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NATIVE AND PLANTED TIMBER OF IOWA.

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NATIVE AND PLANTED TIMBER OF IOWA.

INTRODUCTION.

The increasing demand for agricultural land in Iowa has caused a very rapid removal of woodlots and groves during the past five years, which has greatly reduced the home supply of posts, fuel, and farm repair material. The prices of posts, poles, and lumber imported from other States have risen from one-third to one-half in three or four years, and since the supply of white cedar and red cedar is limited, the price of posts at least will continue to increase. This high cost has led many residents of the State to take steps toward managing their farm woodlots so as to obtain greater returns from them by growing their own fence posts and repair material. This tendency toward the practice of forestry largely brought about the Bixby forestry bill, passed by the legislature in 1907, which provides that lands occupied by woodlots and groves shall be given a taxable value of $1 per acre, if certain conditions of the bill are complied with.

PURPOSE AND METHOD OF INVESTIGATION.

To aid in the movement toward practical forestry in Iowa, investigations were made during 1905 by the Forest Service to determine the extent, character, and value of the native farm woodlots and planted groves. In the studies of natural tree growth, the main water courses were followed. Investigations were made of the relation of topography and soil to existing tree growth, and of the effect of the previous conditon and treatment of the forest upon its present extent, composition, reproduction, and enemies.

In the studies of the planted timber two routes were planned, one in the northern part of the State and one in the southern, in accordance with the answers to letters and question blanks which had been sent out. Much valuable information regarding the planted timber of the State was obtained through these blanks.

Groves and windbreaks were examined to find out what species had been planted and how these species had succeeded under widely varied conditions of soil, moisture, and situation. The rate of growth of various species was also determined.

ADAPTABILITY OF THE STATE TO TREE GROWTH.

TOPOGRAPHY.

The surface of Iowa is in general an undulating plain, bounded on the east by the Mississippi River and on the west by the Missouri and Big Sioux rivers. The numerous tributaries of these large rivers make up the drainage system of the State. As a rule it is only along the valleys of these streams that the surface is broken to any extent. The difference in elevation between the highest and lowest points is so slight (less than 1,100 feet) that the drainage over large areas of the State is imperfect, and this affects the value of the land for agriculture or forestry. There is only one main watershed, and that is not well defined. It extends in an irregular line from Dickinson County on the north to Wayne County on the south.

On account of the slightness of the differences in elevation and other physical characteristics, there is no wide divergence in the types of tree growth in the State, and hence the problems of tree planting and woodlot management are simplified. There are two forest types—one in the low, level, moist areas along streams, made up largely of alluvial soils, and the other on higher, well-drained slopes and uplands back from water courses, or in scattered areas over the undulating prairies. These types merge into each other and it is seldom possible to define their boundaries. In the bottom type are such moisture-loving trees as cottonwood, willow, honey locust, black ash, elm, and coffeetree, and in the upland type are the oaks, hickory, ironwood, butternut, white ash, and hackberry. Throughout the State the soil is adapted to the growth of forest trees.

SOIL.

Iowa soils may be divided into four classes—geest, which occurs mainly in the northeastern portion of the State and constitutes less than 1 per cent of the total area; alluvium, which is usually found in stream valleys and forms less than 6 per cent of the total area; loess, a wind-formed soil, which covers 66 per cent of the State; and till or drift, which is the product of glacier movement, and covers the remainder of the State. It was observed that upon the geest and drift soils reproduction is more abundant and growth more vigorous and that the trees attain a greater age than on either loess or alluvium.

Whenever it is possible, trees, especially the slower growing ones, should be planted on the sandier and coarser soils of the farm, and these soils should be used for growing seedlings in preference to the finer loess or heavier alluvial soils, especially as the finer soils are of greater value for agricultural purposes.

CLIMATE.

The rainfall of the State ranges from 30 inches in the immediate vicinity of the Missouri River to 32.5 inches along the Mississippi. There is a gradual decrease in the average annual rainfall from south to north and from east to west. The rains are usually the result of the meeting of warm, moisture-laden winds from the Gulf of Mexico and cooler air currents from the north and west. There are no places in the State where the rainfall is insufficient for the perfect development of hardy trees. Although droughts do occur in Iowa, they come only at long intervals, generally in the midsummer months; yet it is probable that a greater loss to the State has resulted from excessive moisture during the agricultural growing season than from insufficient rainfall. These periods of excessive moisture favor the growth of trees.

The mean annual temperature is about 47.5°. The transitions between winter and summer are much more rapid than in States nearer the Atlantic coast. This influences to a marked degree the distribution and general growth of trees. Seedlings and often mature trees are seriously injured or even killed by frosts in the fall before the new wood has become thoroughly ripe. The average date of the latest killing frost in the spring has been April 20, and that of the earliest in autumn, October 9.

The prevailing summer winds, which are usually hot and dry, are from the south, while those at other seasons are from the west. These winds are almost constant and have a velocity of from 8 to 9 miles an hour. The distribution of many tree species is determined largely by these constant drying winds, which probably are responsible for the treeless condition of the plains. Their injurious effect, which can be seen on any exposed windbreak or orchard, may be minimized by planting protective borders of low-growing, hardy trees on the exposed sides. Planting of windbreaks and groves in the State during the past fifty years has probably modified the severity of winds, but to what extent is not known. These strong winds stimulate transpiration from the leaves of the trees during the growing period, and increase the evaporation from the soil during the dormant season. This latter causes damage by winter killing.

