, cottonwoods, and other poplars should never be pruned, as the wounds provide ready access to disease germs. These trees at the best are comparatively short-lived, but when they are pruned the results are often disastrous within three or four years. Pruning in the shelter-belt should never be done for the first six years. Sometimes at about this time in the life of the plantation some pruning may be helpful in encouraging the growth of the more valuable species, such as ash and elm, which may become overcrowded by less valuable kinds like poplar and willow. In these cases the side branches of the poplar and willow may be cut back to relieve the ash and elm.

Thinning.—In a plantation where trees are originally spaced 4 feet by 4 feet some thinning may be necessary after 18 to 20 years. In the plantations on the Nursery Station at Indian Head no thinnings have been needed until this age has been reached. At about that period many trees will be found which are being suppressed, making no growth, and which will gradually die. Such trees may be cut out and will furnish good fuel at that age. In thinning great care must be taken not to thin too heavily. The aim should be always to keep a heavy enough crown-cover to completely shade the ground.



PLATES 10 AND 11—PRUNED AND UNPRUNED PLANTATIONS COMPARED.

Plate 10, on the left, shows a plantation of Manitoba maple, about 15 years old, pruned and thinned, with the result that a thick sod has formed beneath the trees, which hinders their growth. Plate 11 shows a Manitoba maple plantation about 13 years old, unpruned and close-planted. In the latter the leaves form a dense shade, which prevents weeds and grass from growing and conserves the moisture. (F.S.C. Photographs 1 and 63).

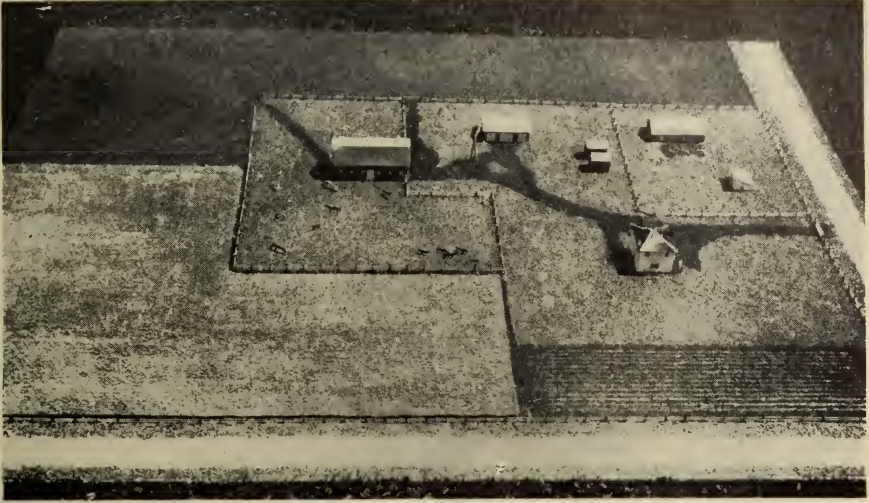


Plate 12.—Farmstead with good buildings and equipment but without trees. F.S.C. Photograph 17947).

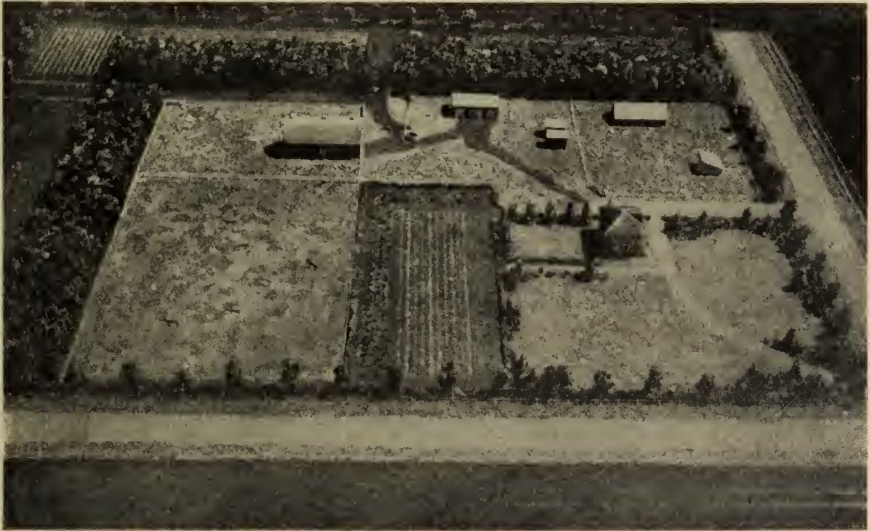
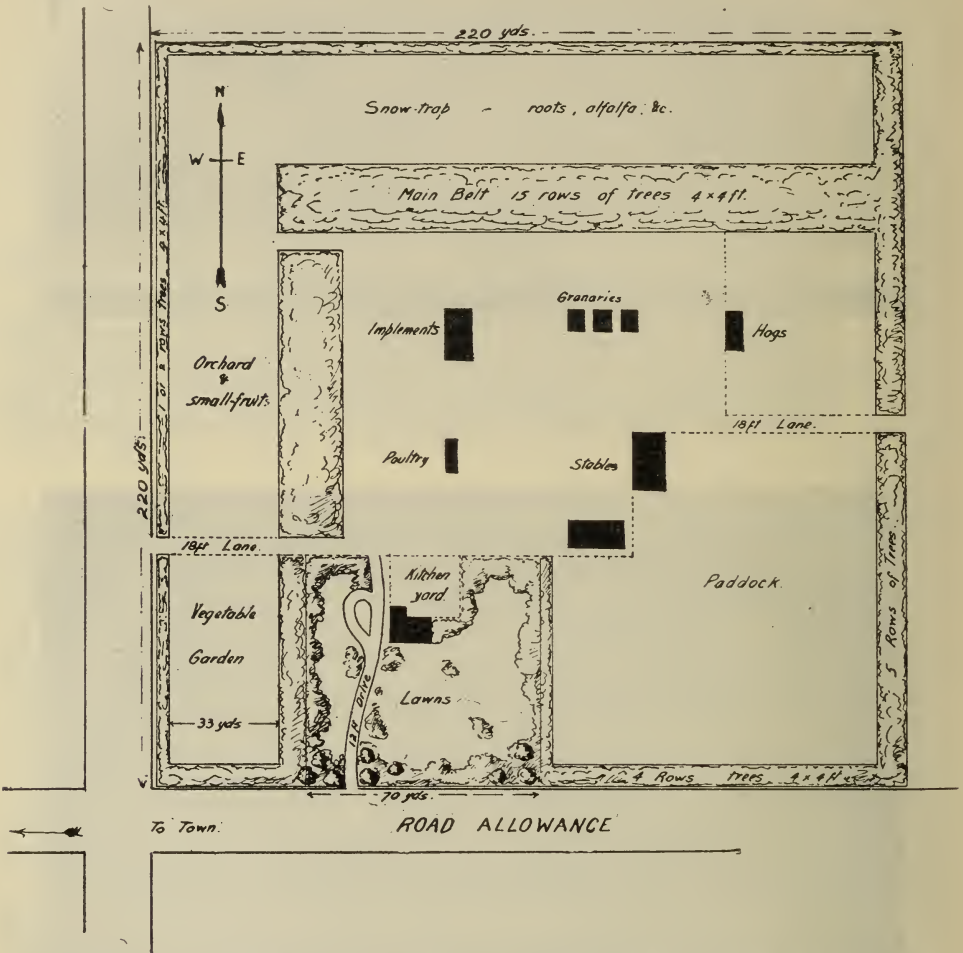


Plate 13.—The same farmstead planted with trees as suggested in plan No. 2. (F.S.C. Photograph 17943).

PLATES 12 AND 13.—MODELS ILLUSTRATING THE APPEARANCE OF A FARMSTEAD WITH AND WITHOUT TREE-BELTS.

SUGGESTED PLANS

The two plans here presented are offered merely as suggestions as to what might be considered necessary to allow for in preparing an original plan for any farm home. Local conditions must necessarily affect the general arrangement of buildings and shelter-belts, and, therefore, no set plan can be given which would suit all cases. As a general thing from seven to twelve acres should be included in the plan; any area smaller than this will undoubtedly result in cramped quarters in future.

PLANN^o1

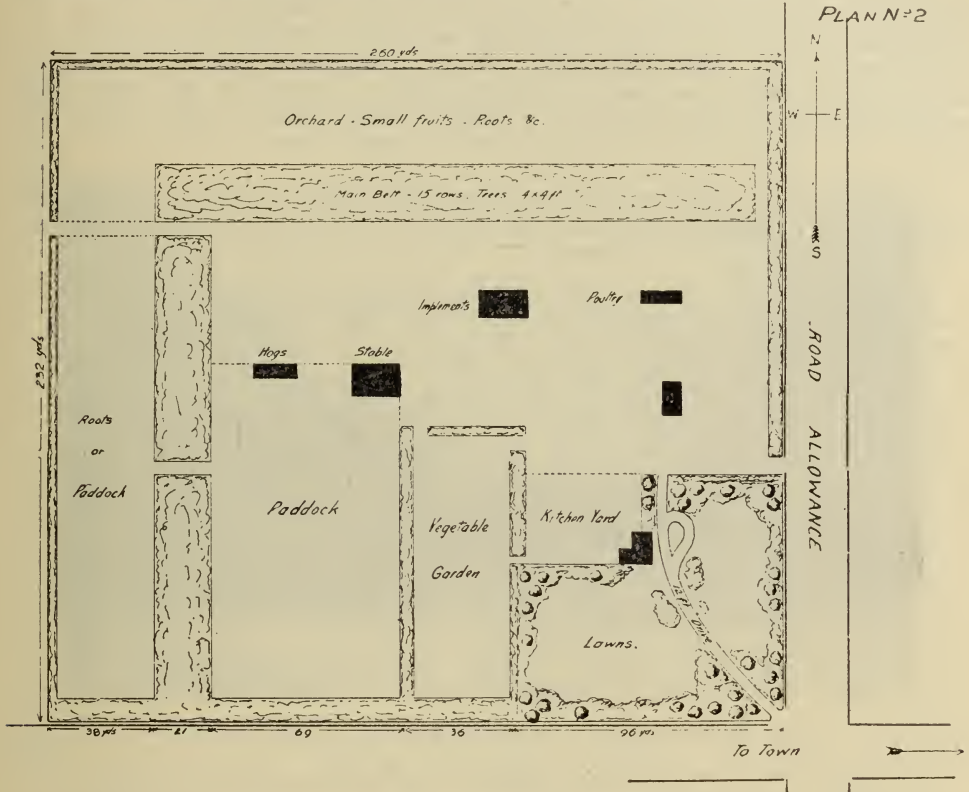
PLAN No. 1.—SUGGESTED PLAN OF FARMSTEAD IN THE SOUTHWEST CORNER OF A SECTION.

Plan No. 1 includes ten acres and is designed for a home site placed in the southwest corner of a section. It embraces practically everything that might be considered necessary in the way of gardens, ornamental grounds, barnyards, and shelter-belts for a farm of from a quarter-section to one section in area. It will be noted that the main belt on the north and west sides is planned for fifteen rows. It may be taken for a general rule that any belt over one rod wide should be protected by a snow-trap as already explained.

In the drier areas, it might probably be better instead of having a solid belt of fifteen rows to plant three strips of three rows each, separating them with two strips of twelve feet each. This will allow more space for cultivation but the whole belt will occupy about the same width.

Such a plan may require several years to complete, the ornamental grounds being possibly the last portion to be developed. To plant according to this plan the owner would require to use from 5,000 to 6,000 seedlings and cuttings, besides such shrubs as might be needed later for the lawns.

