Notes on Forest Trees Suitable for Planting in the U.S.

U. S. Forest Service

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

GREEN ASH (Fraxinus lanceolata).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The Green Ash is distributed over the greater part of the United States east of the Rocky Mountains, even extending into the mountains in Utah and New Mexico; to the northward it occurs as far as the Saskatchewan River in Canada. It is most abundant in the Mississippi basin, and is rather infrequent in the East. In the timber belts along the streams that drain the plains and prairie country of the middle West the Green Ash often occurs as the leading species, but in general, especially in the East, appears singly or in small groups among other hardwoods. The species most commonly found in such natural mixtures are the White Elm, Hackberry, Sycamore, Black Cherry, Red Ash, and Bur Oak.

CHARACTERISTICS OF FORM AND GROWTH.

The Green Ash is a medium-sized tree with a straight, undivided bole when forest grown, and slender spreading branches. A height of 80 feet and a diameter of 24 inches is rarely exceeded. Deep-seated fibrous roots, which extend laterally, form the characteristic root system. Because of the absence of vertical heart or tap roots, transplanting of seedlings is not difficult. The tree prefers full light, and is tolerant of moderate shade only.

In the arid or semi-arid regions the growth is not rapid. In the more humid sections the Green Ash compares favorably with other broad-leaved trees in rate of growth, although under no conditions is it a rapid grower. Under average conditions planted trees should make posts in fifteen to twenty years, and be large enough for stakes or fuel in less time. From measurements made in Nebraska it appears that the diameter accretion in that region is from 0.2 to 0.3 inch annually.

THE WOOD; ITS ECONOMIC USES.

The wood of the Green Ash is hard, heavy, and strong, rather coarse-grained, and brittle. It is utilized in the manufacture of agricultural implements, carriages, and furniture, and, although said to be inferior

in quality, is substituted for White Ash to a large extent; the timber of the two species is often sold indiscriminately. The relative fuel value of the wood is high. Although not first-class for fence posts, it is used for this purpose extensively in the north central States, and is highly prized in the many sections where more valuable species are not available.

SOIL AND SITE.

The Green Ash occurs naturally and is of best development on low, moist ground. It is said that the soils favorable to the best growth of the Green Ash are found on river bottoms and consist of slightly alkaline "gumbo." The tree is in general unusually tolerant of alkaline soils of any nature. Low swales at the foot of bluffs also produce good trees. The tree does not demand rich soil, but will thrive moderately well on a dry sandy loam, or on a stiff clay upland. Its ability to persist and even thrive under adverse conditions of temperature and moisture is unsurpassed by any broad-leaved tree. It is reported to be one of the best trees for planting at Brandon, Manitoba, in latitude 50° north, and will do equally well on the dry plains and in the hot winds of New Mexico. On the arid plains of western Kansas and Nebraska it has survived on abandoned timber claims where nearly all other species have withered and died.

PROPAGATION.

Reproduction of the Green Ash is effected by seed and coppice growth. Propagation by seed is the best and only reliable method of artificial forest extension of the Green Ash. The seed may be purchased from dealers for 50 to 75 cents per pound, but wherever possible it is advisable for the local planter to gather his own supply. The several species of ash seeds are very similar in appearance, and the germination per cent low at best; hence it is advisable to send samples of purchased seed, or even home-gathered stock, to the Seed Laboratory of the United States Department of Agriculture, where all seeds will be identified and tested without charge.

Green Ash matures its fruit in early autumn. Collecting should be begun as soon as the seeds ripen. Stripping the seeds from the trees by hand is the most reliable method of collecting, since they do not fall early enough to be swept up from pavements and roadways. Fall planting may be practiced, but is in general inadvisable. The seeds may be kept over winter in a cool, dry place, or "stratified." If stored dry, the seed should be soaked in warm water for several hours before planting in the spring. If stratified, the winged seeds should be placed in boxes between alternating layers of slightly damp sand, and the boxes stored in a cool cellar. The vitality of the seeds can not well be preserved more than eight months.

Broadcast sowing of ash seeds on prepared or unprepared ground, or even planting the seed in hills where the trees are to stand, is generally an uncertain and unsatisfactory process, hence nursery culture is advised. The nursery and seed beds should be prepared on rich, well-worked ground, an old garden spot being an excellent site if the soil is not too full of weed seeds. Preliminary working of the ground should be as for a garden crop. Planting may begin in spring as soon as danger of frost is over. For convenience in weeding, it is recommended that the seed be sown in drills, 8 to 12 inches apart for hand cultivation, and 2 to 3 feet apart if a horse cultivator is to be used. The normal germination per cent is rather low, hence the seeds should be dropped thickly enough to touch each other in the row. They should be covered about one-half inch deep and the soil pressed down firmly by means of a roller, or pressure with a board. In the arid regions it is sometimes best to cover such seed 2 or 3 inches in depth until after germination is well started, after which the dry surface layer of soil should be raked off, leaving a covering a little less than a half inch in depth. A mulch of chaff, sawdust, or old hay, if kept moist and raked off when the sprouts begin to break the ground, will answer the same purpose. Uniform moisture conditions should be maintained if possible, whether by surface irrigation, sprinkling, or mulching.

The seedlings should attain a height of 6 to 10 inches the first season, and should be transplanted to the permanent forest site when 1 year old. Shading of the young seedlings is not essential. If purchased from nurserymen the cost of seedlings is from $2 to $3 per thousand.

The Green Ash does not cast a heavy shade. It comes into leaf late in the spring and hence should not be planted alone, because in pure plantations the grasses are likely to thrive to the detriment of tree growth and prevent the formation of a desirable forest floor. Close planting (4 by 4 feet) in well-prepared soil is advisable on prairie soils, and wherever possible the ground should be cultivated between the trees until they spread out so as to form a complete ground cover. One of the best trees for mixing with the Green Ash is the Hackberry. Other good species for such a mixture are Boxelder, White Elm, Scotch Pine, and Red Cedar. If grown in pure stands the Green Ash should be underplanted with Choke Cherry, Wild Black Currant, or Wild Plum. These shrubs will endure the shade and keep the ground free from grass and weeds.

ENEMIES.

Several insects are known to prey upon the Green Ash. In case injurious insects appear in alarming numbers upon natural or planted trees, specimens should be sent to the Division of Entomology, where they will be identified and measures suggested for their destruction or control. The chief climatic influence liable to injure the Green Ash is

a protracted growing season, followed by a severe frost. Such injuries, however, are only temporary, and the tree soon recovers fully.

POSSIBILITIES AND USES.

The fairly rapid growth, easy propagation, and unsurpassed hardiness of the Green Ash make it one of the most valuable trees for general planting in the arid, treeless West. It serves a useful purpose, whether planted for windbreaks, ornament, or timber. The wood is believed to be inferior to that of White Ash and many other species, hence its propagation in humid regions is not recommended, but in sections where wood of any kind is of high value because of its scarcity, extensive general planting is advisable. The Green Ash should be planted in place of Cottonwood in many sections.

PLANTATIONS.

Although the Green Ash has been extensively planted in the middle West, figures based on examinations and measurements of well-established plantations are not available. Forest plantations of Green Ash throughout Kansas, Nebraska, Iowa, and South Dakota are, in general, in a very thriving condition.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

WHITE ASH (Fraxinus americana).

DISTRIBUTION.

The natural distribution of the White Ash is from Nova Scotia and Newfoundland to northern Florida, central Alabama, and Mississippi and westward to Ontario, northern Minnesota, eastern Nebraska, Kansas, Indian Territory, and Texas (Trinity River).

It seldom occurs in large masses, but usually as single individuals or in groups among other hardwoods; frequently, however, it is present in considerable numbers. It is said often to form large forests in Maine. The associate species include many of the common hardwoods, as the maples, elms, Basswood, birches, walnut, and oaks.

The range for economic planting is from the valley of the Wabash and Ohio rivers north and west through Indiana and Illinois to the region of the Great Lakes; westward through Iowa, southern Minnesota, and eastern South Dakota; southward through eastern Nebraska and Kansas into northern Oklahoma and Indian Territory.

CHARACTERISTICS OF FORM AND GROWTH.

In the forest the White Ash is a tall slender tree with a smooth bole, often free from branches for more than half its length, and surmounted by a small open crown of stout upright branches. In open ground the trunk divides into branches a few feet above the ground, and forms a graceful, rounded head, widest at or near the bottom, and rather open. In general the tree is of medium size, with an average height of 70 to 80 feet, and a diameter of 2 to 2½ feet; occasionally on the bottom lands of the lower Ohio valley, where the best development is attained, it reaches a height of 100 feet or more.

The roots are numerous. In loose soil they penetrate deeply, but where hindered by rocks or an impenetrable substratum, develop into an extensive lateral system. Young trees are easily transplanted. Mature trees can endure only a moderate amount of shade, but young seedlings will start in dense shade, but need light for their perfect development.

The rate of growth is rapid when compared to that of most of the associate hardwoods, but varies materially according to moisture and

general conditions of situation. In the southern part of its range post timber may be grown in ten to fifteen years. In a drier climate, where the soil is not so well suited to its growth, it requires fifteen to twenty years for the average tree to attain post size; on the dry prairies the trunk does not grow to be more than 5 or 6 inches in diameter in twenty-five years. Trees grown in a dense stand in the Farlington plantation in Kansas made an average annual height growth of 1.7 feet, and a diameter accretion of one-fifth inch annually. This is very slow compared to the rate of growth of other trees under similar conditions.

WOOD; ECONOMIC USES.