DRAINAGE.

The imperfect natural drainage of parts of the State has resulted in scattered, swampy areas, some of which are of very large extent. Since land is rapidly increasing in value these areas are gradually being drained and utilized for farming purposes. On swampy areas which are difficult to reclaim by drainage, arborvitæ, tamarack, willow, and cottonwood can be grown successfully, and in addition to the

posts, repair material, and fuel they will produce, they may be of great value in the ultimate reclamation of the soil by taking up immense quantities of water and depositing layers of organic material on the surface.

NATIVE TIMBER.

DISTRIBUTION.

When white men came to Iowa it is estimated that a fifth of the State was forested. The eastern portion of the State was pretty well covered. The best growth was along the larger rivers, but it often extended many miles away from the banks. Occasional small groves were found on the prairies. Through the southern and western parts and along the Des Moines River and its tributaries in the central part there were scattered groves.

The principal tree species in the early forests were practically the same as those found to-day, bitternut and pignut hickories, and black walnut; white, bur, red, yellow, and swamp white oaks; soft, or silver, and hard, or sugar, maples; white and green ash; white, slippery or red, and cork elms; hackberry, basswood, cottonwood, black willow, sycamore, honey locust, and coffeetree, besides others of less importance.

NATURAL EXTENSION.

Where natural extension of timber took place, it spread from the main bodies along the Mississippi and Missouri rivers and followed the tributaries of those rivers. That it did not extend farther up the streams and outward across the prairies was due principally to prairie fires, which annually and often semiannually swept over a large part of the State. Natural extension was more uncertain and slower in the western part of the State than in the eastern, because of less abundant rainfall, greater exposure to hot, dry winds, and greater frequency of prairie fires. In many cases forest growth extended farther up the southern bank of streams than the northern, and covered larger areas on that side. This was due probably to the fact that snow was not reached by the sun as quickly on the southern bank, and so lasted longer. The spring fires destroyed the trees on the dried-out northern bank, but were checked by melting snow on the other side.

As settlement, which began in the timbered portions of the eastern part of the State, extended westward across the prairies, many of the causes of prairie fires were removed and immediately the forest growth began to extend farther up the streams and back to the uplands.

CONDITION.

The original timber areas consisted largely of scattered groups of trees surrounded by brush and grass. In the eastern part of the State,

where conditions of growth were most favorable, there were tracts of forests that compared well with the best virgin timber in the Ohio Valley. The best specimens of oak, walnut, and sycamore were often from 4 to 6 feet in diameter and from 80 to 100 feet high, but in the settlement of the region these soon disappeared, and have never since been equaled in the State.

Throughout the central and western portions of the State the streams were fringed with thin belts of trees, but usually back of these the growth was poor and scrubby, suitable only for the protection of stock, for a poor grade of posts, and for fuel.

UTILIZATION.

In the more heavily timbered portions of the State the early settlers utilized the best timber for the construction of buildings and fences. The westward extension of railroads had much to do with the exhaustion of the timber. Every accessible tree that would make a bridge timber or sleeper was cut almost before the prairie sections of the State were settled. Even before the railroads reached the valleys of the Cedar and Iowa rivers much of the best red cedar and walnut along these rivers had been cut and rafted to the Mississippi for the down-river trade. Again in the early eighties a very thorough canvass of the eastern and central parts of the State was made by furniture manufacturers, and most of the best walnut was taken out. This thorough removal of the virgin timber of the State soon necessitated the importation of softwood lumber and cedar posts. These are now increasing so rapidly in value that many consumers are being forced to use cheap grades of pine, hemlock, and hardwoods. Portable sawmills are operating wherever timber is found, and the best of the second-growth woods and planted timber is being utilized. Cottonwood and silver maple have been found very valuable for construction purposes where the wood is not exposed to the weather, and they sell for from $22 to $28 per thousand board feet.

The high price of lumber and posts and the rising value of farming land is causing the clearing of many hillsides and ridges in the eastern part of the State. Many of these ridges are not fit for agricultural purposes themselves and moreover are a menace, since rains and melting snows erode them and spread the soil and débris over the fertile lands below. The removal of the forests has led also to floods and to the disappearance of springs and small streams. More than this, it has very considerably lowered the water table in the soil. In southern Wisconsin the lowering of the water table has resulted in the death of many large trees, which could not send out new roots and adapt themselves to the changed moisture conditions of the soil. The dying out of many old trees in eastern Iowa is probably due to this same cause.

MANAGEMENT OF NATIVE GROVES.

Iowa has a smaller proportion of nonagricultural land than any other State, and this is being decreased each year by turning unproductive areas into orchards, pastures, and ranging ground. With the development of the fat-stock and dairy industries there will be an increasing demand for grazing lands, and this in turn will cause the clearing of large tracts now held as woodland.

However, from 10 to 15 per cent of the State will remain in timber, and this portion should be so managed as to yield at least fair profits from the soil. Notwithstanding the excellent farming methods in the State and the increasing desire of the settlers to improve those methods, little attention has been paid to increasing the returns from the woodlot.

Formerly the farm woodlots were used commonly for pasture; this practice, when the annual fires killed the old mature trees, prevented new growth from coming in. When posts, poles, or fuel are needed it is seldom possible now to secure them from the woodlot which should furnish them, and the farmer must purchase them from the local lumberman at a constantly increasing price.