Plan No. 2 is somewhat similar, though the arrangement is different, adaptable to a situation in a southeast corner of a section. The same general features are, however, embodied in this plan, and approximately the same amount of planting material would be required.



PLAN No. 2.—SUGGESTED PLAN OF FARMSTEAD IN THE SOUTHEAST CORNER OF A SECTION.

The point to be emphasized is this:—*Before doing any planting make a plan of some kind to embrace as far as possible all future requirements.* The work should be developed in a systematic manner and no haphazard planting done simply because there may be a strip of summer-fallow or old fireguard somewhere in the neighbourhood of the buildings. A few hours' study over such a plan will well repay any farmer.

It must be clearly understood, however, that, though these suggestions are made by the Department, it would be impossible to guarantee to supply sufficient trees to complete such plans as above outlined.

A limited number of trees and cuttings are sent out each season from the Nursery Station at Indian Head, permitting of an average distribution of from 700 to 800 trees to each applicant in two successive seasons, making a total of from 1,400 to 1,600 plants. Beyond this the farmer should rely upon his own resources for further developing his plantation. Planting material may now be purchased at reasonable prices from commercial nurseries operating in the West, or the farmer may quite easily grow his own stock from seed or cuttings taken from the older belts of trees.

NOTE SPECIALLY

Trees will not be granted for planting closer to any permanent buildings than thirty yards unless in very exceptional individual cases.

COST OF ESTABLISHING A WIND-BREAK

The actual cost of setting out a plantation in the case of a farmer is difficult to figure out. As a rule this work is done by the ordinary labour available on the farm and usually does not entail the actual disbursement of cash for additional labour. If we say it costs \$5 per acre or \$8 per acre to set out a plantation it really conveys very little, as this cost depends entirely on the rate of wages paid. The best way to state the cost is to figure on the actual time required to plant so many trees or to find out the number of trees a man can plant on the average in a working day of ten hours.

On the Nursery Station at Indian Head approximately 100 acres have been set out in plantations spaced about four feet apart each way. The first plantings were made in 1905 and have been added to more or less each season. The method



PLATE 14.—WIND-BREAK OF JACK PINE ACTING AS SNOW BARRIER.

These trees are on the farm of A. Heyer, Neville, Sask. They were supplied by the Forest Service in 1912. Photographed in 1924. (F.S.C. Photograph 17523).

of planting followed has generally been in plough furrows as described under "Planting" on page 15. In some cases planting has been done by spade. In setting cuttings an iron dibble has usually been used. When setting in plough furrows a gang of from three to six men, with a team, has been employed. It has not been found that the number of men employed makes much difference in the number of trees each man can set in a day, provided the teamster also plants if the men cannot keep up with the plough.

At Indian Head it has been found that on an average 831 trees per day can be set by each man in the gang, including the teamster. The highest number on record here is 1,380 per day per man and the lowest 670 per day per man. Where only one or two species are planted more trees can be set in a given time than where four or five species are planted together. These figures are for setting out one-year-old and two-year-old seedlings, or cuttings, or small transplants of the conifers. Larger trees would require more time, depending on the size of holes necessary to accommodate the roots.

Practically no difference has been found in the cost of planting broad-leaved varieties as compared with conifers. Considerably more cultivation, however, is required in the case of the latter after planting, as it takes them longer to cover

the ground. In the case of an average broad-leaved plantation containing a mixture of, say, maple, ash, willow, and Russian poplar, cultivation should not be necessary after the third season; but where spruce and pine are set out four feet apart each way cultivation may have to be continued up to the fifth or sixth season after planting, so that the actual labour or time expended in establishing an evergreen belt may be considered as just about double that required to establish a broad-leaved belt.

The cost of such cultivation can be greatly reduced if the work is done at the proper time, before the weeds get a start. If weeds and grass are ever allowed to get the upper hand an enormous amount of labour is needed to get the plantation into proper shape again. After the belt is well established a cultivated strip at least ten to fifteen feet wide should be maintained around the edges to prevent grass from working in from the outside. Fencing should be so arranged to permit of this.



PLATE 15.—TREE BELTS SHELTERING VEGETABLE GARDEN.
These trees are on the farm of E. L. Staples, Vauxhall, Alberta.

The table below gives comparative rates of growth of different species. Measurements are the average of hundreds of trees of each kind growing in plantations on the Nursery Station at Indian Head.

(The figure at the top of each column shows the age of the tree in years. The figures in the body of the table show the height in feet and inches.)

Species	5 Years		10 Years		15 Years		20 Years	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Manitoba Maple.....	8	0	17	0	21	2	27	8
Green Ash.....	4	8	10	6	15	3	22	6
White Elm.....	4	6	8	6	13	3	19	2
Paper Birch.....	8	5	17	0	21	9	28	0
Russian Poplar.....	12	6	25	0	35	6	47	0
White Spruce.....	1	6	3	0	12	0	16	4
Scotch Pine.....	1	5	8	0	16	10	22	6
Jack Pine.....	2	0	7	9	15	6	21	2
Lodgepole Pine.....	1	0	5	8	13	0	20	1
Tamarack.....	5	8	14	0	21	6	28	0
Siberian Larch.....	4	6	15	0	22	9	31	9

In the case of evergreens the young plants are not set out in the permanent plantations till from four to six years of age. They average at that time from twelve to eighteen inches in height.



Plate 16.—Farm home of Andrew Anderson, Alsask, Saskatchewan. Trees planted in 1912. (F.S.C. Photograph 16595).



PLATE 17.—Farm home of Wm. Hollinger, McTaggart, Sask. Trees planted in 1906.



Plate 18.—Farm home of W. J. Hough, Stranraer, Sask. Trees planted in 1915. (F.S.C. Photograph 18206).

EXAMPLES OF SUCCESSFUL PRAIRIE FARM PLANTING.



Plate 19.—Farm home of D. C. Spafford, Weyburn, Sask. Trees planted in 1907. (F.S.C. Photograph 17492).



Plate 20.—A prairie farm at Ardill, Sask. Trees planted in 1911.



Plate 21.—Another view of the Anderson farm at Alsask, Sask. (F.S.C. Photograph 15692).

EXAMPLES OF SUCCESSFUL PRAIRIE FARM PLANTING.

DESCRIPTION OF SUITABLE SPECIES

BROAD-LEAVED TREES

MANITOBA MAPLE

General Notes.—The Manitoba maple is a tree of very wide range, being found native from western Ontario to Medicine Hat, in eastern Alberta. It seems hardy throughout the prairie districts of Saskatchewan and Alberta. In its native state it is generally found growing in river or creek bottoms, or on rich moist soil. In Manitoba it attains a height of from forty to fifty feet, and reaches a diameter of from sixteen to twenty inches. It is naturally of a very branchy, irregular habit of growth, the main trunk dividing into two or more stems either at the ground or a few feet above.

There are two insects which sometimes attack the maple with, in some cases, disastrous results. These are the canker-worm, a small caterpillar, and the green aphid or plant-louse. The caterpillars may be killed by spraying with Paris green or arsenate of lead and the aphid by spraying with kerosene emulsion. In all cases of insect attack, the well cultivated plantation will suffer least owing to the more healthy and vigorous condition of the trees. As to insect pests, see further Department of Agriculture Pamphlet No. 47, "Injurious Shade Tree Insects of the Canadian Prairies," by J. J. de Gryse. Or write the Entomologist, Department of Agriculture, Indian Head, Sask.



PLATE 22.—MANITOBA MAPLE IN NURSERY ROWS.

Seed sown in drills 30 inches apart. Seedlings about 3½ months old. Indian Head Forest Nursery Station. (F.S.C. Photograph 256).

Uses.—The present value this tree has in the West is for wind-breaks, as it grows rapidly and branches profusely. It is exceptionally easy to propagate and transplant and will adapt itself to a great variety of conditions. It will stand considerable drought on the high prairies, but on very wet or very dry soil growth is very slow and, consequently, this tree should never be planted in such places, except perhaps to fill up a plantation composed of more suitable species.

Owing to its general hardiness and wide range, the maple has proved to be a most valuable tree in plantations throughout the West in the capacity of a nurse-tree to other more tender and desirable kinds. It is a moderate shade-bearer, and forms a good soil-cover, planted in mixture with such trees as ash, cottonwood, and other light-demanding species. From the fact that it is easy to propagate and obtain young seedlings of this maple it has been very widely used throughout the West for avenue and street planting. It is not, however, especially adapted for this purpose, and it requires a great amount of pruning and care to bring it into a proper form and keep the top from becoming straggly and heavy. As an avenue tree it suffers considerably from heavy winds and early snowfalls, and the trunk is frequently damaged by sun-scald, which causes the bark to crack on the south or southwest side, making an unsightly scar and laying the inner wood open to the attacks of fungi, which sooner or later will cause the decay of the stem.

It leafs out very early in the spring, which is one point in its favour, but with the exception of the ash it is the first tree to lose its foliage in the fall.

The wood of the Manitoba maple is hard and close-grained. It makes excellent fuel, and if properly peeled and seasoned will last well as a fence-post.

Propagation.—The Manitoba maple is propagated only by seed. Large crops of good seed are borne after the tree reaches the age of about eight years and are produced almost every year. Seed is borne only on the pistillate or female tree; the staminate or male trees do not bear seed. The seed ripens, according to the season, from early in September to the middle of November, and should be picked after the first heavy fall frost, which causes many of the leaves to drop off, thus making the collection of the seeds the more easy. After picking, the seed should be thoroughly dried by spreading it over a floor or outside in the sun, after which it should be bagged and stored in a dry building. Maple seed properly cured and kept in a dry place will retain its vitality for a number of years. When fresh the germinating percentages average from 60 to 70 per cent. The percentage, of course, decreases according to the age of the seed.

The seed should be sown in the spring, about May 15, so that the young seedlings may germinate when there is the least danger from late frosts and high winds. Many planters claim that it is advisable to soak the seed for several hours before sowing. This, no doubt, shortens the germinating period, but it is doubtful whether any material advantage is gained by this unless in exceptional seasons, as those who sow the seed dry seem to be equally successful in obtaining a good stand of young plants. When the seeds are wet they are inclined to stick together, and it is not so easy to get an even stand. Besides, in raw, cold weather the operation of handling wet seeds is anything but a pleasant one.

It has been the practice at the Nursery Station to sow part of the maple in the fall (late in October). The seedlings from these sowings are always much larger than those from spring sowings, though in some cases the crop has suffered from late frost and very high winds in early spring. It is not, however, advisable to depend altogether on fall sowing for maple.

In an exceptionally dry season some of the seed may fail to germinate, but lies dormant in the soil throughout the summer and following winter, but the

seedlings make their appearance early in the succeeding spring. Before sowing, the seed should be thoroughly rubbed between the hands or well flailed in a bag in order to separate the bunches and break off some of the wings. This will allow of a much more even distribution of seed, and, the wings being broken off, sowing can be done on a windy day, which would not be possible if the wings were left attached to the seed.

The best method of planting the seed is to place it in drills from one and a half to two inches deep, and far enough apart to admit of thorough cultivation between the rows. If horse labour is to be used, thirty inches is about the right distance. The seed should be sown rather thickly, at the rate of about twenty grains per running foot.



PLATE 23.—MANITOBA MAPLE AS AN AVENUE TREE.
Indian Head Experimental Farm. (F.S.C. Photograph 55).

The soil for the nursery should be deeply and finely worked up, and well drained and fairly moist, never wet. A rich sandy loam is the best, as it is possible to work it very early in the spring, and it does not bake or cake after heavy rains as is the case with clay soil.