The wood of White Ash is of great economic value both in the East and the West. The wood of western-grown ash is said to be of less value than that produced in the more humid East. The wood of second-growth trees is usually more tough and elastic than that of the large, slowly grown first growth. Its strength and elasticity are the most valuable qualities of the ash, which, combined with its ability to take a good polish, season without injury, and stand well, make it a timber of first rank for furniture, car construction, carriage building, interior panels and decorating, agricultural implements, oars, and turned tools and playthings of various kinds. In contact with the soil, well-seasoned ash is quite durable. Where available in the West it is largely used for post timber.

SOIL AND SITE.

White Ash seems to prefer rich, moist woods, fields, and pastures near streams. The bottom lands of river valleys in the mild climate of the west central portions of its range produce the finest trees. The ideal site for an artificial plantation is in a protected valley on a soil of sandy loam that is light and readily worked. The White Ash will thrive, however, in less favorable or even in adverse localities. A porous subsoil is essential, while a water-table at a depth of 10 or 12 feet is of decided advantage. For general planting in the semiarid region of the Middle West the White Ash is not so hardy and should yield preference to the smaller Green Ash.

PROPAGATION.

Propagation is by seed, which is produced abundantly about once in three to five years; individual trees along streams or in favorable open situations fruit more frequently. In nature, reproduction is not general, seedlings occurring only now and then and in limited quantities. Under advanced systems of forest management, natural reproduction is easily secured.

The fruit, which is one-winged, ripens in October. It may be sown as soon as gathered or preserved for spring planting by stratifying in

damp sand. If stratified, the seed should be mixed with about three parts of sand to one of seed and placed in a box in a cool cellar. Hand picking, although slow, is the most reliable method of collecting the seed. Low, open-grown trees are the most productive and easiest to pick from. If purchased from dealers, the cost of White Ash seed is from 25 to 60 cents per pound. The seeds of the several species of ash are much similar in general appearance, hence before puchasing seeds from dealers it may be wise to send samples to the Seed Laboratory of the Department of Agriculture, where they will be identified and tested gratis.

Broadcast sowing of ash seed on prepared or unprepared ground, or even planting of the seeds in hills where the trees are to stand, is generally uncertain and unsatisfactory, hence nursery culture is advised. The nursery and seed beds may be prepared on any rich, well-worked soil, an old garden spot being an excellent place if the soil is not full of weed seeds. Preliminary working of the ground should be exactly as for a garden crop. Planting may begin in the spring as soon as danger of frost is past. For convenience in weeding, it is recommended that the seed be sown in drills 8 to 12 inches apart for hand cultivating, and 2 to 3 feet apart if a horse cultivator is to be used. Since the germination per cent is low, the seeds should be dropped thickly enough so that they will touch each other in the row, and should be covered about one-half inch deep, and the soil pressed down firmly by means of a roller or a board. During germination the moisture conditions should be kept as nearly uniform as possible, and irrigation or sprinkling of the beds resorted to in times of drought. The seedlings should attain a height of 6 to 12 inches the first season and may be transplanted to the permanent site the spring they are one year old, or transferred to nursery rows and final transplanting delayed another year. Seedlings may be obtained from nurserymen for $2 to $3 per 1,000.

In plantations the White Ash is successful when planted alone, or it may be combined with other species. Close planting (4 by 4 feet) is usually profitable, but as soon as part of the trees reach marketable size or serious crowding begins, severe thinnings should be made so that the remaining trees may be left unrestricted to attain their maximum size. Desirable associate species are Black Walnut, Black Cherry, Hackberry, Hardy Catalpa, Scotch Pine, and European Larch.

ENEMIES.

The White Ash is attacked by a number of fungous parasites which grow on the living leaves and do more or less injury. These parasites rarely appear in sufficient numbers to do very much harm to the tree affected. There is one fungus which grows in the heartwood of the trunk and branches of the White Ash. This fungus changes the wood into a soft, pulpy yellowish mass, unfit for lumber purposes. In regions

where this disease is common the ash never grows to be a very large or very old tree. A tree once badly infected by this disease is difficult to save, though the disease may sometimes be eradicated by impregnating the diseased parts with tar oil, as described in Bulletin No. 32, Bureau of Plant Industry. In park or shade trees the disease may be prevented by coating wounds with an antiseptic substance such as gas tar.

The White Ash is frequently injured by insects. In case insects appear in alarming numbers, specimens should be sent to the Division of Entomology, where the insect will be identified and measures suggested for its control. Large trees are often doty at the base and sometimes have large heart cracks.

POSSIBILITIES AND USES.

Because of its rapid growth, shapely form, freedom from disease, and ease of propagation, the White Ash is sure to remain a favorite tree for decorative planting. Its hardiness over a wide range, and the unusual value of its timber will make it also highly prized as a tree for economic planting. Where it thrives, it is to be preferred to any other species of ash, but in regions where mere ability to endure extreme conditions of drouth and temperature are the determining qualities in the choice of a species, the Green Ash is entitled to first place, and should be used instead of the White Ash.

NOTABLE PLANTATIONS.

Comparatively few plantations of this species have been made, yet wherever planted it shows great possibilities in favorable localities.

At Scotland, S. Dak., Mr. Christopher Frederick has a plantation which in nine years has reached a net value per acre of $66.80, or a net annual acreage value of $7.43.

Among the sand hills of southern Holt County, Nebr., a plantation has been established which is doing better than that of any other deciduous species. Within a few years it will yield a profitable income for posts.

At Conroy, Iowa, a plantation was established eighteen years ago which now has a net value per acre of $188.96, or a net annual value of $7.18 per acre.

At Farlinton, Kans., in a mixed plat of Hardy Catalpa, Black Cherry, and White Ash, 23 years old, the ash is the predominant tree and still growing, although badly crowded. The estimated value for posts and stakes is $162.72 per acre.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

BLACK CHERRY (Prunus serotina).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The Black Cherry flourishes throughout the eastern half of the United States from Nova Scotia to Tampa Bay, Florida; westward it grows to the Missouri River in southeastern South Dakota, to eastern Kansas and Nebraska, Indian Territory, and Texas; and extends through Mexico and along the Pacific Coast of Central America to Peru. In the northern extremity of the Lake States its distribution is limited to shaded lake shores and banks of streams, while in places it fades out entirely and is replaced by the Wild Red Cherry.

Although growing over a wide range of territory, the region for economic planting should be limited to the region extending westward from Indiana to eastern South Dakota, Nebraska, and Kansas, and southward along the high moist slopes of the Appalachians.

Throughout its range it is common under varying conditions of soil and exposure in open places in hardwood forests, but is nowhere abundant, though occasionally in the most favorable locations numerous groups of trees are found.

CHARACTERISTICS OF GROWTH—ASSOCIATE SPECIES.

Because of its adaptability to different conditions the Black Cherry varies greatly in form and size, depending on the region and locality in which it grows. In New England it is of medium size, 30 to 50 feet in height, with a diameter varying from 10 inches to 2 feet. In the Middle States and westward it becomes larger, with a height of 40 to 70 feet, and with sometimes a diameter of 3 feet, although it becomes smaller along the northern limit of its range. In the moist residual soil of the upper slopes of the southern Alleghenies it reaches its maximum growth; here a height of 100 feet and a diameter of 5 feet is often attained.

When forest-grown the trunk of the Black Cherry is long and slender, free from branches, and surmounted by a comparatively small, open crown composed of large, irregular branches. In the open the crown becomes more spreading, but seldom massive like that of the oak and Chestnut. The root system is extensive, especially on dry, sterile soil, where the heart roots go deep in search of moisture. A considerable

lateral system of surface roots is also developed. The tree is moderately shade-enduring.

The rate of growth is so much dependent upon climatic and soil conditions as to cause different opinions concerning its real capabilities. Under the most favorable conditions it is a rapid growing tree, while in a very cold or exceedingly warm climate, and in unfavorable soil, the growth is rather slow. In a deep, rich soil and a mild climate, trees 25 to 30 years old have been known to make an average annual diameter growth of four-fifths of an inch, but the valuable, dark-colored timber is not produced until the age of 60 to 80 years. On the whole, the Black Cherry may be considered as a rapid-growing, short-lived species.

The trees associated with the Black Cherry include nearly all of the common hardwoods, among which may be mentioned the Beech, birches, oaks, hickories, Black Walnut, Ohio Buckeye, and the maples.

WOOD—ECONOMIC USES.

The wood is light, strong, rather hard, with a close, fine grain which takes a beautiful polish; it is brown or red in color at maturity, with thin, yellow sapwood. It is suitable for cabinetmaking and interior decorating, and for such purposes has been so extensively used that the largest and best trees of the country have now been cut. For general construction work or when exposed to the weather the wood is not good. This lessens the value of the tree for general planting.

SOIL AND SITE.

The Black Cherry is capable of existing in a variety of dry situations, but it is only in the moist, well-drained, rich soils of mild climates that the maximum development is attained. The tree thrives on bottom lands and does fairly well on sandy or rocky uplands if the soil is rich and penetrable. In the West its success as a forest tree has been variable, although on the whole encouraging. In the loess soil of western Iowa, on dry ridges and bluffs, and in black drift soils it makes a rapid growth.

PROPAGATION.

Birds are the natural agents of seed dissemination for the cherry, and by them the tree has been broadly distributed. This means of starting reproduction can hardly be depended upon, however, because the cherry pits are scattered too thinly and many of them are lost through falling in places unfavorable to germination. On limited areas in the South natural reproduction is good on open or partly shaded land, but in the North and West it is often lacking.