PROTECTION.—Shade and protection for stock is necessary, but it is a detriment to the stock to pasture them exclusively in woodlots, for grass growing under trees has but a small percentage of the food value of that grown in the open, and much better results for both cattle and trees can be obtained if from half an acre to an acre of ground for shelter is planted to silver maple or willow, setting the trees close. When the planting is from 3 to 5 years old, cattle or horses may be allowed free access to it from large pastures, and even if the silver maple is gradually killed out the loss will not be as great as if the whole woodlot were used.

If more pasture land is needed on the farm, half the woodland may be cleared and turned into good grassland. If the remaining half is protected from fire and stock and a few careful thinnings are made, it will become a perpetual source of wood for posts, repair material, and fuel.

FIRE.

Every spring and fall, when the damage from fire is greatest, the groves should be closely watched, especially if they are located near a railroad. If old roads or paths run through the tract, they should be raked clear of brush and leaves at least twice a year. When kept clean, they prove very effective in stopping surface fires.

Where there is constant danger from fire, strips two or three furrows wide and a rod apart should be plowed around the grove, if possible. If highways run along the sides of a grove and there is danger of fire

from cigar stubs or matches, the herbs and shrubs should be cut, and if necessary the roadway burned over.

When trees are cut in the woodlot, all branches and smaller limbs should be utilized as fully as possible for fuel. Those which can not be utilized should be taken to an open space and burned or cut up and spread over the ground to hasten their decay.

The tools best suited for fighting fires in woodlots are heavy rakes, with which paths may be cleaned in front of advancing flames. Shovels are very useful where the soil is light and can be easily thrown upon the fire. It will not be necessary to back fire except in rare cases, and then it should be done by raking a path parallel to and some distance ahead of the fire, and starting small fires along this path to destroy débris so that when the two fires meet they will die out for lack of material.

INSECTS AND FUNGI.

Since farm woodlots are usually small in area and widely separated by cultivated fields, roads, and streams, there is less danger of extensive infestation by insects and fungi than where forests occur in solid bodies of wide extent. If insects are unusually abundant and are doing much damage to the trees, specimens should be sent to the Bureau of Entomology of the United States Department of Agriculture, which will identify them and give suggestions for combating them. Where single trees seem to be dying out as a result of a rot or of insects, they should be removed, and all portions of the tops not suitable for fuel should be burned at once. In pruning, care should be taken to cut the limbs close to the trunk in such a manner that water can not find lodgment. The entrance of the spores of fungi may be largely prevented if wound surfaces on trees are painted over with white lead.

MANAGEMENT.

REPRODUCTION.—The following suggestions for the reproduction and care of woodlots are given with the presupposition that stock and fire are to be excluded. Should it be necessary to use a part of the tract for pasture, it may be divided into sections and each section fenced off in succession, until reproduction in each can be accomplished.

Natural reproduction by seeds and sprouts.—The woodlots throughout the State are made up of hardwoods, most of which sprout readily from the stump. A large part of the timber in these woodlots has come from stump sprouts, which, under conditions of healthy growth, make trees of a size suitable for posts and logs in a shorter time than it took the original tree to grow. Because of the ease and cheapness of this method of reproduction, it is likely to be used more extensively than any other. Trees cut during the winter sprout better than those cut at other seasons, but for reasons explained later,

winter cutting is not always desirable. The stumps should be cut as low as possible and left with a slanting surface, so that water will run off readily. The lower the stumps, the less danger there will be of the sprout being broken by wind and the quicker the new tree will form independent roots of its own. The oaks, ashes, mulberry, basswood, walnuts, and hickories may be very readily reproduced by stump sprouts, and the trees so formed are straighter and of more rapid growth, and the wood is as durable as that from trees which have grown directly from seed. A woodlot constantly reproduced in this way will gradually run out as the vigor of the original stumps fail and must eventually be replaced by trees from seed naturally sown or from planted seed or seedlings.

The exclusion of fire and stock will favor the natural seeding of the woodlot from trees already standing on the ground. If the ground is covered by heavy sod or herbaceous growth, natural seeding can be greatly aided by stirring up the soil with plow or mattock just before a crop of seed falls, so that the seeds may reach the mineral soil. This method of reproduction is slow, however, and with the small areas occupied by woodlots it is feasible to plant the open spaces with seedlings of the desired species, and thus shorten the rotation of the crop, and hence increase the returns.

Artificial reproduction by seeding and planting.—Usually where a stand of walnut, butternut, or red oak is desired, the nuts or acorns may be planted directly where the tree is to stand. Spring planting of nuts and acorns is more advisable than fall planting, provided the nuts are properly stored during the winter. If spaces to be restocked are of large size the seeds may be planted 6 feet apart each way in regular rows, or irregularly so that in the ultimate stand, including large trees, the spacing is approximately 6 by 6 feet or a little greater. The precaution should be taken to plant seeds of trees which will endure more or less shade.

If it is desired to underplant the woodlot with conifers or some of the quicker growing hardwoods, like honey locust or catalpa, seedlings from 1 to 4 years old should be used. Seedlings should be spaced as suggested for seeding. Some of the best trees for underplanting, besides those already mentioned, are white pine, white spruce, hemlock, sugar maple, hackberry, and hardy catalpa.