Care of Seedlings.—During the growing season the seedlings should be constantly cultivated, the surface soil never being allowed to become baked. Cultivation should be discontinued not later than the beginning of August, in order that the plants may be induced to stop growing and given time to harden up before the severe fall frosts. If growth is continued too late in the season the young plants are sure to be cut back, and perhaps so badly damaged as to be of no use for transplanting in the following spring.

Maple seedlings, if properly grown, should be transplanted when one year old into the permanent plantation. Sometimes they may be left in the nursery

for two years, but after this age the strong roots which they form make the transplanting of large numbers an expensive operation.

Seedlings one year old average from 12 to 16 inches high.

Seedlings two years old average from 24 to 36 inches high.

The rate of growth depends almost altogether upon the amount of cultivation given.

Flowers appear about May 8 to 12.

Seed ripens towards the end of September.

Seed should be sown about May 15.

Number of seeds per pound is about 13,000.

Weight of seed when dry, with stems and wings, is about 11 pounds per bushel.

When sown in drills 30 inches apart, about 40 pounds of clean seed are required per acre.

Average stand of seedlings per acre sown in this way is about 85,000.



PLATE 24.—GREEN ASH SEEDLINGS IN NURSERY ROWS.

Seedlings one year old. Indian Head Forest Nursery Station. (F.S.C. Photograph 99).

GREEN ASH

The green ash is found in the West in the valleys of the Qu'Appelle, Assiniboine, and Red rivers, also scattered in the Pembina and Moose mountains and in the eastern part of the Dirt hills south of Moose Jaw. On good soil this tree attains a fairly large size. Specimens eighteen inches in diameter and of corresponding height were at one time not uncommon. It is a fairly rapid grower, though not quite so fast as the Manitoba maple. A single specimen seen at Dunstan, in southern Manitoba, measured in 1881 two and a half inches in diameter. In 1901 it had increased to over one foot in diameter at four and a half feet from the ground, and carried this width up to twenty feet, when branching commenced.

Under natural conditions the green ash thrives on heavy, moist soils. It does not stand planting in light, dry localities. It usually grows with a single fairly straight stem. The crown is open and therefore permits a large quantity of sunlight to pass through and reach the ground; this encourages the growth of grass and weeds, which is very undesirable in a plantation, as it retards the growth of the trees. Ash, therefore, should never be planted alone, but should always be mixed with some species of tree which will help to form a complete soil-cover.

Uses.—From the planting that has already been done it has been proved that the ash is hardy all over the West—in fact, more so than the Manitoba maple. One reason for this, perhaps, is that it does not start growing so early in the spring, and thus escapes damage from late frosts, although the foliage in the spring is very tender and, should frosts occur early in June, the young leaves are sure to be blackened. It also matures much earlier in the fall and consequently is seldom cut back by early fall frosts. The wood makes excellent fuel and also lasts well when used as fence-posts. As it is tough, light, and elastic, it is of great value on the farm for small repairs. It is a tree that may be used successfully for pioneer planting in wind-breaks or shelter-belts, mixed with maple, elm, or other suitable kinds. As an avenue tree it is very satisfactory, having a naturally upright growth and requiring but little pruning. It leaves out rather late in the spring, and loses its foliage again rather early in the fall, which is somewhat against the tree from an ornamental standpoint.

From past experience the ash proves to be the most generally suitable tree for planting in any part of the West. In mixture with other species its growth is rapid and strong, and in Alberta, when cottonwoods and maples in the same plantation have been winter-killed to the roots, the ash has come through without injury. It has proved to be particularly drought resistant.

Propagation.—The ash is propagated entirely from seed. This ripens towards the end of September. Many trees do not produce seed at all, as they bear only the staminate or male flowers. The pistillate or female trees bear seed about every second or third season. The seed is easily gathered, as it grows in bunches which permit of picking it in handfuls. The seed should be cured and stored in the same manner as maple seed; seed kept dry has produced excellent crops of seedlings after three and four years. The best time to sow ash seed is probably in the fall, just before the freeze-up. Seed sown at this time in the nurseries at Indian Head commenced to show above ground about May 24, in the following spring. Seed sown on May 6 in a very wet spring did not come up till June 13. This shortens the growing season by nearly one month and makes a great difference in the size of the seedlings in the fall. Ash seed very often does not come up at all in the first season, but lies over till the following spring. For this reason, and also owing to the long period necessary for germination, fall sowing is recommended. Otherwise it should be sown as early in the spring as the ground can be worked. The seed should be planted in drills thirty inches apart, thick enough to ensure a stand of about ten seedlings to the running foot. Compared with the maple the growth of the seedling is slow, an average for the first year being about six inches. It is well to allow the seedlings to remain in the nursery for two years, when they will reach a height of about two feet, and form very strong plants. The formation of a strong tap-root makes it inadvisable to leave them longer without transplanting.

Seedlings one year old average four to six inches high.

Seedlings two years old average eighteen to thirty inches high.

Flowers appear about the end of May.

Seed ripens about the end of September.

Seed should be sown about the end of October or very early in the following spring.

Weight of seed with stems and wings, dry, about 12 pounds per bushel.

Amount required for one acre (drills 30 inches apart), about 40 pounds.
Average stand of seedlings per acre, about 100,000.

WHITE ELM

General Notes.—The white or American elm is undoubtedly one of the best broad-leaved trees for general prairie planting. It is hardy throughout the West, the natural range extending roughly north to about the 54th degree of latitude and west to about the 3rd principal meridian (longitude 106 degrees west). On heavy, moist soils the trees attain a large size, trees two feet and upward in diameter and 60 to 70 feet high being common in the river valleys. The elm has a naturally upright habit of growth, generally forming a good straight trunk, which divides into two or three main stems at a considerable height from the ground. The rate of growth is about the same as that of the Manitoba maple, although it would probably not produce so great a quantity of wood in the same time, as it grows only one stem, whereas the maple usually has two or three.



PLATE 25.—WHITE ELM SEEDLINGS, ONE YEAR OLD, IN NURSERY ROWS.
Indian Head Forest Nursery Station. (F.S.C. Photograph 257)

Uses.—The elm should be largely grown in western plantations, as it is easily propagated and transplanted, and is a rapid grower and long-lived. The wood is very tough, making excellent posts, and is of value for many small repairs for which hardwood is always needed on the farm. The wood when dried makes very good fuel, and after the tree is cut reproduction is very vigorous from the stumps by means of stool shoots. As an avenue tree the elm cannot be surpassed, having, an upright growth and not being subject to sun-scald. When young the branches are liable to split in the forks if heavily laden with snow. Small seedlings sometimes suffer from being eaten back by rabbits in the winter.

Propagation.—The elm, for all practical purposes, is grown almost entirely from seed. Large seed-years occur in the West about every second or third season. A small quantity can, however, generally be obtained every spring. Good seed, though only in small quantities, has been collected from trees fifteen years old. The seed is small and not very conspicuous. It ripens from the end of May to about the second week in June. It should be picked as soon as the kernel is well filled. Any delay in picking is risky, the seed being so light that very little wind is needed to blow it all off the trees.

After picking, it may be allowed to dry for a week or so, when the wings can be easily rubbed off, which greatly facilitates sowing, especially in windy weather. When cleaned the seed very much resembles flaxseed, being about the same colour and size. Sowing should be done shortly after picking. The seed-bed must be very finely prepared, and the seed sown in drills one foot to eighteen inches part (30 inches for horse cultivation), and covered as lightly as possible, never to a greater depth than half an inch. If the season is dry, it will be



PLATE 26.—WHITE ELM AS AN AVENUE TREE.

Trees illustrated are twelve years old. Indian Head Experimental Farm. (F.S.C. Photograph 69).

necessary to water the rows in order to get the seeds to sprout. The young seedlings usually show above ground two or three weeks after sowing. After the seedlings appear, surface cultivation should be given, and if the stand is too thick the plants may be thinned out to about one inch apart. Cultivation should cease early in August. By October the seedlings should average from seven to ten inches in height. The nursery rows should not be disturbed until the following fall, when the seedlings will be of suitable size for transplanting into the plantation. At the end of the second season the plants should average about twenty inches in height.

The elm thrives best on rich, moist soils, and should never be planted on very dry land. As it is rather a light-demanding species, it should be set out in mixture with maple, choke cherry or some other shade-bearer in order to obtain a good soil-cover. If set out in "pure" plantation it may be necessary to under-plant, after fifteen or twenty years with some shade-enduring species in order to maintain good growing conditions.

Flowers appear early in May before the leaves.

Seed ripens early in June.

Should be picked at once.

Should be sown at once.

Average stand per acre, grown in drills eighteen inches apart, 200,000.

COTTONWOOD

General Notes.—The cottonwood is a native of the western prairies from the Rocky mountains to Manitoba. It is found growing in the valleys of the Red, Pembina, South Saskatchewan and other rivers; the writer has seen it as far north as Saskatoon on the South Saskatchewan, and it no doubt extends still farther north along this river. It is hardy and a very rapid-growing tree, and under favourable conditions attains a height of seventy-five to a hundred feet, and a diameter of several feet. Professor John Macoun, in his Catalogue of Canadian Plants, says that in 1880 "there was a grove of these trees of a very large size" at Big Stick lake, north of Maple Creek. "These had escaped the annual prairie fires, being surrounded and partly covered by the sand, and stood as a proof of the existence of forests in the past where now there is not even a bush. The trees were over fifty feet high and some of them at least two feet in diameter." This tree has a very upright habit of growth, keeping one well defined stem throughout. The leaves are large, deep green, and glossy, so that when in full foliage the tree presents a very handsome appearance.

Uses.—The cottonwood, though quite hardy, has not proved to be as generally suitable for prairie planting as some other species. It is a tree which grows naturally along river bottoms and requires considerable moisture for its best development. The general experience has been that, when used as a mixture in a plantation where the trees are set close together, it will die out after ten to fifteen years, as it cannot secure sufficient moisture under such conditions. Where, however, the cottonwood has been planted on good heavy soil in a single row or in a very narrow belt or as individual specimens, the trees appear to make splendid growth, provided the ground around them is kept well cultivated and free from grass. Generally speaking, for shelter-belt planting on upland prairie soil the Russian poplar will prove more satisfactory than the cottonwood.

Propagation.—By cuttings, or, in some cases, from root-suckers.

The growing of cottonwood from seed is not generally undertaken in nurseries, as the seedlings can be obtained very cheaply in large numbers from the sandbars along many of the rivers. Most of the cottonwoods planted in Western Canada are imported from the Western States, where certain firms make a regular business of pulling the seedlings from the sandbars and distributing them wholesale among the nurserymen, who afterwards retail them to their customers. The seedlings obtained are usually from two to three years old and average two feet in height. They should be planted at once in the permanent plantations, as growth is so rapid after transplanting that it would not pay to put them in nursery rows. Two feet of growth is not uncommon in the first season if the trees are well cultivated, and in after years growth varies from two to five feet according to the season. During the first and second winters the young shoots are frequently cut back by frost, especially if the fall is a wet one, thereby inducing late growth. This, however, does not seem to impair the vigour of the young plants which, after the third winter, seldom show the effects of frost.



Plate 27.—Trunk of Russian poplar tree showing result of pruning and subsequent injury from sunscald and canker. Indian Head Experimental Farm. (F.S.C. Photograph 77).



Plate 28.—Healthy ten-year-old Russian poplar, never pruned, at Indian Head Experimental Farm. (F.S.C. Photograph 79).