As the Black Cherry is easily transplanted, it is better to plant the seeds in a nursery and transfer the trees to the final forest site when

one or two years old than to attempt to grow young trees by planting seeds where the trees are to stand.

The fruit, which is borne profusely almost every year by trees in the open and less frequently by those in the forest, ripens in late August or early September and may be collected by hand from low trees or from tall forest trees by shaking it down upon canvas. The pulp should be washed off and the surface of the pit dried to prevent moulding. For winter preservation the pits should be stratified in moist sand and placed on the north side of a building where they will freeze and not be thawed out too often or too rapidly by the sun. In the spring they should be planted in drills 8 to 12 inches apart for hand cultivation, or 2 to 3 feet apart if a horse cultivator is to be used, and covered about 1 inch deep. In the drill the seeds should be placed 2 or 3 inches apart. Planting must be done immediately after removing the pits from the sand, as even a partial drying at this stage is fatal. The transfer to the permanent plantation may be made in the spring when the trees are 1 year old, or they may be transplanted to nursery rows and allowed to develop for another year before the final setting.

The Black Cherry, since it endures considerable shade, may be planted rather close, either in pure stands or with associated species. The best species for a mixture are Boxelder, Red Oak, ash, elm, Silver Maple, Black Walnut, and Hackberry, the choice depending upon the locality.

ENEMIES.

The forest tent caterpillar *(Clisiocampa americana)* often seriously injures the Black Cherry by destroying the leaves. A fungus known as "black knot," by causing unsightly swellings on the branches, greatly disfigures the tree. In case of insect attack specimens should be sent to the Division of Entomology for identification and suggestions as to methods of control.

The leaves and fruit of Black Cherry contain hydrocyanic acid, which is a deadly poison; cattle have in rare instances been poisoned by eating the leaves, and it is said that children have died from eating the pits or swallowing the fruit whole. The fresh leaves are considered harmless, the poison being the result of chemical action in the withering leaves.

POSSIBILITIES AND USES.

For limited use as a mixture in prairie planting, especially on rather moist soil, the Black Cherry will find a useful place. In general, however, it is too short lived and of too limited economic value to be recommended for extensive planting in the West. As a nurse tree in forest plantations and where a luxurious foliage effect is desired it serves a useful purpose.

In the South and East, where it is of longer life and reaches its best development, it does not hold a high place because of the small size of the timber it produces and the presence of more valuable species. It is seldom used for ornamental purposes. With slight protection near the seacoast it has in a moderate degree shown its ability to withstand salt winds.

NOTABLE PLANTATIONS.

H. C. Raymond, of western Iowa, reports that 10-year-old Black Cherry grown in groves is 6 inches in diameter and 28 feet high, while Hardy Catalpa of the same age and in the same soil is of the same diameter but only 25 feet high.

In the Farlington plantation in Kansas the Black Cherry for the first few years gave great promise, but it is now deteriorating and, in many cases, dying.

In a block planted in 1878, containing 196 White Ash, 27 Catalpa, and 7 Black Cherry trees, the Cherry, when measured in 1901, was the largest both in diameter and height. The following was the average size of the 7 trees:

Average diameter at 1 foot from the ground	8.4 inches.
Average diameter at 7 feet from the ground	6.4 inches.
Average height	34.0 feet.
Average clear length of bole	19.0 feet.

In another block containing 149 Black Cherry and 187 Catalpa trees the latter were entirely dominated by the Cherry. The average size of the Cherry was:

Average diameter at 1 foot from the ground	5.6 inches.
Average diameter at 7 feet from the ground	4.0 inches.
Average height	32.0 feet.
Average clear length of bole	19.0 feet.

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COFFEETREE (Gymnocladus dioicus).

DISTRIBUTION AND MANNER OF OCCURRENCE.

Although one of the rarest of our forest trees, the Coffeetree is equaled by only few hardwoods in the extent of its range, growing as far north as Montreal and south to Arkansas. It is nowhere abundant, occurring only as solitary individuals in localities most favorable to its growth. Over large areas within its range, it is entirely lacking or represented only by an occasional individual. More definitely, its geographical distribution is from central New York and Pennsylvania west through southern Ontario and southern Michigan to the valley of the Minnesota River, eastern Nebraska, Kansas, and western Oklahoma, and south between the Mississippi River and Allegheny Mountains to Tennessee. This range has been somewhat extended by seeding from cultivated trees. The range for economic planting includes the natural range and may in places be extended beyond it.

CHARACTERISTICS OF GROWTH—ASSOCIATE SPECIES.

In barren soil the Coffeetree is a slow-growing, long-lived species which seldom attains commercial size. Under normal conditions it is a rapid and moderately persistent grower. Forest-grown trees reach a height of 60 to 100 feet and a diameter of 1½ to 3 feet. Under most favorable conditions the height growth for the first thirty or forty years is moderately rapid, often averaging 1 to 2 feet annually, while the annual diameter increment may vary from one-fourth to one-half inch. The trunk is uniform in diameter and, when crowded by other trees, often free from limbs for 50 to 80 feet. The branches, which are stout, pithy, and blunt, combine into a rather close crown. The tree is essentially light-needing, and because of the thin, open nature of the foliage and its habit of coming into leaf late in the spring does not shade the ground sufficiently to keep down grass and weeds if planted in pure stand. The root system is extensive. When the main trunk is severed, the roots send up a large number of suckers. In nature the Coffeetree is associated with the ashes, walnuts, Hackberry, elms, Basswood, Cottonwood, Honey Locust, and hickories.

PROPERTIES OF THE WOOD.

The wood is heavy, moderately hard, very stiff, of coarse texture, durable in contact with moisture; the heartwood is reddish, the thin sapwood yellow. The wood shrinks and checks considerably in drying, works and stands well, and takes a good polish. It is used to a limited extent for cabinet work and posts, but is little known at present.

SOIL AND SITE.

The Coffeetree grows naturally and best on the richest bottomlands, along banks of upland lakes and water courses, and in moist ravines; in such situations it attains its maximum development. It is adapted, however, to the drier, less fertile sandy and gravelly soil of the uplands, but in such situations the growth is slower and the size smaller. It is not susceptible to climatic variations, and will endure the cold winters of Minnesota and the hot winds of western Oklahoma with no sign of injury.

PROPAGATION.

The fruit, which matures in September or October, is a thick, broad pod, containing 6 to 9 large seeds (beans), inclosed in a jelly-like pulp. It is produced abundantly and in the South and West gives rise to fair stands of seedlings in the neighborhood of the mother trees. Reproduction is also effected to a very limited extent by root suckers.

Because of the heavy nature of the seeds and the lack of any special means of dissemination, natural regeneration is not extensive. Likewise the root sprouts are limited in their spread to the area which the main roots cover. Hence artificial reproduction must be resorted to as the only sure and rapid means of Coffeetree production.

The pods remain unopened on the trees for some months after reaching maturity, and hence may be collected at any time during the late fall or winter. They should be macerated in water, the seeds separated from the pods and pulp and dried. In this condition they may be kept in a cool, dry place for several years with only a slight annual diminution in vitality. If desired for planting the following spring, they may be stratified in sand or stored dry during the winter. Seeds may be purchased for 75 cents to $1 per pound. Just before planting in the spring the seeds should be treated as follows:

Place the seeds which are to be planted in a tub or pail, and pour very warm water (150° to 160° F.) over them, stirring vigorously during the operation. Continue to stir for fifteen or twenty minutes, then cover the vessel and leave the seeds to soak for two or three days. At the end of this time sort out the seeds that have swollen, with a sieve having a mesh that will allow the seeds not swollen to pass through. Pour off the water from the remainder and soak again in warm water. Continue this treatment until all the seeds have become spongy and swollen.

After being thus treated the seeds must not be allowed to dry out, but should be planted immediately.

Plant the seeds in the nursery in rows 2 feet apart, if to be cultivated by hand, or 3 to 3½ feet if a horse cultivator is to be used, spacing them 2 or 3 inches in the row and covering 1 to 2 inches deep, and afterwards pressing the dirt down firmly. Transplanting to the permanent site may be done when the plants are one year old, or delayed another year, the plants in the meantime being transferred to nursery rows. Better plants are secured by once transplanting in the nursery, but as a measure of economy they should be set out in the forest site the first year.

When making a forest plantation of Coffeetree, it should be combined with such species as White Elm, Red Elm, Hackberry, oaks, and ashes. If planted several years previous to its associates, it may be mixed with Hardy Catalpa, Russian Mulberry, or Black Locust. The growth and habits of the Coffeetree in the Southwest are very similar to the growth and habits of the Walnut, and one may be substituted for the other in almost any plantation.

ENEMIES.

The Coffeetree is not known to be subject to the attack of any especially injurious insects. In case of any serious insect attack, specimens should be sent to the Division of Entomology for identification and suggestions as to control.

POSSIBILITIES.

The Coffeetree in the past has not been extensively planted in commercial quantities, but there seems ample reason why its future extension should be encouraged. It occurs in a variety of soils, and may be grown successfully throughout the greater part of the Middle West, being especially suited to moist river valleys and the soil along water courses. It has an advantage over many hardwood species adapted for western planting, in that the wood is of more general value, being suitable for general construction purposes and durable in contact with the soil.

In pleasure grounds and for general ornamental planting it is quite a favorite, especially in the East, because of the unusual character of the leaves and the interesting and unique winter aspect of the tree, the blunt, naked branches giving it a peculiar dead appearance, which is further augmented by the absence of foliage until late in the spring.

Coffeetree plantations of importance are not known to exist. The species has been recommended and will be tried in several plantations in Oklahoma, Kansas, Nebraska, and Iowa.