Improvement thinnings.—If after the young seedlings in a woodlot are well started they are left entirely to themselves, the struggle for light and space will be so great that many good specimens of the most valuable species will be killed out and such worthless weed trees as ironwood, blue beech, hawthorn, and prickly ash, through their ability to reproduce and grow in shade, will thrive in their place. If at that time a little judicious thinning is done, nature will be greatly aided in her production of valuable material. Too often the best

trees are selected and cut every time a piece of wood is wanted. If mature, dying, or worthless species are removed with care so as not to injure the young growth, the grove will constantly improve in composition as the place of the overmature, diseased, and worthless trees is taken by the better young growth.

In an old woodlot which is badly run down, thinnings should begin at once and be repeated often, but at no time should trees be removed in such a way as to permit the formation of extensive areas of brush and grass. If only large, overmature trees are present, they may be cut in groups and the vacant area sown to acorns or nuts, or planted with valuable species which can endure shade. In this way all the large trees may be gradually removed and the area restocked with valuable young forest growth.

Great care should be exercised in all thinnings, especially on hillsides and ridges, not to cut out so heavily as to expose the soil to erosion. This washing away of valuable soil and the formation of gullies is each year destroying large areas of land in Iowa. Two hundred square miles is said to be so lost each year in the United States, and Iowa is doing more than her share toward increasing this figure.

Harvesting the crop.—The best time to cut the trees to insure sprout reproduction is in winter or early spring, and the wood of sprouts which form in early spring has ample time to ripen before winter. However, if the trees are cut between late July and September, during what lumbermen call "the second running of the sap," and then left to lie for several days, until the leaves are completely wilted, seasoning will take place rapidly and thoroughly after the posts or poles are peeled. Peeling should be done at once, and the logs should be piled so that no part touches the ground. Posts so treated will greatly outlast those of the same species and size cut in winter and stacked on end without peeling. Trunks should not be left lying on the ground before utilization, as this invites attacks of fungi and insects and hastens rot.

PLANTED TIMBER.

SPECIES.

When the people learned that the prairie soil was as valuable for agricultural purposes as that of the hardwood regions, and the settlement of the State began to extend westward from the timbered lands along the Mississippi, there arose a need for the protection of the new homes from the severity of hot and cold winds. Since the need was immediate and seeds and seedlings of the softwoods were cheap, easily obtained, and gave early results, the first plantings in the State were of such species as silver maple, cottonwood, boxelder, and willow. The silver maple has been more widely planted in Iowa than any other tree because it makes good fuel, when seasoned under cover,

and attains a greater age than the other softwoods mentioned. As a section of the State becomes older and more wealthy, better homes are built and are surrounded by slower-growing, longer-lived trees. The planting of evergreens was begun at an early date, as the settlers saw that, since they retained their leaves throughout the year, they were much more effective for windbreaks than deciduous trees.

PURPOSE OF PLANTING.

Following the period of planting quick-growing trees on the prairies for protection only came the time when anxiety as to future timber supplies, aroused by the depletion of the virgin timber by railroads and the exploitation of red cedar and walnut, led to the planting of better, slower-growing hardwoods. The State law of 1868, which granted a rebate of taxes for a certain amount of planting, resulted from this fear of a timber famine. Under this law a large amount of planting was done, but frauds caused its repeal during the eighties. Altogether the law worked for good, since it not only increased the amount of planting done, but aroused interest in trees and increased the knowledge of planting and of species best adapted for the State. In nearly all cases the plantations which were made under this law were composed of soft-wooded hardwoods, and to-day these species form a very large proportion of the planted groves. Black locust, black walnut, green ash, honey locust, and European larch were planted for posts and lumber, and wherever even the slightest attention and care was given, such groves, with the exception of the black locust, have given good results. The black locust, a few years after planting, was destroyed by the locust borer (*Cyllene robiniæ*). Many nurseries came into existence between 1865 and 1880, and did much toward the introduction of evergreens and more desirable hardwoods.

PROBABLE CAUSES OF SUCCESS OR FAILURE.

There were many failures during the early years of tree planting in the State, and there are still many. These failures, however, have been useful in supplying knowledge of the best species to plant and of the best methods of establishing and caring for plantations.

The greatest cause of failure was the absence of proper care. Small trees of silver maple, green ash, and black walnut were planted in groves as close as 3 by 6 feet or 4 by 4 feet. They were not cultivated or thinned, and as they became larger many were deformed and killed by crowding and lack of moisture. In many cases the groves were used for stock yards or feed lots during winter, and browsing and trampling prevented reproduction and often exposed the roots and damaged the bark of older trees so that they died. Trees respond readily to cultivation and care. They will not succeed to the fullest degree if sod is allowed to form about them or if the soil is packed down around the roots by the constant trampling of cattle and horses.

The use of undesirable species was frequently the cause of failure. Such trees as black locust, chestnut, beech, and others which were widely used, were total failures because of insect attacks or lack of hardiness.

PLANTING AND CARE OF WINDBREAKS.

SPECIES TO BE USED.—A greater variety of trees has been planted in the State for windbreaks than for any other purpose, but the number which can be used successfully is limited. Certain species, although not of the greatest usefulness for windbreak purposes solely, have a high value for fuel, posts, and farm repair material. These may be used to advantage both for windbreaks and the production of wood supplies. The best of these "dual purpose" trees are included in the following list:

Honey locust.
European larch.
Silver maple.
Cottonwood.
Green ash.
Hardy catalpa.
Russian olive.
White willow.
Osage orange (in central and southern Iowa).