PLATES 27 and 28.—RUSSIAN POPLAR: COMPARISON OF PRUNED AND UNPRUNED TREES

Cuttings.—Cuttings are made from well ripened wood, generally of the previous season's growth. They can be made at almost any time when the tree is in a dormant condition, but preferably in the late fall or very early spring. If made in the fall they should at once be buried in moist soil and left until spring. The best cuttings are made about ten inches long and from one-quarter to three-quarters of an inch in diameter. They should be planted out as early as possible in spring, on well prepared soil. Holes should be made with a dibble of suitable size; the cutting is placed in this hole, buds pointing upwards and about one inch of the top left above the ground; the soil is then firmly tramped around it. The cuttings may be spaced about three inches apart in rows far enough apart to admit of cultivation. If 60 to 70 per cent of the cuttings strike root, it may be considered very successful. After rooting, the new shoots make very rapid growth, often as much as three feet in the first season. They should be transplanted from the nursery in the following spring.

Of recent years it has not been easy to obtain good hardy stocks of northern-grown cottonwood seedlings. Only northern-grown stock should be used. For Alberta and western Saskatchewan the Russian poplar is generally preferable to the cottonwood.

Carolina poplar and Norway poplar are varieties of cottonwood which are sometimes offered by nursery agents for prairie planting. While an occasional planting of these poplars has shown good growth, the general experience has been that they are not sufficiently hardy to warrant recommending their planting generally in the West, except in an experimental way. In 1913, several thousand Norway poplar were set out as test plantings on the Indian Head Nursery Station. The trees made good growth for some years, but in the spring of 1918, about 90 per cent of the trees were dead to the ground; some of them were fourteen feet high. The Carolina poplar suffered in a similar way.

RUSSIAN POPLARS

General Notes.—Three species of Russian poplar have been introduced into the Prairie Provinces and have proved to be more or less hardy and desirable under certain conditions. The names of these three are given as *Populus petrovski*, *Populus certinensis*, and *Populus wobstiriga*. Nurserymen and others find these species difficult to distinguish as there seems to be great uncertainty as to the exact characteristic differences. However, as their habit of growth and general requirements are very similar, they may for all practical purposes be here considered under the one head of Russian poplar.

The growth of this tree when young is extremely rapid. Specimens planted as cuttings in various places show an average growth of twenty to twenty-five feet in from eight to ten years. The trees are exceptionally hardy. It is very seldom, even in the case of young plants, that the new shoots are frozen back, as is often found to be the case with the cottonwoods after the first hard fall frost.

Uses.—Although the Russian poplar is hardy and a very rapid grower, it cannot be recommended as a suitable tree for planting in too large numbers, and in no case would it be advisable to plant it at all extensively where it is possible to successfully grow other kinds of trees. Owing to its rapid growth and extreme hardiness this tree was widely exploited in the prairie districts of Minnesota and other Western States. It has since been found to be very subject to the attacks of certain borers which seriously injure the trees—to such an extent, indeed, that authorities on tree-planting in these states are now discouraging the extensive use of this poplar. In the Prairie Provinces it would seem that the Russian poplar will thrive on all kinds of soil, but after nine or ten years on heavy clay land the heart of the tree commences to decay and unsightly cankers form on the trunk, which would undoubtedly cause the death



Plate 29.—Russian Poplar plantation.

Trees are up to 45 and 50 feet high and average $6\frac{1}{2}$ inches in diameter. Planted 8 ft. by 8 ft. about 1899. Many trees are dead, others are dying rapidly through frost crack and attacks by canker and borers. Heavy brome-grass sod. Photographed in July, 1922. (F.S.C. Photograph 15090).



Plate 30.—Avenue of Russian Poplar.

Trees about 25 feet high; all dead. Probably 12 to 15 years old. Originally there were three rows on each side of the driveway. Rows 4 feet apart, trees 8 feet apart in the row. Photographed in July, 1922. (F.S.C. Photograph 15092).

PLATES 29 AND 30.—RESULTS OF PLANTING RUSSIAN POPLAR ALONE.

of the tree before many years. On sandy, gravelly, or sandy loam soils the growth is slower, and consequently the wood is not so soft. Trees seen growing on such soils do not appear to suffer from the early decay. The uses for the Russian poplar in the West are practically limited to the formation of shelter-belts and wind-breaks, and for ornament where a quick tree effect is desired. A particularly objectionable feature of this tree is its habit of suckering from the roots in cultivated land. If a belt of these poplars is planted around a garden, roots are sent out on either side which run along just beneath the surface of the soil. If these roots are cut or injured by the plough or cultivator when the land is cultivated, they immediately send up suckers which grow exceedingly rapidly, often three or four feet in the first year. Suckers have been found growing at a distance of fully thirty feet from a ten-year-old tree. In a garden or on a dirt road this suckering is most objectionable, and the more the ground is cultivated and the oftener the suckers are cut back the more numerous they become. After it is once fairly established it is almost impossible to get the roots all out of the ground, should it be desired to get rid of the tree, without an immense amount of labour. For this reason, it would be well not to plant these trees near land used for a garden or frequently cultivated for ordinary crops.

The Russian poplar will probably produce more fuel in a shorter time than any other species of tree which can be successfully grown on the prairies. In this connection figures have already been given on page 9 regarding the yield of a plantation of Russian poplar on the Indian Head Nursery Station.

Propagation.—The Russian poplar is very easily raised from cuttings (as described under "Cottonwood"), also by digging up and transplanting the small root-suckers before mentioned. The cuttings may be either dibbled in in their permanent positions or else planted in nursery rows, and allowed to remain for one season before transplanting. The cuttings will make an average growth of from two to two and a half feet in the first season. The percentage of those that strike root is generally larger than that of cottonwood under similar conditions.

OTHER POPLARS

The Northwest Poplar.—This is a hybrid between the Cottonwood and Balsam Poplar and has been planted considerably during the past ten to fifteen years. It makes a very rapid growth and does not seem quite so susceptible to canker as the Russian Poplar. Another hybrid propagated on the Dominion Nursery Stations under the name *Saskatchewan Poplar* is giving equally good results. The original tree was found growing on the banks of the South Saskatchewan River near Saskatoon.

Balsam Poplar or Balm of Gilead.—This is a native variety of wide distribution and can be propagated easily from cuttings. It has been used as a street tree with fairly good results in many Alberta towns and also to some extent in shelter belts. It will not grow so rapidly as some of the other poplars but where soil conditions are favourable it develops into a large tree with very handsome dark green foliage.

WILLOWS

There are many species of willow hardy in the Prairie Provinces which can be used to advantage in most places where rapid growth is desired. The species of most importance are the white willow (*Salix alba*), *Salix fragilis*, *Salix Voronesh*, the Russian laurel-leaf willow (*Salix laurifolia*), the Russian golden willow (*Salix aurea*), acute-leaf willow (*Salix acutifolia*), and Russian red willow.

Propagation.—The method of dealing with willow cuttings is much the same as that of treating Russian poplar and cottonwood. However, it is not necessary to be very particular about the time of planting, as cuttings made at any time

from early spring to well on in June and set immediately seem to strike root equally well, provided there is sufficient moisture in the soil. It is hardly necessary to keep the plants in nursery rows during the first year, as the percentage of cuttings which do not strike root is very small. The growth, too, during the first season is very rapid, and the plants in the second spring are too big to be handled conveniently and cheaply. The best time to plant is early in spring, as then, of course, the plants can take advantage of the whole growing season. Cuttings of almost any diameter and size will root, but preferably those about ten inches long and from one-half to three-quarters of an inch in diameter should be used. These can be planted out in well prepared land to remain as a permanent plantation. Willows should be used only in outer rows and in low spots; general planting on high land should be avoided as far as possible.

Uses.—As a fuel producer the willow is excellent, not so much on account of the quality of the fuel, which is only medium, but rather owing to its rapid growth and its habit of sprouting profusely from the stump after being cut down to the ground. For fuel production, to ensure rapid growth the soil must be good and the supply of moisture greater than in the average situation. Single rows of willows, well cultivated, make very rapid and vigorous growth and are splendid for a quick and temporary shelter and after seven to ten years would give quite a quantity of good fuel if it was decided to cut them out.



PLATE 31.—PAPER BIRCH PLANTATION

The trees are ten years old, and have an average height of 20 feet 6 inches. Indian Head Forest Nursery Station. (F.S.C. Photograph 9396).

PAPER BIRCH

This tree, known also locally as the "canoe" or "white" birch, has one of the widest ranges of any of the northern trees. In Western Canada it is found scattered all over Manitoba, Saskatchewan, and Alberta, and in the Territories, and extends about as far north as the limit of tree growth. In habit it is an upright-growing tree, often reaching a height of 60 or 70 feet, with a trunk diameter of over two feet. It is found growing amongst other trees, hardwoods and evergreens, especially on the moister and richer soils, although it adapts

itself to much drier conditions. When transplanted it seems to be a rapid grower in mixed plantations. As it has a very open crown and is very light-demanding, it should never be planted alone in large numbers.

Uses.—The white birch will probably prove of value in mixed plantations and as a nurse-tree for other broad-leaved trees or conifers. It is an exceptionally beautiful tree and is largely used for ornamental planting. The wood when green makes excellent fuel, but if left lying in the open decays very quickly. As it is very susceptible to attacks of Borers, the average life in prairie plantations does not seem to exceed about twenty years.

Propagation.—The birch is grown from seed. The catkins ripen about the middle of August, but will often hang on the trees for some months if not exposed to violent winds. The seed is exceptionally small and light, there being over 800,000 grains to the pound. From the experience of the Indian Head Nursery Station in raising birch it would seem that the best time to sow seed is in the fall of the year. The seed should be sown in beds as described for conifers, as the young plants require shading during the first season. In the first summer they will probably grow about three to four inches. In the fall they may be taken up and heeled in ready for transplanting next spring, or they may be left in the beds over winter. In the spring they should be planted out in nursery rows about two to three inches apart in the row, the distance apart of the rows depending upon the method of cultivation to be used. After one year in the nursery the seedlings will be ready to transplant into the permanent plantation, as they make a growth of from eighteen inches to two feet in the second year.

BUR OAK

The bur oak, also called the "mossy cup" or "scrub" oak, is a native of south-eastern Manitoba. Its natural range extends west about as far as range 2, west of the 2nd principal meridian (102 degrees west longitude), and north to about township 21. On good soils and under favourable conditions this tree reaches a large size. In southern Manitoba, in the Pembina and Turtle mountains, trees of two feet in diameter are not at all uncommon, and stumps left in the woods show that before cutting commenced there were originally trees of a much larger size than this. The name "scrub" oak is somewhat misleading, as one would naturally infer that the growth was stunted and scrubby. It is true that dwarfed trees are very common in some parts, but these are found only on very poor soils and at the limits of the natural range of this tree. On heavy soils and where plenty of moisture can be obtained it will attain large proportions. It is one of the long-lived trees. From rings counted on the stumps of the trees grown in thick bush it would seem that about two hundred years were required to produce an individual measuring two feet in diameter.

Uses.—The wood of the bur oak is hard and heavy, and, though coarser in the grain than white oak, affords valuable lumber in certain sections. It makes excellent posts, as it does not rot readily in contact with the soil. Where it can be obtained in Manitoba the wood is used largely for fuel in preference to any other kind. For forestry purposes this tree will prove valuable in southern Manitoba, although it cannot be recommended for general planting even within the limits of its natural range. It should be set out only on the best soils, preferably in mixture with other broad-leaved trees. After the tree is cut close to the ground reproduction is very vigorous from the stump. In Manitoba the bur oak seems to be a moderate shade-bearer.

Propagation.—Seedlings are raised from the acorns, which fall from the trees about the beginning of September. They should be collected as soon as they fall and sown at once in drills, the acorns being dibbled in about two inches apart in the rows and about one and a half inches deep. The seedlings will probably require to be kept in the nursery for two years before transplanting. The oaks develop a very strong, straight tap-root when young, consequently they should not be left in the nursery too long. As far as the writer knows,

this oak has not been much used for planting in Manitoba, and the above directions are not based on actual experience. It may prove later on that it would be more advisable to plant the acorns immediately in the permanent plantation, as it is often stated that oaks are particularly hard to transplant. However, in the dry climate of the Prairie Provinces it will be best, if transplanting can be done successfully, to give the young plants a couple of seasons in the nursery. S. B. Green, in "Forestry in Minnesota," states that bur oak seedlings on good prairie soil attain a height of about four feet in five years.