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BOXELDER (Acer negundo).

DISTRIBUTION.

The Boxelder is among the most widely distributed of American trees. East of the Appalachian range it is found in small numbers from Vermont and Ontario to Florida; it is more abundant from Manitoba and the Allegheny Mountains to the foothills of the Rockies, extending southward to western Texas and Arizona. In California it reappears as a distinct variety.

It is most common in valleys and along bluffs overlooking water courses in the Middle West, seldom occurring as the ruling species but usually as scattered individuals or in groups among the other hardwoods.

The range of the Boxelder has been considerably increased by planting and has been made to include most of the New England States, while in the West it has been successfully introduced into regions which are much drier than the river bottoms which are its natural home. The best region for economic planting comprises the greater part of the treeless West from North Dakota to Texas.

CHARACTERISTICS OF GROWTH—ASSOCIATE SPECIES.

Compared with its associate trees the Boxelder is rather small. Because of this, and because of its great shade enduring qualities, it usually occupies the lower story of the forest in which it grows. In the Northeast its average height is from 30 to 40 feet, its diameter 1 to 2 feet. In the Carolinas it is only 20 to 30 feet in height. The largest trees are found in the North Central States, where specimens 70 feet in height and 3 feet in diameter occur. It is usually a rapid-growing tree, although its growth depends largely on the character of the soil.

When grown in the open the trunk often divides at a short distance from the ground into several stout, wide-spreading branches; when in a dense stand a single upright bole is produced, although the clear length is usually short. Perfectly straight boles are rarely seen.

The most common associate species are White Elm, Hackberry, Silver Maple, Black Walnut, Green Ash, and Kentucky Coffeetree.

PROPERTIES OF THE WOOD.

The wood is soft, weak, light, close-grained, creamy-white, with a thick sapwood scarcely distinguishable. Its principal use is as firewood, although occasionally it is utilized for interior finishing, woodenware, cheap furniture, and paper pulp. Maple sugar is occasionally made from the sap.

SOIL AND SITE.

The deep, moist soil in valleys and on the borders of swamps and lakes is best suited for the Boxelder. A sandy loam with the water not more than 20 feet below the surface, even though far removed from streams, is also well suited for this species. Although it succeeds best in moist soil near running water, the Boxelder tolerates great variations of climate and soil, and will bear severe exposures and thrive on rocky slopes, or on the semi-arid prairies. The best development is attained in the valley of the lower Ohio and its tributaries.

PROPAGATION.

The seeds ripen in early autumn and are usually produced in great abundance. They may be gathered as soon as ripe and planted immediately in the nursery, or stratified in sand during the winter for spring planting. Collecting in mild climates may even be delayed until winter, as the seeds hang on the tree until spring. Collecting may be done by the local planter, or seed may be purchased at 35 to 50 cents per pound. Although produced in abundance and apparently sound, the seeds give an average germination of only 40 to 60 per cent. Often a tree apparently loaded with fruit will have no vital seed whatever.

The best way of propagating the Boxelder is to grow the seedlings in nursery beds on rich, well-tilled soil, and when one year old transfer them to the plantation, Spring planting is usually most satisfactory and may be done as soon as the ground becomes warm and dry. The seeds should be sown in rows $3\frac{1}{2}$ feet apart for horse cultivation, or 2 feet apart for hand cultivation. In the rows the seeds should be planted 1 to 5 inches apart, covered three-fourths to 1 inch deep, and the soil over them gently firmed down by a roller, or pressed with a board. If carefully planted and thoroughly cultivated, the seedlings will attain a height of 10 to 14 inches the first season. No shading of the young plants is necessary.

Close planting is advised for the Boxelder because of its tolerance of shade and tendency to form a spreading head. In pure stands, 4 by 8 feet would be none too close. In a forest plantation it is often more desirable to plant the tree with more valuable species such as White Elm, Hackberry, locusts, European Larch, Green Ash, and Black Walnut,

than to plant it alone, except for windbreaks, shade, etc. It is useful for underplanting in forests that are too open. In natural stands reproduction is fairly good in moist situations, and when a plantation is once established, it may be perpetuated, if skillfully managed, through natural seeding. In groves developed for shade, the trees should stand from 15 to 25 feet apart.

In the Northern States considerable damage is often done the Box-elder by drifting snow, which collects on the thick branches and upon melting settles down and breaks them off. If insects appear and threaten the existence of the Boxelder or any valuable tree species, specimens should be promptly sent to the Division of Entomology, where steps will be taken for their identification, and measures suggested for their destruction or control.

POSSIBILITIES.

As a street and lawn tree the Boxelder is of undoubted value because of its hardiness and attractive appearance. But where uniformity is desired trees of the same age are apt to vary so much in form and rate of growth as to make their use inadvisable. As a tree for western planting, it has been very extensively used, and while fairly satisfactory is inferior in many places to other trees, such as White Elm. For underplanting, for wind-and-snow-breaks, for ornament, and as a nurse tree, it should find some use over the whole region east of the Rockies.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

CHESTNUT (Castanea dentata).

DISTRIBUTION.

The Chestnut is distributed throughout the eastern United States at elevations varying from sea level in Massachusetts to 4,500 feet in North Carolina. It ranges from southern Maine southward through New England, being most abundant in the lower valleys of the Merrimac and Connecticut rivers, but common in Rhode Island and Connecticut and as far south as Delaware, except near the sea. It is common in the Province of Ontario and in the Middle States, especially in New Jersey, Pennsylvania, and parts of Maryland. Farther south it is found all along the higher Alleghenies to Alabama, growing well in all soils above 2,000 feet elevation, but less abundant below. In the middle West it is confined to Michigan, Indiana, and Tennessee.

The area for economic planting outside of the natural range is rather limited. The tree can be grown with fair success throughout Missouri and Iowa, in the eastern counties of Nebraska and Kansas, and in the southern half of Minnesota, but nowhere on prairie soil is it long-lived or of first-class growth. In Colorado it grows well under irrigation, and would probably succeed in other parts of the West if well watered. If carried too far north the shoots fail to ripen before they are nipped by the early frosts. The tree will endure the heat and cold of its natural home, and will remain thrifty in sunny, dry situations, but is very susceptible to injury from hot winds.

SOIL, SITE, AND ASSOCIATE SPECIES.

The Chestnut will thrive on various kinds of soil from almost pure sand to coarse gravel, shale, or even limestone. On the latter, however, it is found only when the strata are tilted. In general it prefers the dry, rocky land of the glacial drift to the richer, more compact alluvial soil of the lowlands. It does not demand a rich soil. Its failure to grow in most of the prairie country is due, no doubt, to the alluvial nature of the soil and the frequent presence of lime.

The finest Chestnut trees grow in the higher elevations of the southern Appalachians in western North Carolina and eastern Tennessee, where specimens 13 feet in diameter and 120 feet tall have been found. In this region the tree's greatest development is reached in deep hollows at an altitude of about 3,000 feet. It is here found in mixture with the White, Scarlet, and Black Oaks, ash, hickories, Tulip-tree, and other hardwoods. In the North the tree is likewise found associated with many of the hardwoods, especially the oaks and maples, but is generally of smaller size than in the South, the average being a height of 60 to 80 feet and a diameter of 3 to 6 feet. In southern New England it

is often found in mixture with White Pine, with which it may often be grown in plantations. Throughout its range the Chestnut enters largely into the composition of most second-growth hardwood forests. Near the northern and western limits of its range the tree, besides being smaller in size, sprouts less freely from the stump. The region where planting or systematic management will pay is about the same as the natural range of the tree, or may be extended to a limited distance beyond that range. In the Northeastern States the tree may be depended upon to thrive almost anywhere south of the forty-fourth parallel of latitude in the soils which are suited to it.

MANNER OF OCCURRENCE—CHARACTERISTICS OF GROWTH.

Within the limits of its range the Chestnut occurs either singly or in scattered groups or groves, usually most abundant on the high, gravelly, well-drained hillsides and ridges, and seldom in pure stands.

Chestnuts grown in the forest vary greatly in general form and habit from those grown in parks, pastures, and other open places. The forest tree soon loses its lower branches and develops a tall, tapering trunk, adapted for telegraph poles, ties, and for general use as lumber. But when grown in the open and given plenty of room, it develops a broad, spreading crown, and short, thick trunk.

The Chestnut's rate of growth is the most rapid of any of our truly valuable hardwood trees. Seedlings usually attain a height of 10 to 15 inches the first year and continue growing at the rate of 15 to 20 inches per annum for twenty to thirty years. Sprouts grow even more rapidly than this, often attaining a height of 4 to 6 feet the first year, and in twenty to twenty-five years make timber large enough for ties and poles. After thirty years, however, the rapid growth ceases. In New Jersey a Chestnut is recorded which had a diameter of 60 inches when 70 years old. In the same State several trees 35 years old ranged from 24 up to 34 inches in diameter, with a height of 40 to 50 feet. The average rate of growth is, of course, far less than the above. It varies according to the nature of the soil, the thinner soils being less favorable to rapid growth than rich upland soil.

The root system spreads out extensively, but no deep tap root is developed. This makes transplanting less difficult than with many other nut-bearing trees. The Chestnut is rather intolerant of shade.

THE WOOD—ITS ECONOMIC USES.

The wood is light, rather soft, coarse-grained, and inflexible, the sapwood white, the heartwood darker brown. The wood shrinks and checks considerably in drying, splits and works easily, and because of the tannic acid it contains is very durable in contact with the soil. It is used in cabinet work, cooperage, for interior finishing, fence posts, telegraph poles, and cross-ties. About 5 per cent of the railroad ties in the United States are of Chestnut. The original Chestnut forests

have everywhere been cut, except in parts of the southern Appalachians, but the reproduction of the coppice is so rapid that a fair supply of small-sized timber is still available.