The black or yellow locust would answer the two requirements better than any of the trees mentioned but for its susceptibility to the attacks of the locust borer, which riddles and kills it within a few years.

Some of the pines and spruces are much more valuable than any of the broadleafed trees for windbreak planting alone. They retain their leaves throughout the year and thus provide protection during the winter when it is most needed. The hardier evergreens may be successfully grown under nearly all conditions of soil and moisture, and their growth is often more rapid than that of the more permanent hardwoods. Climatic and other conditions which influence tree growth are more severe in the western part of the State than in the eastern counties, and it has been found that certain of the Pacific coast and Rocky Mountain conifers do better there than those from the East. The evergreens recommended for planting in different parts of the State are given in the following list:

Eastern Iowa.

White pine.
White spruce.
Norway spruce.
European larch.
Austrian pine.
Colorado blue spruce.
Arborvitæ.
Hemlock.
Scotch pine.
White fir.
Douglas fir.
Western yellow or bull pine.
Tamarack.

Western Iowa.

Black Hills spruce.
Western yellow pine.
Austrian pine.
Scotch pine.
Douglas fir.
White pine.
Colorado blue spruce.
White fir.
European larch.
Norway spruce.

The red cedar is not recommended because it is a menace to fruit orchards through the spreading of apple rust; one stage of the life of this fungus is passed on the branches of the red cedar, when it is known as the "cedar apple." It is also slow in growth and there are other evergreens which are more valuable. The arborvitæ and tamarack require permanently moist situations.

SEEDS OR SEEDLINGS.—Because of the difficulty and expense of raising evergreens from seeds, it is usually advisable to purchase from nurserymen seedlings 2 or 3 years old which have been transplanted once. These have well-developed root systems and will grow with little difficulty. They should be put out in garden soil in rows from 10 to 30 inches apart and with the trees from 6 to 10 inches apart in the row. After two or three years they can be transplanted to the permanent location. By this method better stock is obtained and the total cost of the windbreak is reduced one-half or more. There is practically no loss from transplanting.

For the broadleaf trees recommended for planting it will be cheaper and fully as satisfactory to collect or buy the seeds and raise the seedlings. A safe rule to follow in the planting of seeds such as those of maple and elm is to plant them immediately after they ripen, or before midsummer. Most other seeds should be planted the spring following ripening, yet seeds of basswood and Russian olive germinate better if planted in the fall.

In keeping seeds over winter, nature's manner of storage should be followed as nearly as possible. Where seeds remain on the tree until late winter or early spring, as in the case of catalpa and honey locust, they should be collected in late fall and hung up in a dry, cool place in porous cloth sacks. Nuts and acorns which fall during the autumn and are buried among the leaves should be stratified through winter in boxes of moist sand and planted as soon as the ground can be worked in the spring.

In many instances seedlings of the silver maple, willow, cottonwood, green ash, and honey locust can be pulled from the ground in bottomlands, or in groves, and set out very cheaply and with little danger of loss. Cuttings of willow and cottonwood, which may be made from new wood in late winter or spring and "heeled in" in a cellar until planting time, give good results, especially in permanently moist situations.

TIME FOR SETTING TREES.—It is advisable to plant windbreaks of both conifers and hardwoods in the spring. The severity of the cold, drying winds of winter, which injure growth that has not had time to mature fully, makes fall planting on the plains west of the Mississippi impracticable. Conifers may be successfully transplanted during any season of the year if care is taken, but the spring, as soon as danger of

severe frost is past, is the best time, since the seedlings will by winter be strong enough to resist the cold, drying winds. Broadleaf trees should always be transplanted between late March and early June.

METHODS OF PLANTING.—In planting evergreens care must be taken to prevent the drying out of the roots. When seedlings can not be planted at once, they should be removed from the packing case and "heeled in" in some shaded situation. If the packing case with the seedlings is placed in a cool cellar and the roots well moistened they will remain in good condition for several days, but if the tops become wet they will heat, become moldy, and die. Small evergreens should be carried to the planting site in baskets or pails containing a few inches of water. The roots may be kept moist with wet moss or sacks placed about them. The hole should be considerably larger than the root system and the seedlings should be set a little deeper than they stood in the nursery row. The soil must be packed firmly about the roots.

SPACING.—The pines and spruces should be planted in rows from 12 to 16 feet apart, with the trees from 6 to 10 feet apart in the row. There should not be less than four rows in a windbreak. When the trees are from 8 to 12 years old the rows should be thinned, in order that all the trees may have sufficient moisture and room for full development. Corn may be grown between the rows for two or three years, which will provide cultivation for the trees and at the same time yield a profit. The hardwoods, such as silver maple, catalpa, honey locust, and ash, should be planted from 6 by 6 feet to 10 by 10 feet apart each way. Thinnings should be begun when the trees are small poles and continued as long as there is danger of injury from overcrowding.

DISTANCE AND DIRECTION FROM DWELLINGS AND ORCHARDS.—Many windbreaks have failed because they were placed too close to the home buildings and orchards, so that snow is piled in around the buildings and over the orchards. Windbreaks should be 5 or 6 rods from the buildings they are to protect, and there should be a space of 2 or 3 rods between the outer and inner rows of trees.

Orchards should not be completely surrounded by windbreaks, since lack of air drainage seems to increase the danger from disease and insects. The stillness of the air within such an inclosure makes it possible that a warm day may start the buds of fruit trees enough so that they will be killed by the frost which usually follows. The same stillness of air may, on the other hand, cause a lower temperature on a cold day or night, and create a "frost pocket," so that there may be killing frosts within an orchard too completely surrounded by windbreaks, when they do not occur outside.