BASSWOOD

In the West the basswood is native only to southern Manitoba, its western limit being about range 30, west of the 1st principal meridian (a short distance east of the western boundary of the province). It reaches a fair size in the Pembina mountains and along the Assiniboine valley. At Portage la Prairie there are still some good-sized trees, and evidence in the shape of stumps shows that large specimens have been cut in that district.

Uses.—The wood of this tree is light and very easily worked. It is largely used in furniture and carriage manufacture and for other purposes. As a fuel it would probably be about equal to cottonwood. For forestry purposes it should be very valuable for planting on good soil in certain districts of southern Manitoba. It is a rapid grower and reproduces vigorously from the stump

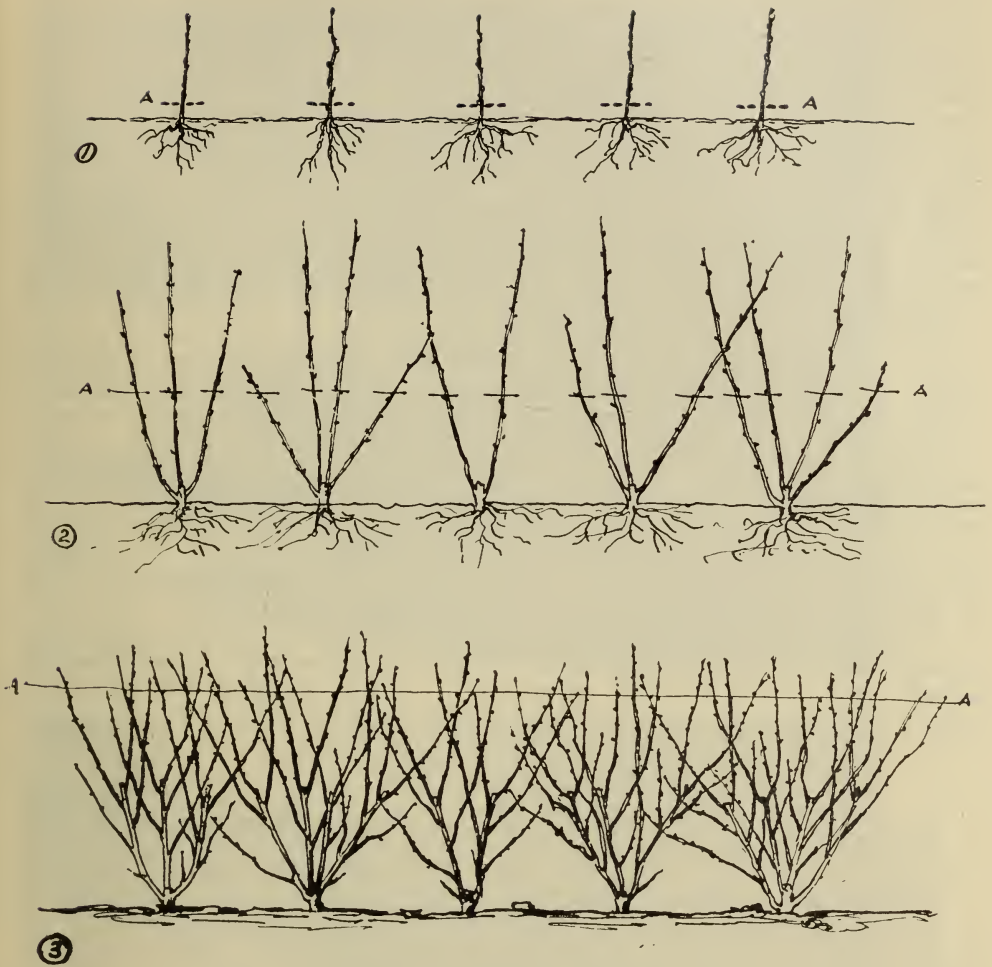


PLATE 32.—CARAGANA HEDGE ABOUT SEVEN YEARS OLD.

This hedge was grown from seed. It is about five feet high, and is trimmed every year. (F.S.C. Photograph 16060).

after being cut down. For street planting, the basswood forms a very handsome shade tree, and is largely used for this purpose in eastern towns. In spring the flowers are very numerous, and emit a very pleasant odour. Honey obtained from these flowers is said to be of excellent quality. In a plantation the basswood is a moderate shade-bearer.

Propagation.—The basswood is usually raised from seed, which ripens about September 1. The seed grain is about the size of a pea and is very hard. It should be sown soon after picking, in drills about one and a half inches deep. Quite frequently the seed remains dormant in the ground for a whole season, germinating only in the second spring. Consequently, if the seedlings do not appear at once, the ground should not be ploughed up but left undisturbed for another year. The seedlings will probably require two years in the nursery.



STARTING A CARAGANA HEDGE

CARAGANA

There are several species of caragana hardy in the West, but the one commonly found and used very widely for hedge purposes is the *Caragana arborescens*, introduced from Siberia. Though it cannot be classed as a tree, the caragana is so hardy and vigorous, and adapts itself to such varied conditions of soil, that it must be considered as a most valuable plant for shelter purposes.

It is particularly suited for hedge purposes, as it will stand trimming well and can be kept at any height between five and fifteen feet and if properly trimmed will grow quite thick and dense from the ground up. As a mixture in shelter-belts it is very useful, particularly in Alberta, where it is difficult to get many of the other species which are hardy in Saskatchewan and Manitoba to stand the extreme weather conditions satisfactorily. When planted in alternate rows with Russian poplar and willow it keeps a thick growth in the bottom of the shelter-belt, which is so desirable in all such plantations.

For hedges the seed may be sown directly in the permanent position, or one-year-old seedlings may be used. When a caragana hedge is started from seed, the soil should be well and finely prepared, the seed sown in a shallow drill not more than three-quarters of an inch deep, with about ten to twelve seeds to the running foot. The seed germinates best if sown in the fall, but when sown very early in the spring results are practically as good. In districts where Cutworms are numerous, seedlings from both fall and early spring sowings are likely to be severely damaged. In such cases seed sown in the latter part of June and early July will germinate well and escape cutworm injury. From the time the seedlings show above ground the row must be kept entirely free from weeds and the surface soil well cultivated. As the growth gets up occasional straggling shoots should be kept trimmed back, but no general cutting back will be necessary until the plants have reached almost the height at which the hedge is to be maintained.

If the hedge is started from seedlings, the plants, preferably one year old, should be spaced about one foot apart in the row. Nothing is gained by spacing them closer, nor by planting the seedlings in a double row. The principal point to observe in the making of a good hedge is, that the plants must be severely cut back in order to get a thick bushy growth from the bottom. Hence the first operation *immediately* after planting should be to cut the tops off to within about an inch of the ground. Each seedling will then send up from two to four shoots instead of growing only a single stem. In the following spring six to ten inches of the previous season's growth should again be cut off. (See illustration, page 45). The hedge can then be left to grow to the necessary height, when it should be kept properly trimmed once or twice each season.

Caragana seed is produced abundantly on plants over four years old. The pods should be picked as soon as the seed has become well filled and is turning a dark colour. They should be spread out in a warm, dry place and frequently stirred. In drying they split open and the seed is thrown out.



PLATE 33.—PLANTATION OF BROAD-LEAVED TREES SUPPLEMENTED BY EVERGREENS.

Inside the belt of broad-leaved trees have been planted four rows of evergreens. Farm of A. Heyer, Neville, Sask. (F.S.C. Photograph 18051).

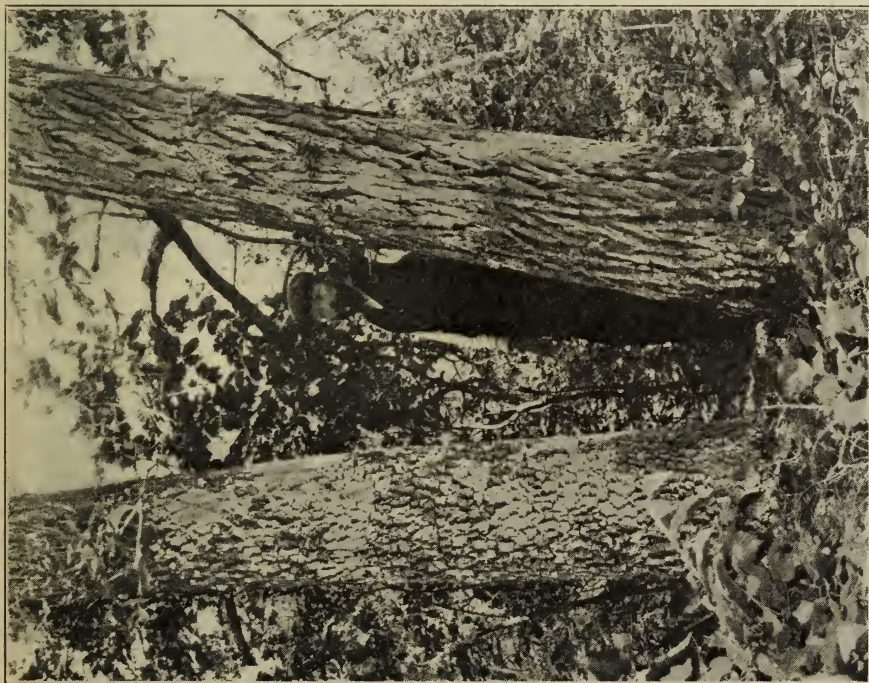


PLATE 34.—ASH AND OAK; GROWTH ATTAINED IN NATURAL WOODS,
SOUTHERN MANITOBA.
(F.S.C. Photograph 9)

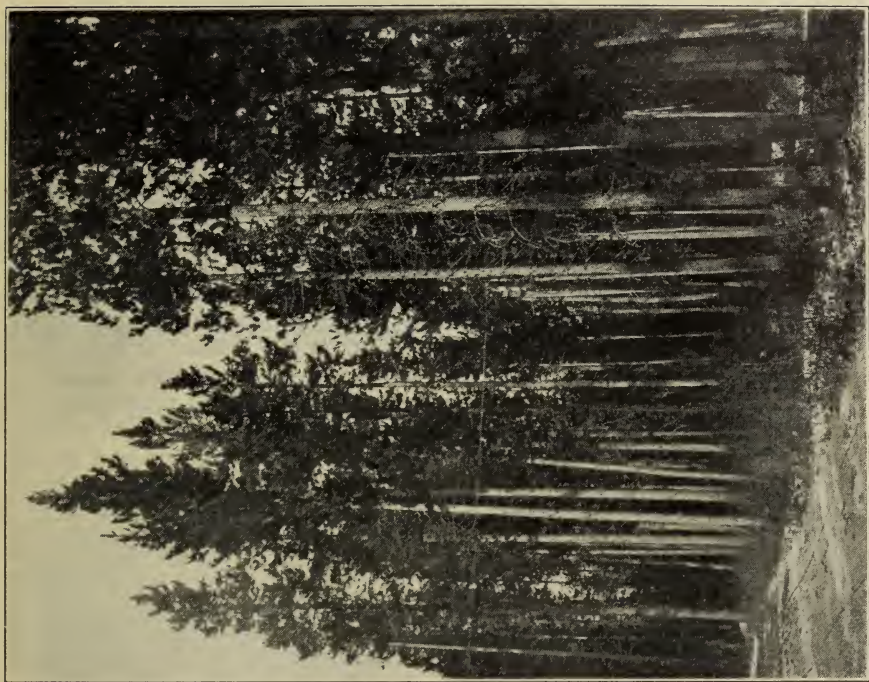


PLATE 35.—LODGEPOLE PINE IN NATURAL FOREST, BANFF, ALBERTA.
(F.S.C. Photograph 182)

CONIFERS

GENERAL NOTES ON NURSERY TREATMENT

There are four or five kinds of conifers (also called "evergreen" and "needle-leaved" trees) which are native to parts of Manitoba, Saskatchewan, and Alberta, namely, the white spruce, black spruce, jack pine, lodgepole pine, tamarack (American larch), and Douglas fir. Besides these the Scotch pine and the European larch are hardy, and will prove of value in prairie plantations. As the methods of raising and caring for the seedlings of the conifers are practically the same for all the above species, the following suggestions in regard to rearing the young plants in the nursery will apply in all cases unless the contrary is stated.