PROPAGATION.

Chestnut reproduces easily both by seeds and stump sprouts. Nuts are borne nearly every year and a full crop occurs usually every other year, thus keeping the ground well seeded. The nuts that are spared by the squirrels germinate readily and, if there are enough of them, quickly reclothe the ground with seedlings. They grow, however, only in pasture land and open woods, since they can not tolerate dense shade. Their growth may be encouraged by leaving seed trees, protecting the nuts from chipmunks and squirrels, and breaking the ground where the nuts fall.

By far the more common and rapid means of Chestnut reproduction is by the coppice sprouts which spring from the newly cut stumps. While not so long lived nor so sound as seedling trees, the coppice sprouts should be encouraged because of their rapid growth and ease of propagation. A clear cutting of a Chestnut forest in the fall or winter when the trees are dormant, taking care to leave smooth stumps, is all that is needed to insure a future growth. In the Middle and New England States a clear cutting system with a rotation of twenty-five to thirty years gives the best results, and will in that time produce trees large enough for fuel, ties, or posts. A stump will retain the power of sprouting with almost undiminished vigor through several rotations. By starting a small number of seedling trees of the same or other species among the Chestnut coppice and allowing them to live through two or three rotations of the sprouts, large timber trees may be secured. The Chestnut is admirably adapted to several systems of forest management.

For commercial or ornamental planting either nursery culture or direct field planting may be practiced. In either case the nuts should be gathered when mature in the fall and stratified in moist sand through the winter, care being taken that they do not dry out after ripening, or become moldy in the sand. If placed in single layers between alternate layers of moist sand in a strong box, out of doors in a sheltered place, they may be depended upon to winter safely.

If started in the nursery the rows should be 3 feet apart, and the nuts placed 1 foot apart in the row and covered 1 to 2 inches deep. In one season the plants should attain a height of 10 to 15 inches, and may be set in the plantation in the spring when either 1 or 2 years old. If transplanted several times in the nursery the plants are improved, but this is usually too expensive to be practiced in economic planting.

For extensive operations direct placing of the nuts in their permanent location is cheapest and best. Fall planting is advised if the planted nuts can be protected from mice and squirrels. Holes should be dug and 2 or 3 nuts placed in each and covered about 2 inches deep,

and the dirt packed down quite firmly. The holes should be dug 5 to 6 feet apart. The Chestnut will thrive in pure stands, but can be grown to better advantage in mixtures. It is especially adapted for planting with the White and Red Pine on waste land in New England, and can also be combined with the oaks, ash, and maples.

ENEMIES.

The Chestnut as a forest tree is as a rule little troubled by insects or fungi. Several forms of borers work in the wood and under the bark, and their ravages are sometimes extensive. The nuts are attacked by the larvæ of two or more species of weevil, but to the timber grower this is not serious. In case insects of any kind appear in alarming numbers, specimens, accompanied by a detailed account of their appearance and habits as far as determined, should be sent to the Division of Entomology of the Department of Agriculture for identification and suggestions as to their control. The trunks of the young trees in warm situations are often affected by a body blight, or sun scald, as it is called. The bark cracks and loosens on the south and west sides of the tree, and the affected portion finally dies. The extent of injury from this source is, however, not great. A new disease of unknown cause has been doing considerable injury during the past ten or fifteen years.

POSSIBILITIES AND USES.

For protective and commercial forest planting few eastern trees are deserving of greater commendation than the Chestnut. Among our long-lived hardwood trees it is difficult to find its equal in rapidity of growth and ease of propagation on soils which are good or medium in quality. It is amenable to various systems of forest management, forms a vigorous coppice, yields a wood which is valuable for a variety of uses, and produces a very valuable nut.

The tree grows so extensively in the East that almost no planting has been done except for ornament and for the production of the nuts. In the West little Chestnut planting has been done because it is popularly believed that the tree does not generally thrive west of the Mississippi, but in Kansas, Nebraska, and Missouri the few trees that have been started are doing well.

PLANTATIONS.

Mr. L. A. Goodman, of Kansas City, Mo., has two rows of Chestnut trees on his estate in Westport. They were twice transplanted before set out, were well cared for, and when 20 years old were 40 feet high, with a spread of 28 feet.

At Farlington, Kans., Chestnuts were set out with Black Cherry, Black Locust, Black Walnut, and a few Catalpas, 4 feet apart each way. They were set in 1882, and in 1895 were 3 inches in diameter breast high and 28 feet high, and free from live branches for 10 or 15 feet.

United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

SLIPPERY ELM (Ulmus pubescens).

DISTRIBUTION AND MANNER OF OCCURRENCE.

Slippery Elm grows from the valley of the lower St. Lawrence southward to Florida, Alabama, and Texas, and westward through southern Canada and the United States to North Dakota and central Kansas. Throughout its entire range it is less frequent than the White Elm, often occurring as a solitary tree in open woods or fields, or less frequently on the moist banks of streams in groves of almost pure stands.

The territory in which forest planting of this species seems advisable comprises the entire Mississippi Valley east of the ninety-eighth meridian, from northern Texas to the Red River Valley of the North. Along river valleys it may be planted for some distance west of this line. To the eastward it will thrive even to the coast.

CHARACTERISTICS OF GROWTH—ASSOCIATE SPECIES.

On good or medium soil Slippery Elm is a rapid but not persistent grower. In the open it is a shapely, spreading tree, with a broom, or vase-shaped crown. It occasionally attains a height of 135 feet and a diameter of 4 feet, but usually it is smaller, with an average height of 60 to 70 feet and a diameter of 1½ to 2 feet. In the crowded forest it grows tall and straight, with cylindrical trunk undivided for a considerable distance above the ground. The root system is composed of numerous deep-seated, fibrous, lateral roots, which are adapted to transplanting. The tree is moderately shade enduring.

The Slippery Elm occurs in association with many of our common hardwoods, including the walnuts, hickories, birches, oaks, and maples.

THE WOOD—ITS ECONOMIC USES.

The wood of the Slippery Elm is far superior to that of any other elm. It is heavy, hard, elastic, strong, and moderately durable in contact with the soil, splits easily when green, works fairly well, and stands well if properly seasoned. Careful seasoning and handling are essential for the best results. The heartwood is dark brown or red, the thin sapwood of lighter color. Unlike most timber, the sapwood, if thoroughly dried, is said to be as durable as the heart, hence trees can be utilized

for posts when very small. When green the wood rots quickly in contact with the ground. When used for posts the poles should be cut in summer and peeled and dried before setting. The greatest economic value of the wood is for fuel, fencing, ties, sills, wheel stocks, sleigh runners, etc. It becomes very tough and pliable when steamed, and is of value for the ribs of canoes and skiffs. The thick, mucilaginous inner bark is quite palatable, slightly nutritious, and of medicinal value.

SOIL AND SITE.

Slippery Elm occurs in the greatest abundance and is of the largest size in the rich, moist, alluvial soils of stream valleys. Fair sized trees, however, are produced on rocky hillsides and on rather sterile upland soil. Slippery Elm is about as hardy in dry sites in the prairie States as the White Elm. It is able to resist drought to a considerable degree, and within the limits of its natural range is seldom injured by climatic extremes.

PROPAGATION.

Reproduction of the tree is by seeds and sprouts. The coppice sprouts do not develop to extent sufficient to make this method of regeneration practical; hence, natural or artificial seeding must be resorted to. On sand bars and along banks where the seeds are carried by water, a young growth often springs up, while fresh, moist soil near the parent tree is occasionally reclothed with vigorous seedlings. In general, however, natural seeding from forest stock can not be depended upon. When mature forest plantations become a reality, their perpetuation will probably be possible through systematic cuttings and natural seeding, but at present purely artificial seeding must be resorted to. In establishing a forest plantation, the trees should be started from seeds sown in a nursery, rather than in the permanent site. The seeds, which ripen in May or early June, are produced at rather irregular intervals of two to four years, and for the most part not abundantly. They may be stripped from the trees by the hands, shaken down upon canvas, skimmed from the surface of the water along streams, or collected in small quantities where they wash up on sand bars. They must never be allowed to dry out.

If mature trees are at hand, the seeds may be gathered by the planter in the region where they are to be used, which has the advantage that the seeds are fresh and are really Slippery Elm seeds. If purchased from dealers, the cost will be about $2 per pound. Since seed crops do not occur every year, and since the seeds will not retain their vitality for more than a few months, there is always danger of getting worthless seeds if purchased from seedsmen. An excellent plan is to send samples of all seeds to the Seed Laboratory of the United States Department of Agriculture, where all seeds will be tested without cost.

It has been asserted that seeds of the Slippery Elm, unlike those of other elms, will not germinate in the season in which they mature, and should be stratified until the following spring. It has been found, however, that if sown about the time they begin to fall from the tree, and given proper care, they will germinate and make a growth of 12 to 20 inches the first season. Careful handling of the seeds to prevent their drying out, and the presence of uniform moisture conditions in the seed bed, are factors essential to success.

The seed beds should be made in moist, finely pulverized soil, which is as free as possible from weed seeds. The elm seed should be sown in rows 8 to 12 inches apart for hand cultivation, and 2 to 3 feet apart if a horse cultivator is to be used. In the rows the seed should be spaced 1 to 2 inches apart, covered about one-half inch deep, and the soil gently firmed down by means of a roller or by pressing with a board. In times of drought the nursery should be frequently irrigated; under no circumstances should the seeds be allowed to dry out from the time of ripening until germination is complete. Even after germination a moderate amount of moisture is essential for the rapid growth of the seedlings. Shade for the young plants is not a necessity, although at times a partial protection from sun or beating rain is beneficial. The young trees should be transplanted to the forest site when one year old.