DIAGRAM FOR PROPOSED WINDBREAK.—For average soil and moisture conditions in central Iowa, the following scheme for planting is suggested:

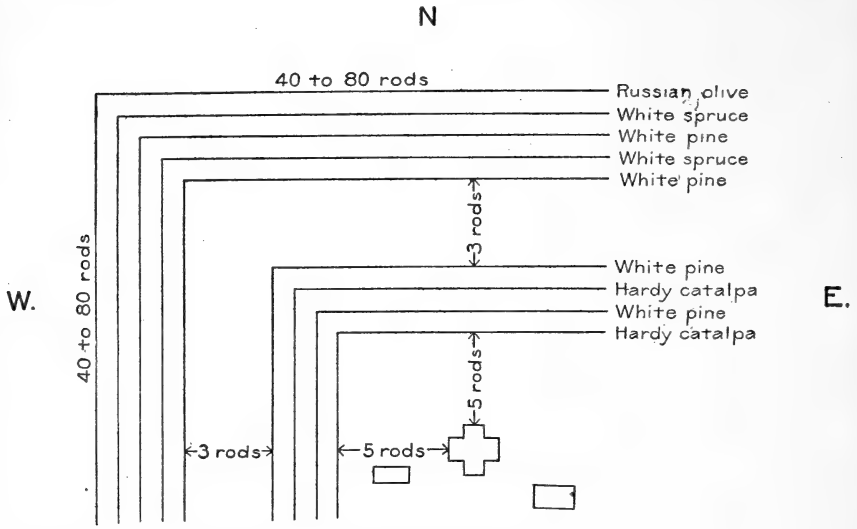

FIG. 1.—Diagram for proposed windbreak, for average soil and moisture conditions in central Iowa.

The outer rows should be 12 feet apart and the trees spaced 8 feet apart in the rows. The trees in the inner rows should be planted 6 by 6 feet each way, and the catalpa should be removed when large enough for fence posts.

Russian olive is suggested for the outside row because it is a hardy, low-growing tree, which succeeds under a wide range of soil and moisture conditions. It will protect the evergreen seedlings on the interior and will produce a medium grade of fence posts. Russian mulberry may be used in the same way in places where it is hardy. It is not advisable to plant such quick-growing trees as silver maple or boxelder with the slower growing species, for they quickly overtop the more valuable trees and retard their growth by shade, and if they are not removed in time will be a detriment to the windbreak.

CARE OF YOUNG AND OLD TREES IN THE WINDBREAK.—A large proportion of the failures of windbreaks is due to a lack of cultivation and care during the first few years. The land upon which the planting is to be done should be well prepared. Growing corn on it for a year or two will put the soil in excellent condition. After the seedlings are planted the ground should be cultivated as long as it is possible to pass between the rows, usually from two to four years. Cultivation should be discontinued by August 1 each year, for it is likely to stimulate new growth which can not become mature before winter. Windbreaks

require little or no pruning. The evergreens should be allowed to retain their lower branches, since they increase the efficiency of the break. When the lower branches begin to suffer from crowding, enough trees should be removed to permit complete development of the remaining ones.

A number of successful windbreak plantings in different parts of the State are mentioned here to show that success has been attained in parts of the State which vary widely in soil, moisture, and situation:

On the farm of F. F. Bakken, 5 miles west of Decorah, Winneshiek County, is an excellent grove of white pine 25 years old. The soil is a sandy loam, well suited to this pine. The trees are from 30 to 34 feet high and from 4 to 12 inches in diameter.

On the farm of W. Herring, Lincoln Township, Dallas County, there is a good windbreak of red cedar. The trees are 9 years old, and from 12 to 16 feet high and from 1 to 3 inches in diameter. Although the trees are making rapid growth on the rich black loam of this section, they are badly infested with cedar apple fungus.

On rich prairie loam on the farm of W. A. Wilson, 5 miles northwest of Ainsworth, in Washington County, there are several rows of white pine which have made excellent growth. The trees are 35 years old, and range from 60 to 70 feet in height and from 9 to 16 inches in diameter.

The Amana colony, in Iowa County, has several large groves of white pine and other pines which have proved very successful. The soil of this region is usually a rich sandy loam.

Four miles east of Dougherty, Floyd County, on the farm of Henry Schafer, there is a windbreak of Scotch pine 10 years old, which has so far been very successful. Millet has been grown between the rows to keep weeds down.

On the C. E. Whiting estate, 2½ miles north of Whiting, Monona County, is an excellent example of a black walnut windbreak.

TREE PLANTING FOR COMMERCIAL PURPOSES.

The rich prairie soil of Iowa is so valuable for the production of grain and stock that it will not pay to plant large areas for commercial purposes. Forestry in the State will always be a matter of farm groves or native woodlots. It is probable that in the future, as frequently in the past, a large proportion of the grove plantings will be for the combined purposes of protection and the production of fuel, fence posts, repair material, and shade for stock. Hence, species should be selected which will most nearly meet these combined requirements.