Seedlings of the cone-bearing trees are much more difficult to raise than those of the broad-leaved trees and require considerably more time and labour before they are large enough to plant out permanently. In moist climates two-year-old plants are frequently used in planting, but in the West the plants should be at least four, or perhaps five, years old before they are put out in the permanent plantations. Unless a person can afford to give the young seedlings plenty of care and attention during the first season, it would not be advisable for him to try raising this class of stock, and it would be much better to purchase young plants from a commercial nursery.

Seed-bed.—The best soil in which to raise conifers is a good sandy loam. If such soil cannot be found in the nursery, it should be made by mixing about equal quantities of sand and rich loam together. The ground should then be made up into beds, preferably about three and a half to four feet wide (so that a person can easily reach to the middle to weed and cultivate), and any desired length. The sides of these beds should be protected by rough inch boards set on edge and held in place by pegs driven in on the outside at suitable distances.

Sowing.—After the surface of the soil is made perfectly smooth and level the seed should be scattered broadcast over the whole bed, or it may be sown in rows two or three inches apart. The former method takes much less time. The latter probably results in a more even stand and permits of more thorough cultivation after the seedlings are up. If sown broadcast the seed should be pressed lightly into the ground by going over the surface of the bed with the flat side of a broad board. A very light covering, about an eighth of an inch, of fine sandy loam may then be put on. This is best done by sifting it through a fine wire screen. If the seed is sown in rows it should also be covered to about the same depth. In the dry climate of the Prairie Provinces it is not advisable to rely upon rain to start the seeds, but the beds should be watered constantly. The evaporation of moisture from the beds is very rapid and may be stopped to a considerable extent by placing screens above them. The most satisfactory screen, and one easily put together, is made by nailing common lath to strips of 2 by 2 inches or 2 inches by 1 inch, spacing the lath about an inch apart. For convenience in handling, these screens should be made as wide as the beds and about six to eight feet long. Anything, however, which will exclude a portion of the sun's rays would answer the purpose, as, for instance, brushwood laid across poles or on top of coarse wire netting. Whatever is adopted, however, should be light and easily moved, as the screens must be frequently taken off in order to water and cultivate the beds.

Mice and birds often do considerable damage in the nursery by eating the seeds of conifers, especially the pine seeds, which are comparatively large. This can be prevented to some extent by coating the seed with red lead. This is done by slightly moistening the seed and then sprinkling the powder over it and mixing it well up till every grain is coated. Traps set in the beds will also keep down the number of mice.



PLATE 36.—ROLLING SEED-BEDS IMMEDIATELY AFTER SOWING.
(F.S.C. Photograph 18518)

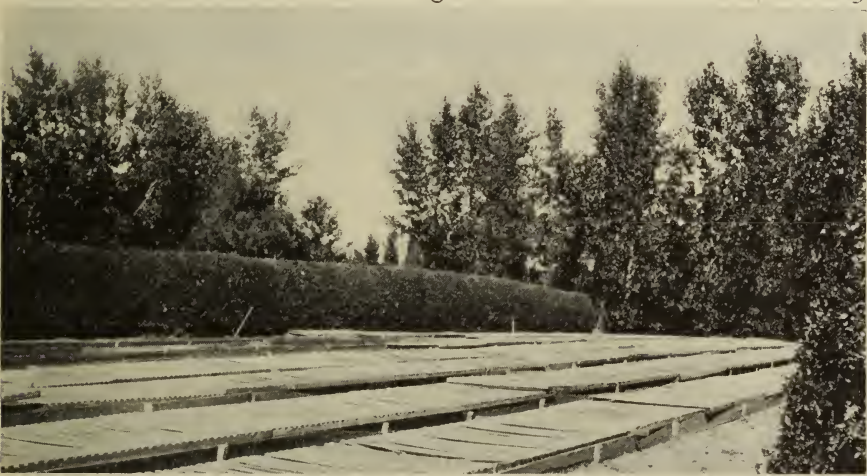


PLATE 37.—GENERAL VIEW OF SHADED SEED-BEDS FOR PROPAGATION OF CONIFERS, SUCH
AS SPRUCE AND PINE.
(F.S.C. Photograph 14276).

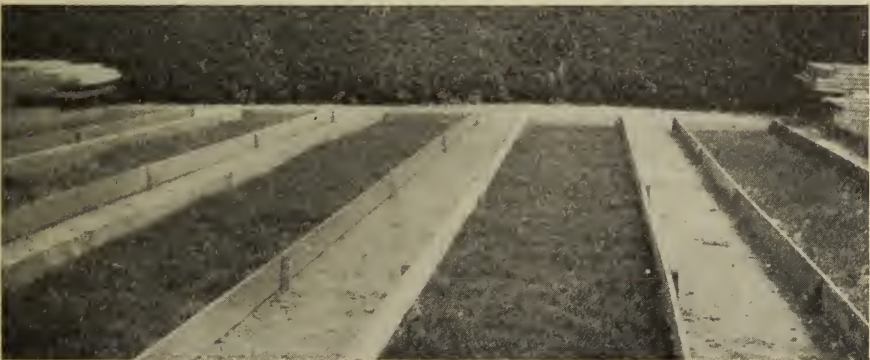


PLATE 38.—SEED-BED OF SCOTCH PINE DURING SECOND SEASON.
(F.S.C. Photograph 15177)

Method Followed at Indian Head.—On the Indian Head Nursery Station Scotch pine, jack pine, lodgepole pine, and white spruce are raised in comparatively large quantities, several thousand square feet of beds being sown each spring. The method followed, which has given uniformly successful results in all average seasons, is the following:—

The area to be sown is first well cultivated and levelled off roughly. Beds are then measured off four feet wide and as long as the plot of ground will permit; a two-foot path is left between each bed and the next. Next, the boards for the sides are put up, rough lumber six inches wide and one inch thick being used for these. The boards are nailed to stakes two inches square driven about one foot into the ground and flush with the top of the side board. After the side boards are in place the surface of the bed is forked over, raked level and all small stones removed. The seed is then sown broadcast by hand; by this method it can be put on very quickly. The surface is raked over, so as to lightly cover the seeds, and this is followed by a light lawn-roller to bring the moisture up to the seeds. Screens, as previously described, are immediately placed over the beds and the operation is complete. The work of sowing and preparing the beds is all done in the spring, so as to complete the work early in May.

Damping off.—During the first two or three weeks after germinating, the beds must be carefully watched, as at this stage the young plants are very tender and are often killed off in great numbers by a certain fungus known to gardeners and nurserymen as the “damping-off fungus.” It is noted more particularly in wet, cloudy weather, especially if the air is warm. Patches of seedlings are found lying flat on the ground, where they quickly wilt. If one of these small plants is examined it will be seen that, just at the point where the root and stock join, the stem is brown and withered for about an eighth of an inch, the rest being apparently healthy. When damping off commences, immediate steps must be taken to stop, if possible, the spread of the fungus. Otherwise the whole stand of seedlings may be destroyed in a few days. If possible all dead and dying seedlings should be picked off, the surface of the bed thoroughly stirred and dry sand or road dust, if either can be procured, scattered thinly over it. The screens should be removed for a short time if the sun is shining, and if it is raining they should be slightly tilted up and covered with matting or lumber in order to keep the beds as dry as possible. If the beds are kept well drained and the surface occasionally cultivated, danger from damping off need not be feared in ordinary weather. As soon as the stems of the young plants become hardened, no more anxiety need be felt. During the growing season the beds may need an occasional watering, and of course must be kept free from weeds. Watering should be stopped after the beginning of August. Though no protection is given them at the Nursery Station other than that afforded by the screens, no damage has yet been done in the seed-beds by winter-killing.

Transplanting.—When two or three years old the seedlings should be transplanted from the seed-bed to nursery rows. When the young plants are raised great care must be taken not to injure the roots nor to allow them to dry out for a single instant. The seedlings should then be placed in rows six to twelve inches apart and placed three to four inches apart in the row. While planting is going on, the roots should be kept in muddy water. Suitable holes can be made with a small dibble, or the seedlings may be planted in shallow trenches, and the soil pulled in by hand. Care should be taken not to plant too deeply and to *thoroughly firm the soil around the roots.*

The seedlings should be allowed to remain in the transplanting beds either one, two, or three years, according to species, when they may be set out in the permanent plantation. If the young trees have not to be transplanted over any



PLATE 39.—SCOTCH PINE IN NURSERY ROWS.

The young trees are two years old, and have just been transplanted to nursery rows, where they will stay for two seasons. (F.S.C. Photograph 15174).



PLATE 40.—WHITE SPRUCE IN TRANSPLANT ROWS.

The young trees are six years old, and have been three years in the seed-beds and three years in nursery rows. (F.S.C. Photograph 14034).

great distance, it is advisable in lifting them to take up with the roots a small ball of soil which should not be disturbed in planting. *On no account should the roots of this class of tree be exposed for an instant to sun and wind, as once the small rootlets dry out the tree is practically killed.* The great number of failures experienced in transplanting evergreens is without doubt due to carelessness in this respect.

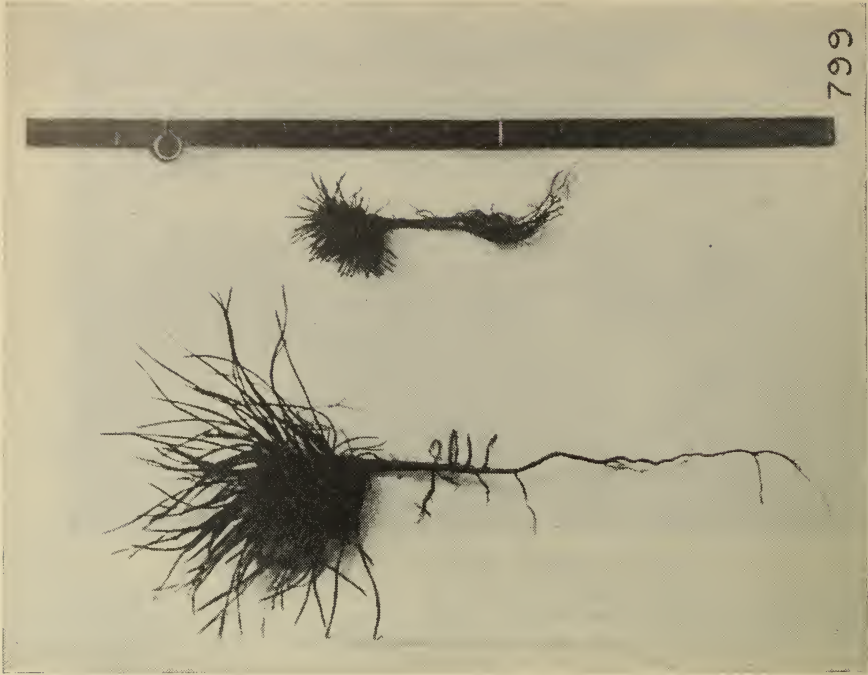


PLATE 42.—SCOTCH PINE SEEDLINGS

Comparative size of one-year-old and two-year-old seedlings is shown. (F.S.C. Photograph 799).