For prairie planting the Slippery Elm may be set in rows from 4 to 6 feet apart each way. Where a heavy growth of grass exists it should be turned under a year or two before planting, and if possible a crop of cereals grown on the ground. Planting may be done in furrows or in holes dug with a spade. During the whole transplanting operation the roots should be kept constantly moist, and the soil packed firmly around the roots of the newly placed seedling. In the East preliminary preparation of the ground is not so essential, although weeds and grass should not be allowed to crowd the young plants.

Slippery Elm may be grown in a pure stand or in mixtures with the White and the Green Ash, Hardy Catalpa, Black Walnut, locusts, Red Cedar, Scotch Pine, and Black Cherry. If combined with the Black Walnut, or with conifers, it should not be set in the forest until the other species are 5 to 6 feet high, or should be so outnumbered that its rapid growth in youth will not cause injury to the associate species, which grow slower the first few years.

ENEMIES.

Although not so susceptible to injury from canker-worms and other injurious insects as the White Elm, yet when weakened by drought and lack of nourishment the Slippery Elm is often attacked by various insect pests. In case of extended attack specimens of the insect in its

various forms, together with a full description of the injury done, should be sent to the Division of Entomology for identification and suggestions as to its control.

POSSIBILITIES AND USES.

The graceful outline, luxurious foliage, and rapid, vigorous growth of the Slippery Elm make it a general favorite for ornamental planting in parks and along roadsides. Quite as hardy as the White Elm, its more valuable timber makes it preferable in timber lots. In the commercial plantation it may be used as the principal species or utilized as a nurse tree or for underplanting with more valuable or more hardy species. As to its behavior when grown under such conditions, it has not been used sufficiently in forest plantations to justify conclusions.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

WHITE ELM (Ulmus americana).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The White or American Elm has been distributed through natural agencies from southern Newfoundland westward along the northern shores of Lake Superior to the eastern base of the Rockies, and through the United States to the Black Hills, western Nebraska, Indian Territory, and Texas; southward it grows as far as Florida. It is infrequent in the extreme western and southern portions of its range, but appears in greatest abundance in the Northeast, especially in New England, where trees of remarkable size and beauty are found. The highest development is attained in the rich alluvium of the Connecticut River Valley.

Although seldom the most numerous species in a forest stand, the White Elm is widely and uniformly distributed in the East and is one of the most common trees. Its favorite place of growth is in rich intervales, or on fertile wooded slopes where moisture is constant and abundant. It will grow, however, in almost any soil, hence it may be found in nearly every open field, or woodlot, and along roadsides everywhere throughout the East. In the middle West it is one of the most common species, but is more closely confined to river valleys than farther east.

The range advised for economic planting comprises all of the middle Western States, as far south as northern Texas. For purposes of shade and ornament, planting may be done throughout the entire range of the tree.

CHARACTERISTICS OF GROWTH—ASSOCIATE SPECIES.

The divided trunk and spreading vase, or broom-shaped crown, of trees grown in the open is well known. When grown in the forest the trunk remains a single stem and the crown becomes reduced in size. In the South and West, and in unfavorable situations, the tree becomes shorter, with a low, rounded crown not unlike that of the oak. Mature trees vary from 60 to 120 feet in height, and have a maximum diameter of eight feet. The elm usually has a rapid growth and a long life, although on sterile soils both these qualities are materially reduced.

The most rapid growth is during the first 50 to 60 years; there is a falling off before the century mark is reached. The roots are long and fibrous, and run near the surface for a long distance. The tree can endure a moderate amount of shade. The associate species include nearly all of the common hardwoods, especially those with a preference for moist soils, as the walnuts, ashes, sycamores, Tulip-tree, birches, etc.

THE WOOD—ITS ECONOMIC USES.

The wood of the young elm is very tough, but is usually considered of not much value. When the tree has reached maturity it furnishes timber which is moderately strong, coarse-grained, difficult to split, not susceptible to polish, not durable, and liable to warp and check in drying. It is used chiefly in the manufacture of agricultural implements and carriages, and for flooring, cooperage, and saddletrees.

SOIL AND SITE.

The preferable soil for the White Elm is a deep, alluvial loam which is never dry or lacking in abundant plant food. Failing to obtain ideal conditions, the tree adapts itself readily to soils less favorable, or even decidedly poor, and to an adverse climate. It is considered one of the hardiest trees for prairie planting, and is able to endure the great extremes of temperature and drouth of the treeless West. Few trees have been more generally used in prairie planting, and perhaps none is more generally adapted for the exposed and arid planting places of the western plains and prairies.

PROPAGATION.

Reproduction of White Elm is by seeds alone. If propagated for timber it should be done by artificial methods and not left to natural seeding. The rearing of the young plants in nursery beds is usually advisable. Occasionally, when seeds can not be obtained, or when the nursery crop fails, the seedlings which spring up in damp, open places may be dug and used on the plantation site. One-year-old seedlings can be obtained from dealers at from $3 to $5 per thousand, but it is often economy for the local planter to grow his own stock.

The oval, winged fruit, with the seed inclosed in the center of the papery membrane, is produced in abundance nearly every year. It ripens in May, about the time the leaves appear, and should be gathered and planted at once. Seeds may be obtained from dealers for $1 to $1.50 per pound, but it is safer to depend on home-collected material, because, since the vitality of unplanted seeds can not be preserved more than a few weeks at best, those furnished by dealers are liable to be worthless.

The seeds may be gathered by sweeping them up from the pavements, shaking them down from the trees into a canvas spread out

below, or collecting them in eddies or on sand bars where carried by streams. They should never be allowed to become dry from the time they mature until germination is complete. Planting should be done in nursery beds in rich, moist soil, an old garden spot being a desirable site. The seed should be sown in shallow drills in rows 8 to 12 inches apart for hand cultivation and 2 to 3 feet apart if a horse cultivator is to be used. In the rows the seeds should be spaced 1 to 2 inches apart, covered about one-half inch deep, and the surface soil gently firmed down by means of a roller or by pressing with a board. Irrigation should be resorted to in times of drought, since a uniformity of moisture conditions is essential for successful germination of the seed and the most rapid growth of the seedlings. Shade for the young plants is not a necessity, although at times a partial protection from the hot sun or beating rain is beneficial. The seedlings may be transplanted to the permanent site when 1 to 2 years old, at which time they should be 6 to 12 inches high.

To produce the most shapely trees, some of the best nurserymen cut the young trees back to the ground when they are 2 or 3 years old from the seed. Vigorous sprouts start from near the wound; the best one is selected for the trunk of the tree, and all other sprouts are kept pruned off. The strong root forces up a tall, straight trunk, which adds to the form and value of the tree.

For prairie planting the White Elm may be set in rows from 4 to 6 feet apart each way. Where a heavy growth of grass exists it should be turned under a year or two before planting, and if possible a crop of cereals grown on the ground. The trees may be set in furrows or in holes dug by a mattock or spade. During the whole transplanting operations the roots should be kept constantly moist, and the dirt packed firmly around the newly-placed seedlings. Cultivation between the rows is advisable until the trees are large enough to shade the ground underneath. In the East the preliminary breaking of the ground is not so essential, although the young trees should not be allowed to become overtopped by weeds or grass.

White Elm may be grown in pure stands, or in mixtures with various rapid-growing, light-needing species, or with slow-growing trees if they are planted first and allowed to attain a height of 5 to 6 feet before setting the elm. Good associate species are the Hardy Catalpa, ashes, locusts, Coffeetree, Black Walnut, Black Cherry, Red Cedar, and European Larch.

ENEMIES.

Although seldom injured by wind, snow, or fungi, the White Elm is seriously affected by numerous insects. Borer larvæ channel the inner bark and the surface of the wood so frequently as to kill the tree; but by far the greatest damage is done by the elmleaf-beetles, and other

leaf destroyers. In parts of the country park and street trees have been killed, and planting of the elm has been discontinued on this account. It is possible, however, by early and thorough spraying to protect the trees and in the end to bring about the reduction or extermination of the leaf-destroying insects. In case of extended ravages, specimens of the insect, together with a full account of the character of the injury done, should be sent to the Division of Entomology of the Department of Agriculture, in order that the insect may be identified and measures suggested for its destruction or control.

POSSIBILITIES AND USES.

Stately and graceful in form and outline, and rapid growing and hardy in varied soils and severe climates, the White Elm adapts itself to the needs of most tree planters, and is grown extensively throughout its broad range. As a shade or park tree it has few equals, and throughout the East is considered the ideal tree for ornamental planting. It does not thrive in cities where soft coal is habitually used, nor along streets where the moisture is all carried off by artificial drainage. On the borders of gardens or cultivated land it is objectionable because of the extensive spreading of the surface roots. For western planting it has a recognized place in forest plantations which it well deserves.

United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

EUROPEAN LARCH (Larix europæa).

DISTRIBUTION.

The European Larch is not indigenous to the United States, but has been generally introduced under cultivation. It is a native of northern and central Europe, where it is found on moist mountain sides. Small plantations for windbreaks and ornament have been made in various parts of this country from New England westward to South Dakota, and usually with fair success. Further experiments must be made, however, before definite limits of the range for economic planting can be determined. At present it seems evident that planting will be successful throughout the northeastern States, and westward through Indiana, Illinois, Michigan, and Minnesota, to eastern South Dakota, on soils that are somewhat moist and of moderate fertility.