LOCATION.—Usually those portions of the farm unsuited for other agricultural purposes have been utilized for tree growing, and this is

right, for it is desirable to utilize completely or reclaim such waste portions. The owner frequently can not afford to plant any other part of the farm, for the better portions are necessary for its proper management. Good returns may be obtained by reforesting these rough lands, and caring for the plantations to keep out dense growths of weeds, shrubs, and scraggly trees. Large ranches and farms, however, can profitably devote several acres of good, rich land to trees for posts and farm repair material. There is no reason why large farms should not grow more than enough posts for their own fencing. But even on the best soils, unless the trees are carefully planted and protected, they will yield only a very small part of their possible returns.

SPECIES.—Where a considerable area is to be devoted to the production of posts, the best species to use are: Osage orange, which, however, is hardy in the southern half of the State only, hardy catalpa, European larch, honey locust, and green ash. Where very quick results are desired, willow may be successfully grown, but even the best quality of seasoned willow posts will not last more than from three to five years. Other slower-growing species make excellent posts, and it would be well to devote a small portion of the area to black walnut, coffeetree, white ash, slippery elm, red oak, Russian olive, and Russian mulberry.

On bottomlands subject to overflow, and which are consequently not adapted to tillage, cottonwood and silver maple may be planted in groves for lumber. Excellent returns in lumber and dimension material have been obtained from plantations of these species. On dry soils cottonwood groves do not succeed.

PLANTING.—Where Osage orange, hardy catalpa, Russian mulberry, or honey locust are planted on the heavy, rich loess soils of the State for the production of posts, they should be spaced 4 by 6 or 6 by 6 feet, or if planted with a field crop like corn, they should be planted 8 by 8 feet each way. Such spacing will cause the young trees to make a rapid height growth, which is necessary for the production of the greatest number of good fence posts. On light sandy soil, the trees should be set at a greater distance apart, since there is not sufficient moisture to permit close planting.

Seedlings of hardy catalpa, Osage orange, and honey locust have been successfully planted with corn in this State. A field is planted to corn in the usual way, and just as it is breaking through the ground a seedling is set in every other hill of every other row, in place of the corn. Two-thirds of the crop of corn is obtained in this way and the seedlings receive thorough cultivation and are protected by the stalks during the first year. Corn may also be planted the second year and a third of a crop obtained. In this way sufficient corn

may be grown during these two years to pay for the rent of the land and for the cultivation.

A very good example of this method of starting a catalpa grove is the 10-acre grove of George S. Waller, 2 miles south of Pioneer, Humboldt County. Twenty years ago Mr. Waller obtained hardy catalpa seed from Tennessee and raised seedlings which, when they were one year old, he put out with corn. The rows are about 8 feet apart each way and the cultivation, while the corn remained on the ground, gave the trees an exceptional start. Measurements show that the growth has been above the average throughout the twenty years. The trees are now from 25 to 32 feet high and from 4 to 10 inches in diameter, and will average at least 3 good posts per tree. In 1903, 400 posts were cut out of the grove as a thinning, and a careful estimate in 1905 showed that there remained on the 10 acres 6,146 trees. With 3 posts to a tree, the plantation now contains 18,438 posts. Besides this a large quantity of cordwood will be obtained when the final cut is made. If these posts are worth 15 cents each, the grove represents a value of $2,765.70. Add to this amount the returns from the 400 posts cut in 1903, at 15 cents each, and there is a total of $2,825.70, a good return from 10 acres in 20 years. During this period the grove has served as a windbreak for the home and farm buildings, and produced nearly all the fuel and repair material needed on the farm.

The usual method of planting seedlings is to have two or five men work together. When there are two, one digs the holes with a spade or mattock and the second follows with the seedlings in a basket or pail. As explained before, the roots must be covered with wet moss or a sack and the trees should be set somewhat deeper than they stood in the nursery row. Where five work in a gang, two men dig the holes and three plant. On ordinary ground one man can plant from 400 to 700 trees per day.

Growth and probable returns.—The probable rate of growth of any species and the returns under the most favorable conditions for growth can be stated only indefinitely. The data obtained during the investigation of the State's timber represents growth under unfavorable conditions. The groves studied had been, as a rule, pastured constantly, had not been thinned, and fires had run through most of them. Even under these conditions the returns have fully repaid the owners for their financial outlay and the occupation of the ground.

The hardy catalpa, which has been planted extensively throughout Iowa, grows rapidly and produces a good grade of posts, repair material, and fuel. Fence posts reach a diameter of 4 or 5 inches in from six to nine years, according to the care and cultivation which

is given. The most satisfactory results have been obtained with this tree by cutting the 3-year-old seedlings back to the ground during the winter. The stumps send up a number of straight, clean shoots the following spring. All but one shoot should be removed within a few weeks or as soon as the best shoot can be selected. This principal shoot which is left will grow straight and clean to a height of from 8 to 14 feet the first season. By this process posts can be obtained as quickly as if the trees grew from seed without cutting back, and of a better quality. By cutting on short rotations, other crops of posts may be obtained from the stumps in a shorter time than the first crop. The Russian mulberry, Russian olive, and Osage orange may be treated in the same manner with satisfactory results.

Posts from 3 to 5 inches in diameter may be grown from the Osage orange in from seven to eleven years; from honey locust in from eight to fourteen years; from Russian mulberry in from nine to fifteen years; from European larch in from nine to sixteen years; and from green ash in from seven to fourteen years.

Some forms of the white willow will produce fence posts of ordinary size in from four to seven years. Nearly all of the slower-growing, more permanent species mentioned require from twelve to thirty years to form posts from 3 to 5 inches in diameter. The red oak and coffeetree are not planted as extensively as their value warrants. Both are hardy, fairly rapid in growth, and excellent for posts, repair material, and fuel; and each can be reproduced readily from seeds or stump sprouts. The coffeetree prefers moist situations, and the red oak well-drained slopes and uplands.