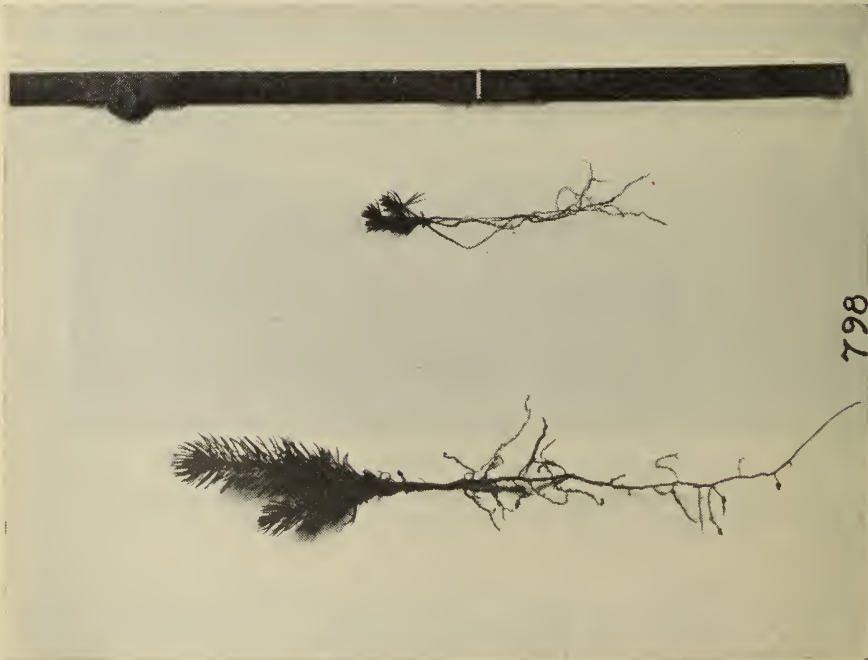


PLATE 41.—WHITE SPRUCE SEEDLINGS

Comparative size of one-year-old and two-year-old seedlings is shown. (F.S.C. Photograph 798).

Species Tested.—The following species of conifers have been grown at the Indian Head Nursery with varying degrees of success:—

- *Scotch Pine (*Pinus silvestris*)—Quite hardy.
- *Jack Pine (*Pinus Banksiana*)—Quite hardy.
- *Lodgepole Pine (*Pinus Murrayana*)—Quite hardy.
- †Swiss Stone Pine (*Pinus cembra*)—Very hardy, but slow-growing.
- †Limber Pine (*Pinus flexilis*)—Very hardy, but slow-growing.
- White Pine (*Pinus Strobus*)—Lives, but cannot be considered hardy.
- †Dwarf Mountain Pine (*Pinus montana mughus*)—Very hardy.
- Western Yellow Pine (*Pinus ponderosa*)—Lives, but not hardy.
- Austrian Pine (*Pinus austriaca*)—Not hardy.
- Red, or Norway, Pine (*Pinus resinosa*)—Hardy from Manitoba seed.
- *White Spruce (*Picea canadensis*)—Quite hardy.
- *Colorado Spruce (*Picea Parryana*)—Very hardy, but slow-growing.
- †Black Spruce (*Picea mariana*)—Hardy.
- Norway Spruce (*Picea excelsa*)—Almost hardy.
- †Balsam Fir (*Abies balsamea*)—Quite hardy.
- Siberian Fir (*Abies sibirica*)—Apparently quite hardy.
- Douglas Fir (*Pseudotsuga taxifolia*)—Not hardy.
- Concolor Fir (*Abies concolor*)—Lives, but not hardy.
- †Siberian Cedar (*Thuja occidentalis Wareana*)—Very hardy.
- Cedar (Arbor-vitæ) (*Thuja occidentalis*)—Grows fairly well in favourable locations.
- †European Larch (*Larix europea*)—Hardy.
- *Siberian Larch (*Larix sibirica*)—Hardy.
- *Tamarack (American larch) (*Larix laricina*)—Hardy.
- Japanese Larch (*Larix leptolepis*)—Not quite hardy.
- †Savin (Juniper) (*Juniperus Sabina*)—Practically hardy.

Species marked * can be safely planted almost anywhere in the West. Those marked †, while hardy, are more adapted for use in parks and ornamental planting.

WHITE SPRUCE

The white spruce is native to many parts of the West, its principal distribution being in eastern and northern Manitoba, northern Saskatchewan, northern Alberta, and along the foot-hills of the Rockies in southern Alberta. It is also found in a completely isolated district in the sand-hills of Manitoba (which extend over townships 8, 9 and 10, in ranges 12 to 16, west of the first principal meridian)—the greater portion of which has been set aside as the Spruce Woods national forest—and also scattered in the Cypress hills in the neighbourhood of Fort Walsh. The spruce grows to a large size. In Brandon, Prince Albert, and other places, large quantities of this timber are sawn into lumber, and logs two feet in diameter are not at all uncommon. The spruce has proved hardy wherever it has been tried in the Prairie Provinces. Most of the young trees which have been transplanted have been secured from the sand-hills or natural spruce woods and are not nursery-raised specimens. Owing to carelessness in digging and transplanting these trees, and also very often because the trees taken were far too big, there have been many failures in planting spruce on the prairies. In consequence of these failures there is a general impression in certain districts that the spruce cannot be transplanted, but there is no doubt that with proper handling there is no reason why there should be less success with this than with any other hardy tree. In taking plants from the woods there are certain points which should be observed.

1. Never select plants which are growing in very sheltered spots, but take them from the most exposed situations, so that the change from the woods to the plantation may not be too great.

2. The greatest care should be taken when lifting the trees not to injure the roots, and during transportation never to allow them to become at all dry from exposure to wind and sun.

3. Always secure small seedlings in preference to larger trees. Those about ten inches or one foot in height will prove far more satisfactory than those three or four feet high, aside from the fact that they are much more easily and cheaply handled.

4. Do not waste time on poorly rooted plants.



PLATE 43.—WHITE SPRUCE PLANTATION, SOUTHERN MANITOBA.

A plantation planted by the late A. P. Stevenson on his farm near Morden, Manitoba. (F.S.C. Photograph 852).

Uses.—The white spruce is one of the most useful trees from an economic standpoint. It is a most valuable timber tree and is extensively used in the manufacture of pulp. For forestry purposes the spruce will undoubtedly prove one of the most useful trees for western planting. As it is an evergreen, it is sure to become a favourite on the prairie, where everything is welcome that tends to relieve the monotony of the landscape in winter. The tree grows with a single main stem, from which the branches spread out on all sides at right angles almost from the ground, so that it forms, when planted closely in rows, an ideal wind-break. The spruce will endure heavy shade and may be planted either pure or in mixture with some light-demanding variety. After the fourth or fifth year the rate of growth is fairly rapid, the annual growth at Indian Head averaging about eighteen inches a year.

The seed of the spruce ripens about the middle of August. If the season is dry and hot, the cones seem to ripen earlier, open, and shed their seed. On one occasion when a quantity of seed was collected by the Forest Service in the sands-hills east of Brandon it was found that as early as August 22 many of

the cones had already opened and a large proportion of the seed had fallen out. The seed inside the cones is ripe when the cones themselves are still quite green. When the cones are cut open the seed can be examined, and if the hull is found to be black and the kernel white and fairly stiff the cones may be considered ready to pick. The cones grow only on the tops of the trees, except in the case of isolated specimens, when a few are sometimes found on the lower branches. The best way to pick them is to climb into the tops and put the cones into a bag carried slung over the shoulders. As the cones are covered with soft resin and the needles are very sharp, it is pleasanter to use gloves than to pick with bare hands. The resin can, however, be easily removed from the hands by the application of a little coal oil. After the cones are collected they should be spread out in the sun. If they can be dried under glass the scales will very quickly open and the seed can then be readily shaken out by stirring the cones over a fairly coarse wire sieve. Before sowing the seed should be separated from the wings by rubbing or flailing in a bag. The broken wings are then easily blown out by an ordinary fanning-mill. The seed may be sown either in the fall or very early in the spring. If kept dry the seed can be stored for a long time, as the kernel is very oily and retains its germinating power very well.

Seed ripens in August or early in September.

Cones should be picked as soon as the seed is ripe.

Seed should be sown late in fall or early in spring.

Of recent years two insect pests have done considerable injury to Spruce in the Prairie Provinces. These are a very small Spider Mite and a small White Leaf Scale. Where the trees appear unthrifty, of a dingy colour and look as though suffering from drought, the presence of either one or both of these insects may be suspected. If not controlled, the trees are very liable to die. Leaflets on the control of these pests may be secured from the Entomological Laboratory at Indian Head, Sask.

JACK PINE

The jack pine is a native of Western Canada and is found usually on types of soil where other trees would find difficulty in growing. It is extremely hardy and seems to thrive on even the poorest soils. It, however, responds well to cultivation and makes rapid growth on clay or loam soils, provided there is no alkali present.

The tree in itself is not so ornamental or symmetrical in growth as the Scotch pine, but is likely to prove specially useful for close planting for wind-breaks owing to its extreme hardiness and rapid growth. S. B. Green, in his book, "Forestry in Minnesota," says: "The jack pine is not a pretty tree, and is seldom used in ornamental planting. It is, however, the hardiest native evergreen we have, and is especially adapted to dry, loose soil, where it has a wondrous power of withstanding drought. It is of rapid growth when young, which, together with its great hardiness, has led to its being planted on some of the sandiest, dry lands of the West."

Uses.—In certain districts the wood is largely used for railway ties, also for fencing material and fuel. For planting it will no doubt prove especially valuable in dry situations, but it should also grow well and produce good timber on the better soils. It is a tree demanding a moderate amount of light and will probably thrive best in mixture, although it grows naturally in pure forest.

Propagation.—The cones should be collected about the latter part of August or the beginning of September. The cones, however, either of jack pine or lodgepole pine (see following section) may be picked at almost any season, as they remain on the branches for many years, the seed still retaining its vitality. The cone of this pine is particularly hard, and it is often very difficult to extract the seed. In order to open the cones enough to allow the seed to be shaken out, artificial heat must be used. A steady temperature of around 150° Fahrenheit

heit must be maintained for some hours in order to do rapid work. Care should be taken not to exceed this temperature, as the germinating power of the seed would probably be injured. When subjected to this heat the cones should fully open in three or four hours. The seed should be sown in early spring, and subsequent management should be the same as that previously given for conifers in general, except that shading is not necessary, although it would probably be of benefit in checking evaporation of soil moisture.

Cones ripen the end of August.

May be picked at any time.

Seed may be sown in late fall or early spring.

SCOTCH PINE

The Scotch pine is a native of Europe, and there are many different types of this species depending upon where it is grown. The Russian type, or *Pinus silvestris rigaënsis*, was at one time considered to be the most hardy, but from trial plantings of stock grown from seed originating in Sweden, Germany, and Scotland, covering a period of over ten years, no difference has been noted so far as hardiness is concerned, but the differences in rate of growth, colour of foliage, and general appearance of the trees are quite marked. On the Nursery at Indian Head the most rapid growth has been made by plants raised from seed supposed to have been collected in Bavaria at comparatively high elevations. These trees commenced bearing cones when about ten years old and a considerable quantity of seed has been collected season by season since that time. The germination of the seed is excellent and the seedlings appear strong and vigorous.