Throughout northern Illinois the European Larch is used extensively as a street tree and occasionally in plantations, and seems admirably adapted to the soil and climate of that State. For prairie planting in this region it has given good satisfaction on moist soils in somewhat sheltered locations. It resists the cold very well, but is liable to injury from hot winds.

Unfortunately, in some parts of the West the Larch has fallen greatly into disfavor because of the practice of many nurserymen of substituting for it native Tamarack seedlings, dug or pulled in the swamps of Minnesota and Wisconsin. The Tamarack is a swamp tree, and though desirable in certain locations, is unfit for prairie and upland planting. Planters who desire European Larch should insist upon being supplied with nursery-grown trees and should see that they get what they order.

SOIL AND SITE.

In Europe the Larch is of largest size on loamy soil formed from the debris of granitic rocks, or in limy soil where the surface is kept cool by moisture. In northern Illinois, where some of the finest planted trees are found, the soil is a rich, black alluvial loam with a porous gravelly subsoil. The tree, however, is adaptable to varying conditions and will thrive on hillsides and uplands and on soils which are clayey with a nonporous subsoil. In general, soil of sedimentary nature seems best, although it need not be deep.

CHARACTERISTICS OF GROWTH.

The form of the European Larch is very similar to that of our native Tamarack. In a close stand it has a very straight, slender bole, which is valuable for poles, fence posts, joists, beams, ship masts, etc. The tree is light demanding, and when in a close pure stand or combined with slower-growing, more tolerant species, it cleans itself well of branches. The seedlings up to an age of 4 or 5 years show a tendency to develop strong tap roots, but in later years an extensive lateral root system is developed.

On good soil and under favorable conditions the Larch is a rapid growing tree. Prof. S. B. Green states that "one tree grown at Owatonna, Minn., attained a height of about 50 feet and a diameter of 15 inches in thirty years, but so rapid a growth is uncommon here." Near New Haven, Conn., the best of the dominant trees of a small plantation have attained a height of 50 to 53 feet and a diameter of 9 to 12 inches in twenty-three years. The seedlings were imported from Europe and were about 2½ feet high and 3 to 5 years old when planted. In dense stands the diameter growth is often rather slow, in proportion to the rapid height growth.

THE WOOD; ITS ECONOMIC USES.

The wood of the Larch is heavy, hard, strong, flexible, and very durable in contact with the ground. When grown on good soil it is yellowish-white, but in cold, elevated situations it is reddish-brown and much harder. Because of its strength and durability, it is very valuable for cross-ties, poles, posts, etc., and is largely used in ship building.

PROPAGATION.

Reproduction is entirely by seeds. Propagation is best effected by transplanting nursery-grown seedlings or transplants to the plantation. The seeds are borne abundantly in small, upright cones, and are easily collected. In this country, however, because of the small number of trees which have reached fruiting age, it is necessary to use imported seeds, which may be obtained direct from foreign dealers or through the larger home seedsmen. Prices are as low as $1 per pound.

Although a deciduous tree, the Larch is a conifer and should be treated as such in all nursery and planting operations. Nursery culture is simple and should be conducted according to the general rules given in Bulletin No. 29 of this Bureau. Nursery seed beds should be prepared in moist loam, and the seeds sown in shallow drills 6 inches apart, and lightly covered with fine dirt. Partial protection from the sun and beating rain should be given the young seedlings for the first two years. The simplest screen for protective purposes is made of lath nailed to a light frame, the laths alternating with open spaces equal to their width,

so as to give a half shade. These frames may be permanently fastened at a height of 5 or 6 feet above the beds so that a man can work under them, or may be temporarily supported on posts or poles 1½ to 2 feet from the ground. Seedlings may be transferred to the field when 2 years old, or at this age transplanted to nursery rows and not put in the field until a year later. In transplanting Larch it is absolutely essential that the work be done very early in the spring, as the buds start early and a disturbance of the plants after growth begins means death or serious injury to the young trees.

Plants in either a pure or mixed European Larch plantation should be set from 4 to 6 feet apart each way; the shorter distance is preferable in the West. In the West the ground must be broken and well subdued before the plants are set. Check rows may be made with a plow or cultivator and the plants set in by hand, or they may be set in holes dug with a spade. Corn may be raised between the rows for several years. Cultivation of the young plantation is essential in most cases. In the East the preliminary preparation of the land and the subsequent cultivation may be dispensed with.

Mixed plantations are in general most desirable. The Larch may be combined to advantage with the following species: White and Green Ash, White and Slippery Elm, Scotch Pine, Red Pine, White Pine, Norway Spruce, and Red Cedar. Often three or four of these species may be advantageously combined, as the European Larch, White Elm, White Ash, Red Cedar, or White Pine. In such mixtures considerable care and skill are required in the thinnings, which should be done when the trees begin crowding.

In many portions of the country other species are of greater value and better adapted for planting than the European Larch. It is, however, a valuable tree for certain sections and for combining in many mixtures. In Europe it is not considered a lowland tree and the best specimens are produced on the uplands, but it readily adapts itself to wet, low ground, and should often be planted in moist situations where other trees would not thrive. As an ornamental tree it is of good form and in the spring is made beautiful by the delicate nature and verdant freshness of the newly expanded clusters of needle-like leaves.

ENEMIES.

The mature native Tamarack of the Northeast was almost entirely killed some eighteen years ago by the larvæ of a sawfly and young trees are still seriously injured by insects. As yet no serious damage by this insect has been reported from plantations of the European species in the West, but the small plats which exist in New England have been badly injured and in some cases nearly destroyed by insect pests. In case of serious attack, specimens should be sent to the Division of Entomology for identification and suggestions as to

control. On low ground a fungus known as *Trametes pini* often attacks the Larch and so destroys the substance of the wood that the tree breaks down in even a slight wind.

NOTABLE PLANTATIONS.

A grove of European Larch near Clear Lake, S. Dak., was planted on the high prairie about fifteen years ago (1886). The trees are now 3 to 5 inches in diameter at the base and 30 to 35 feet tall. The stand was originally very thick, the trees probably standing 3 feet by 4 feet. Most of the trees will each make a single post and there are many that would make stakes in addition, almost large enough for posts. The trees from which this plantation was started were shipped from England.

A plantation of 1½ acres, now owned by Mr. Sulfin, is situated near Dundee, Ill. The trees were planted at a uniform distance of 4 by 4 feet and are now 28 years old, tall and straight, with no side branches. On a half-acre plat that was measured, there were 400 trees with an average diameter at base of 6.4 inches, at 7 feet from the ground 5.1 inches, and an average height of 35 feet. Nineteen of the trees are now suitable for telephone poles, i. e., 9 or more inches in diameter and 30 feet high.

At Greenfield Hill, Conn., is a mixed plantation of European Larch and White Pine planted 5 by 5 feet each way in equal proportion. The site was rich cultivated land and the growth was correspondingly rapid. Measurements made on 7,509 trees when 15 years old gave the following: Average height, 33.2 feet; diameter of average tree, 3.5 inches. Up to the summer of 1901 practically no injury had been done by the sawfly, but that summer the larvæ were present in large numbers and were rapidly defoliating the trees.

A variety of the common European Larch known as *Larix europæa siberica* is largely grown in central Russia. Prof. N. E. Hansen, of South Dakota, believes that it would be a very desirable tree for our prairie States, as it is much hardier than the common form and much superior to it in many ways. Our commercial growers should introduce this desirable variety.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

LOCUST, BLACK LOCUST, YELLOW LOCUST (Robinia pseudacacia).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The Locust was originally indigenous to the mountainous region from Pennsylvania to Georgia, and possibly as far west as Arkansas and eastern Indian Territory. Through cultivation and other agencies it has been introduced throughout the United States east of the Rocky Mountains. Of recent years it is appearing in great abundance on abandoned hillside farms of Pennsylvania, Ohio, and Kentucky, and is also increasing in the southern portion of the plains region west of the Mississippi. It rarely forms extensive pure growths except in southern Pennsylvania, Ohio, and eastern Kentucky, where it is most abundant. Even in these localities it is usually associated with other deciduous trees, occurring in small scattered groves.

Along the Appalachians it occurs with hickories, Black Walnut, ash, White Oak, and Chestnut, and reaches its best development on the western slopes of the mountains in West Virginia.

The range for planting is extensive, covering the region between the Atlantic Ocean and the Mississippi River, and extending west of the Mississippi south of the thirty-eighth standard parallel as far as the Rocky Mountains. It is also well adapted to the valleys of Utah, Idaho, and eastern Oregon and Washington, where planted on irrigated land. The planted groves to be seen near Salt Lake City, Utah, and Walla Walla, Wash., are among the best in the United States.

CHARACTERISTICS OF FORM AND GROWTH.

The growth of the Locust is very rapid, especially in rich soil, where during its early growth it makes an average annual height growth of 2 to 4 feet, and a diameter growth of one-fourth to one-half inch. A post 4 to 5 inches in diameter may be produced on good soil in seven to ten years. On wet soils it is of slow growth and is short-lived. Usually, after the first 25 or 30 years the average height and diameter growth lessens, and by the fiftieth year almost ceases. When the tree is once established it sprouts vigorously from the root, so that coppice growth is easily maintained. The trees usually attain a height of 40 to 80 feet, with a diameter of 2 to 3 feet. In the open the tendency of the trunk is to divide and branch low and not produce stems long enough for timber or telegraph poles. Trees grown in the open are often twisted and the branches irregular, giving them a ragged appearance. In crowded stands the trunks become longer and more valuable, often producing poles with a clear length of 18 to 20 feet.