The appended table shows the returns which have been obtained from various species under ordinary conditions of treatment. Typical groves in different parts of the State were selected as the basis of the table.

Returns from typical planted groves of various species in Iowa.

Species and county.	Town or township.	Age of grove.	Area of grove.	Spacing.	Average diameter.	Total production per acre.	Average annual production per acre.	Average annual return per acre at $3.50 per cord.	Poles, telegraph or telephone, per acre.	Posts (additional to poles), yield per acre.	Average annual return per acre, poles valued at $1 and posts at 15 cents each.
Silver maple (*Acer saccharinum*):		*Years.*	*Acres.*	*Feet.*	*Inches.*	*Cords.*	*Cords.*	*Dollars.*	*Number.*	*Number.*	*Dollars.*
Clarke	Liberty	32	3.3	4 by 4		68.5	2.1	7.35		560	2.62
Marshall	Eden	30	2.0	8 by 8		54.0	1.8	6.30		384	1.92
Ida	Ida	30	5.0		8.2	47.4	1.6	5.60	40	728	4.97
Wapello	Richland	40	4.0	4 by 8	11.0	58.0	1.5	5.25	128	114	3.63
Worth	Manley	24	1.5	8 by 8	8.2	46.0	1.9	6.65	174	480	10.25
Cottonwood (*Populus deltoides*):											
Pocahontas	Dover	23	1.75	6 by 22	11.0	34.6	1.5	5.25	145	90	6.89
Harrison	Woodbine	25	2.0		10.8	43.1	1.7	5.95	184	16	7.46
Black birch (*Betula nigra*):											
Iowa	Amana	27	1.5	8 by 3		12.3	.5	1.75		296	1.64
White willow (*Salix alba*):											
Clay	Clay	21	1.5			42.5	2.0	7.00		495	3.53
Greene	Greenbrier	23	4.0	12 by 2½		33.1	1.4	4.90		504	3.29
Kossuth	West Bend	27	2.0		7.4	33.3	1.2	4.20	180	420	9.00
Hardy catalpa (*Catalpa speciosa*):											
Iowa	Amana	21	9.5	9 by 5		42.0	2.0	[a] 7.00		1,896	13.54
Do	....do	20	9.2	9 by 5		11.8	.6	[b] 2.10		572	4.29
Dallas	Lincoln	21	1.5	4 by 10		24.8	1.2	4.20		1,296	9.26
Humboldt	Weaver	22	10.0	8 by 8		17.0	.8	2.80		1,288	8.78
Crawford	Denison	25	3.0			23.3	.9	3.15		1,680	10.08
Montgomery	Sherman	23	.5			21.3	.9	3.15		1,464	9.55
Black walnut (*Juglans nigra*):											
Adair	Jefferson	25	.3	3 by 6		15.3	.6	2.10		900	5.40
Monona	Moorehead	38	1.0			12.6				672	2.65
Wapello	Richland	30	2.25	8 by 16		35.3	1.2	4.20			
Madison	Madison	30	1.25	4 by 4		35.5	1.2	4.20			
Green ash (*Fraxinus lanceolata*):											
Poweshiek	Chester	34	2.5	8 by 4		28.2	.8	2.80		1,134	5.00
Ida	Idagrove	23	2.0			13.0	.6	2.10		768	5.01
Honey locust (*Gleditsia triacanthos*):											
Boone	Peoples	23	.4	8 by 10		6.6	.3	1.05		344	2.24
European larch (*Larix europæa*):											
Poweshiek	Chester	24	.25	6 by 10	10.0	65.4	2.7	9.45	328		13.67
Washington	Highland	31	2.0	4 by 4	8.6	37.5	1.2	4.20	288		9.29
Cass	Grove	33	3.0	4 by 4	9.1	33.1	1.0	3.50	260		7.88
Montgomery	Sherman	29	1.0	6 by 4	7.8	33.1	1.1	3.85	352		12.14

[a] On good rich soil.

[b] On poor sandy soil.

Returns from typical planted groves of various species in Iowa—Continued.

Species and county.	Town or township.	Age of grove.	Area of grove.	Spacing.	Average diameter.	Total production per acre.	Average annual production per acre.	Average annual return per acre at $3.50 per cord.	Poles, telegraph or telephone, per acre.	Posts (additional to poles), yield per acre.	Average annual return per acre, poles valued at $1 and posts at 15 cents each.
Norway spruce (*Picea excelsa*):		*Years.*	*Acres.*	*Feet.*	*Inches.*	*Cords.*	*Cords.*	*Dollars.*	*Number.*	*Number.*	*Dollars.*
Iowa	Hilton	25	3.1			22.0	0.9	3.15	36	474	4.28
Washington	Highland	31	¾	12 by 12	10.7	29.0	.9	3.15	168	88	5.85
White pine (*Pinus strobus*):											
Iowa	Amana	27	1.5	8 by 4 8 by 16	7.9	29.7	1.1	3.85	220		8.15
Madison	Madison	28	.80	8 by 8		35.3	1.3	4.55		350	1.87
Washington	Highland	35	.25	12 by 12 24 by 12	3.6	88.0	2.5	8.75	52 (a)		1.49

a 244 saw logs.