PLATE 44.—SCOTCH PINE PLANTATION JUST AFTER PLANTING.
Indian Head Forest Nursery Station. (F.S.C. Photograph 86)

In Europe the Scotch pine is one of the principal timber trees and reaches a large size on comparatively poor soils. It seems to adapt itself to a great variety of conditions, growing almost as well on light, dry soils as it does on heavy, richer ones (though, of course, more slowly). It is very easily raised from seed, if care is taken to prevent damping off fungus in the early stages. The seed generally used in this country is obtained from Europe; consequently it is rather high-priced. The seed, however, is small and a large number of trees can be grown from one pound, which, according to authorities, contains from 38,000 to 70,000 seeds, depending upon season, locality, etc.

As with all other exotic species it is never safe to rely altogether upon the results of only a few years and it is impossible to state with accuracy how this Scotch pine will do after it reaches a more mature age. Trees on the Experimental Farm at Indian Head now between 35 and 40 years old are still in a healthy condition and there is no particular reason yet to believe that they will not continue in this state for many years.

The Scotch pine is especially adapted for wind-break planting on the prairies. It grows, probably, more rapidly than any of our other evergreens, and is quite hardy, but like other conifers should not be used where there is any alkali in the soil.



PLATE 46.—PLANTATION SHOWN IN PLATE 44 AT TWENTY YEARS OF AGE.

The dead side branches were removed in 1920, opening the way for future light thinning. (F.S.C. Photograph 13857)

LODGEPOLE PINE

Lodgepole pine is found west of the Athabaska along the gravelly slopes of the foot-hills of the Rockies, at about 4,000 feet elevation, also at the western end of the Cypress hills, but not lower than 500 feet from the summit. (Macoun, "Catalogue of Canadian Plants," part III, p. 467.) It is the principal tree at Banff, on the mountain slopes.

Seed collected from the Cypress Hills region produces stock especially adapted to prairie conditions. Seed from the eastern foot-hills of the Rocky mountains has also proved reasonably satisfactory, but seedlings produced from seed secured farther west in British Columbia have not proved entirely hardy



PLATE 47.—PLANTATION OF TAMARACK AND WHITE SPRUCE.

Photographed just after planting. Indian Head Forest Nursery Station. (F.S.C. Photograph 80)



PLATE 48.—PLANTATION SHOWN IN PLATE 47 AFTER EIGHTEEN YEARS' GROWTH.
(F.S.C. Photograph 13985)

This pine is quite suited to prairie planting, both in wind-breaks and for ornament. Its habit of growth is straight and symmetrical, but the branches do not spread as far as do those of the Scotch pine. The growth is not quite so rapid and it seems to be even more susceptible to injury from alkali than either the jack pine or Scotch pine.

The remarks regarding collection of cones, extracting seed, sowing, etc., under "Jack Pine" apply equally well to the lodgepole pine.

TAMARACK, OR AMERICAN LARCH

The tamarack or larch is found ranging from the Maritime Provinces as far west as the eastern foot-hills of the Rockies. It grows naturally in the low spots and swamps, seems to adapt itself easily to new conditions, and strikes root readily and thrives well on ordinary clay soil.

The tamarack is one of the few coniferous trees which lose their leaves every autumn. Like the spruce, it grows a single, straight, gradually tapering stem.

Plantations of tamarack set out on the Nursery in 1905 and at subsequent times have all made excellent progress; the growth has been very rapid and if this species can escape the attacks of the larch sawfly it should prove very valuable for prairie planting. The wood is useful for many purposes and is considered specially good for such uses as fence-posts, rails, and telephone poles. Much damage, however, has been done to the natural stands of tamarack in Eastern Canada by the sawfly, and a few years ago the larches in Manitoba and eastern Saskatchewan, both in the natural woods and cultivated plantations, were badly affected. At the Indian Head Nursery Station and also at the Sutherland Nursery Station it is found necessary every year to spray all larch plantations very thoroughly in order to control this insect, although for the last few years it has been found that certain natural parasites are helping very materially to keep it in check. It would not be advisable, therefore, to plant the larches or tamarack at all extensively unless one is prepared to control the sawfly, although it is hoped that in a few years the natural parasites will become sufficiently numerous to keep these insects in check.

Judging from the results of the plantations on the Indian Head Nursery the tamarack or larch is well suited for wind-break purposes and in fact will make a denser shelter than practically any of the broad-leaved species, and it is at the same time a rapid grower. It will do well in mixture with caragana, ash, and maple, but should not be planted with willows or Russian poplars, as these grow too fast and would crowd it out.

The tamarack is a very good ornamental tree, the leaves appearing very early in the spring, and the general habit of the tree is very graceful and symmetrical.

Propagation.—The larches are easily grown from seed, the cones ripening as a rule early in August. Cones should be collected as soon as seed is ripe, and the seed extracted in the same manner as described for white spruce. The seed is sown in beds and the young plants handled exactly the same as those of pine, and transplanted to nursery rows at two years old.

EUROPEAN LARCH

This is a European species which, though hardy and a rapid grower, does not usually make such a straight tree as the tamarack. The needles are longer than those of the native tamarack and remain on the tree later in the season. The rate of growth is about the same as that of the tamarack. For the prairies it can quite well be planted for wind-break purposes but will be more useful

for ornamental work, provided tamarack seedlings can readily be secured. The objections to the European species are the generally crooked growth of the main trunk, the fact that rabbits appear to be very fond of eating the smaller plants (and consequently are liable to destroy young plantations which are not adequately protected) and the uncertainty of transplanting once the buds commence to open. While the tamarack will transplant successfully, even when the leaves are as much as one-quarter of an inch long, the European larch very seldom can be moved after the buds once show green. As the European larch is among the first trees to bud out in the spring the planting must be done very early to ensure success.

SIBERIAN LARCH

The Siberian larch is very similar in general growth and appearance to the European larch. It is, however, a remarkably straight-growing tree and appears more vigorous and hardy than the European species. It sheds its leaves at least two weeks earlier in the fall, indicating that a much shorter season is necessary in which to mature the growth of the year. In test plantations at Indian Head where the three species, namely, tamarack, European larch, and Siberian larch, are growing side by side, the Siberian larch presents much the best appearance and can be safely recommended for planting in preference to the other two species wherever stock can be obtained. It is, however, difficult to secure the seed, which has to come from Europe, as it is a very poor seed-producer. The Siberian larch has evidently not been tested to any great extent either in Canada or the United States, as several inquiries have been made for photographs and specimens of foliage from the Indian Head plantations. Specimens of flowers and cones were forwarded by request to the Arnold Arboretum in Massachusetts, and in a letter received from Prof. C. S. Sargent he states: "Your trees are interesting, for I think this is the first time *Larix sibirica* has fruited in America. As I saw this tree growing in Siberia I felt that it might be an excellent tree for the colder parts of Canada and it looks as if this view about it was correct." In the fall of 1925 measurements were taken of about one hundred trees of each species growing side by side at the Indian Head Nursery; the trees had been planted in 1908, and thus had been growing for eighteen seasons. These measurements afford some indication of the comparative rates of growth of the three species. They are as follows:—

Species	Average height		Maximum height		Diameter at 4 ft. 6 in. from ground
	ft.	in.	ft.	in.	in.
American Larch or Tamarack.....	29	3	34	6	4.01
European Larch.....	33	0	38	9	5.44
Siberian Larch.....	33	6	36	0	4.40

SWISS STONE PINE

This is another European species which has proved exceptionally hardy at Indian Head. Its particular merit is as an ornamental or lawn tree. It belongs to the group of white pines, the needles being in bunches of five the same as the eastern white pine (*Pinus Strobus*), and the tree somewhat resembles it in general appearance, except that the growth is very much slower and more sturdy. This species being so slow-growing is not recommended for shelter-belt planting.

LIMBER PINE

Limber pine is a native of the Rocky mountains, is very hardy, and, at least when young, resembles almost exactly the Swiss stone pine. The rate of growth is about the same and the general remarks regarding the Swiss stone pine apply equally well to it.

LOW-GROWING OR SHRUBBY EVERGREENS

Dwarf mountain pine (*Pinus montana mughus*), savin or "juniper" (*Juniperus Sabina*), Siberian cedar (*Thuja occidentalis Wareana*), are all hardy species, but are useful only for landscape or ornamental planting. The dwarf mountain pine will attain quite a size, perhaps, in some cases, eight to ten feet in fifteen years. It branches out from the ground and does not grow a straight, single trunk as do most other pines. The juniper and cedar mentioned above are both low-growing, the juniper spreading out along the ground in a dense mass, generally not more than two and a half to three feet in height. The Siberian cedar is very hardy, also very slow-growing, reaching not more than three feet in height in ten years on the Nursery at Indian Head. These three species can be used to great advantage in any ornamental plantings in combination with each other and also with groups of deciduous shrubs.

FREE TREES FOR FARMERS

NOTE.—For information concerning tree-planting and the free distribution of trees to farmers in Manitoba, Saskatchewan, and Alberta by the Forest Service of the Department of Agriculture, apply to the Chief of Tree-Planting, Dominion Forest Nursery Station, Indian Head, Saskatchewan.

HEDGES

Reference has already been made to the *Caragana arborescens* as a hedge plant. This is the best all-round general purpose hedge plant for prairie planting. Other species, however, of a more ornamental nature may also be used very satisfactorily, particularly in the immediate neighbourhood of the residence and gardens.

Lilac.—The common lilacs, both purple and white, make very attractive hedges. These hold their leaves later in the fall than any other deciduous species. They should be trimmed just after the blossoms are over so that the blossom buds are not cut off and there is still time left for buds for next season's flowering to be formed.

Tartarian Honeysuckle.—A very attractive tall-growing hedge; should not be trimmed too severely.

White Spruce.—Stands trimming very well and makes a very satisfactory hedge for all seasons of the year.

Balsam Fir.—Stands trimming very well and makes a fine hedge in districts where it is hardy. There is an excellent hedge of this species at the Indian Head Nursery station.

Common Cedar.—This is used very extensively in Ontario as a hedge plant, but cannot be depended upon in the prairie regions, except in more favoured localities. There is an excellent hedge of this cedar on the nursery station at Indian Head, set out over 20 years ago, still in excellent condition and apparently improving each season. This species should only be used where the site is more or less sheltered by older trees and wind-breaks.

LIST OF BOTANICAL NAMES OF TREES MENTIONED IN THIS BULLETIN

Manitoba Maple, *Acer Negundo*
 Green Ash, *Fraxinus pennsylvanica* var. *lanceolata*
 White Elm, *Ulmus americana*
 Cottonwood, *Populus deltoides*
 Russian poplars, *Populus petrovski*, *P. certinensis*, *P. wobstiriga*
 Willow, *Salix* spp.
 Paper Birch, *Betula alba* var. *papyrifera*
 Bur Oak, *Quercus macrocarpa*
 Basswood, *Tilia americana*.
 Caragana, *Caragana arborescens*
 White Spruce, *Picea canadensis*
 Jack Pine, *Pinus Banksiana*
 Lodgepole Pine, *Pinus Murrayana*
 Scotch Pine, *Pinus silvestris*
 Swiss Stone Pine, *Pinus cembra*
 Limber Pine, *Pinus flexilis*
 Dwarf Mountain Pine, *Pinus montana mughus*
 Tamarack, or American Larch, *Larix laricina*
 European Larch, *Larix europea*
 Siberian Larch, *Larix sibirica*
 Siberian Cedar, *Thuja occidentalis Wareana*
 Savin ("juniper"), *Juniperus Sabina*

Bulletin No. 142, New Series, on "Hedges and Their Uses," may be obtained free from the Publications Branch, Department of Agriculture, Ottawa.

OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1933