The roots of the Black Locust are shallow, and where the soil is poor reach out to great distances to obtain nutriment. The shallow roots are in part accountable for the sprouting tendency of the tree, as well as for its rapidity of growth and adaptability to soils underlaid by tenacious subsoil. Trees of all ages are very intolerant of shade and must be given plenty of light from germination to maturity.

WOOD; ECONOMIC USES.

The timber of the Locust has found extensive use for fence posts, ribs of vessels, treenails, telegraphic insulator shanks, and vehicles. It also has been used somewhat for railroad ties and telegraph poles. Its great durability in contact with the soil makes it very valuable for use in the ground, and its toughness and elasticity adapt it to use where great strength is required. It also has a very high value as a wood for fuel, ranking next to Bur and White Oak for this purpose.

Its most common use is for fence posts, for which purpose it is extensively grown. Unlike many timbers, the young wood is almost as durable in the soil as the old on account of the large proportion of heartwood. Posts under average conditions will last from fifteen to twenty-five years.

SOIL AND SITE.

The largest and most perfect Locusts are usually found in well-drained, deep clay lowland soil, but they grow successfully on sandy or gravelly soils, and are said to produce better timber on such sites than in situations more favorable for rapid growth. In its native home it is found growing upon mountain slopes, along the borders of forests, and in rich soils generally. But it has been found adapted to a far wider range of soil and climatic conditions and to extremes of heat and drought. It is, however, not hardy in the extreme north-central West. Its shallow root system makes it adapted to locations where the upper layers of the soil are thin and the subsoil is impenetrable.

PROPAGATION.

The Locust is easily propagated from root cuttings and from seed. In nature reproduction is by seed and by root and stump sprouts. The seed, which is borne in small pods that mature in early autumn, is produced on forest trees only at intervals of three or four years. In the open it is borne more frequently and in greater abundance. Reproduction from seed is not plentiful, although in favorable open situations considerable quantities of seedlings spring up. Reproduction from root suckers is more abundant, although the extent of such distribution is limited to the radius of the root system. Stumps as large as 1 foot in diameter produce sprouts, while trees killed by fire often send up sprouts from the base. Artificial reproduction, especially from root sprouts and seeds, should be encouraged, but for general planting nursery culture must be resorted to.

The seed may be gathered locally by the individual planter or purchased from dealers for 25 to 60 cents per pound. It is well to send samples of the purchased seed to the Seed Laboratory of the Department of Agriculture, where they will be identified and tested free of charge. The seeds may be left in the pods and stored in a cool, dry place for as long as two years without serious harm. If the seeds are removed from the pods and stratified in moist sand in a cool place the vitality will gradually lessen and cease after five to seven years. Just before planting, the seeds should be soaked for several hours in water at a temperature of 150° to 160° F., which will cause part of them to swell. These should be sorted out with a sieve having a mesh of proper size to allow the seeds not swollen to pass through and the rest should be soaked again, repeating the operation until all have swollen. Planting should immediately follow the soaking of the seeds, as under no consideration should they be allowed to dry out.

Spring planting is in general advisable, although the seed can be sown as soon as it matures, when it will generally come up and make a considerable growth the first season. The seed should be sown in well pulverized, rich, loamy soil in early spring. If hand cultivation is to be given, it may be sown in drills 12 to 15 inches apart in a bed, but if horse cultivation is to be practiced, rows 2 to 3½ feet apart will give the best results. The seed should not be covered more than one-half to three-fourths inch deep and should be kept uniformly moist during germination. A pound contains about 28,000 seeds and is sufficient for a row 900 feet long. The seedlings will be large enough to set out in their permanent sites the following spring after planting, at which time they should have attained a height of 1½ to 2 feet. If purchased from nurserymen, the price of seedlings varies from $2 to $7 per 1,000.

The method of management adopted in a plantation of Locust largely determines its usefulness and value. Thick planting should be the rule in order to force the tree into straight, tall growth. In most cases, 4 by 4 feet, or 3 by 6 feet, are suitable distances.

If the trees are planted in a solid block and surrounded by a few closely planted rows of other trees there will be no difficulty from excessive sprouting, as Locust sprouts do not grow where the ground is shaded.

The best success usually results when the Locust is grown mixed with some low-growing, heavy-foliaged tree, as its own shade is not dense enough to keep out grass and weeds. The Osage Orange, Russian Mulberry, Boxelder, Hardy Catalpa, and White Elm are good associates, as they cast heavy shade and do not grow rapidly enough to overtop the Locust. The associate tree need not occupy more than one-third of the spaces in the mixture. The Locust is a good tree to plant with the Black Walnut where the latter is desired as the permanent stand. The two may be planted alternately in the rows. Within fifteen

years the Locust may be cut for use as fence posts, leaving the Black Walnut for the final stand.

ENEMIES.

The value of the Locust is practically destroyed in many parts of the United States, outside of the mountain forests which constitute its native home, by borers which riddle the trunk and branches. Trees standing alone or in pure stands are more seriously injured, while those which have been planted on the Pacific slope, in Oklahoma and Indian Territory, and in some other regions, are almost entirely free from insect attack. In the Northeast scarcely a tree remains unaffected. Injuries from this source, however, can be reduced to some extent by proper management.

Every effort should be used to keep the trees in thrifty growth for the first twelve or fifteen years. Borers seldom injure the trees that are growing rapidly, but confine their attacks to those of less vigor. If there is great danger of damage from borers the trees should be cut for use before they cease rapid growth. Sprouts from the stump will at once renew the growth. By this method of cutting a crop of posts can be produced every ten or twelve years, despite the borers.

Whenever insects or other dangers become alarming in a plantation the Department of Agriculture should be immediately informed as to the character and extent of the injury, and, in case of insects or fungi, specimens should be sent for identification.

POSSIBILITIES AND USES.

If free from borers the Locust will be a tree of the highest value for general planting. The value of the timber, rapidity of growth, adaptability to different soils and climates, and ease of propagation from seed and sprouts combine to give the tree unusual value over a wide range. For ornamental planting the light, open foliage and delicate, sweet-scented flowers commend it for limited use, although the tendency to send up root sprouts and become ragged with age lessens its value. It is in the great durability of the wood and its consequent value for posts, poles, ties, etc., that the greatest utility of the Locust lies. Even with the certainty that the borers will early cause the trees to become stunted and diseased the Locust can be planted with profit because of its value for post timber. If the ravages of the borers can be stopped or materially reduced the Locust should be grown alone or combined in mixed plantations wherever possible. In the South and Middle West, where the borers do less damage than farther East, the Locust may be grown for fence posts with a profit often exceeding that to be obtained from agricultural crops. Many farmers and ranchmen have established plantations to supply the posts and poles required in keeping up fences and sheds, and thus save many dollars annually.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

WHITE OAK (Quercus alba).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The White Oak is common from southern Maine and the valley of the St. Lawrence westward through Ontario and the United States to central Minnesota, eastern Nebraska, and Kansas; thence south to Texas and Florida and the intervening Gulf States. Artificial propagation may be carried on throughout the entire range. The region of best development is on the lower slopes of the Alleghenies, and in the valley of the Ohio and its tributaries.

Naturally a gregarious tree, the White Oak often occurs as the major portion of the forest growth over considerable areas; and again appears only as single trees in open woods or fields, or in small groups among other hardwoods.

CHARACTERISTICS OF FORM AND GROWTH; ASSOCIATE SPECIES.

A long, clean trunk of rather uniform diameter, surmounted by a comparatively small crown, is the characteristic form of the forest-grown oak. In the open the crown becomes rounded and massive, with large limbs striking out almost horizontally, often making the head several times broader than high, and supported by a short, sturdy trunk. The tree often grows to a height of 60 to 100 feet with a diameter of 3 to 6 feet under average conditions. In the southern Appalachians specimens much exceeding these dimensions are often found. Near the western limits of the range the trees are smaller, and are chiefly replaced by Bur Oak. A taproot, reinforced by numerous deeply seated lateral roots, constitutes the root system. Transplanting is difficult, if not impossible, unless root pruning is practiced. For its best development the oak needs plenty of light, although it will exist in a partial shade. Young seedlings will start in dense shade, but will not live unless the canopy above them is somewhat broken.

The rate of growth is slow, yet persistent; the amount of wood laid on every year often remains uniform until the tree is well past 100 years of age. During the seedling stage the root system develops rapidly, while the part above ground grows very slowly until the roots are well established.

The White Oak grows naturally in association with the Chestnut, elms, Basswood, hickories, maples, Black Walnut, and Tulip-tree, and with the Red, Yellow, Scarlet, Post, and Chestnut Oaks.

WOOD; ECONOMIC USES.

The wood of the White Oak is considered superior to that of any other species of the genus. It is strong, heavy, hard, tough, close-grained, and very durable; checks badly in drying, and shrinks considerably. It is used extensively in shipbuilding, general construction, cooperage, carriages, farm implements, and for ties, posts, piling, etc. So great is the economic value of this wood that the available supply is being rapidly exhausted and not replaced.

SOIL AND SITE.

The White Oak thrives fairly well except on cold, wet land with an impenetrable subsoil. It reaches its best development on rich, moist, well-drained sandy or gravelly loam, and prefers a protected situation. It does not demand rich soil. Deep bottom lands and protected coves offer the ideal conditions. It belongs to the more hardy species since it resists both drought and cold, although somewhat susceptible to very low temperature.

PROPAGATION.

The White Oak reproduces itself by seeds and sprouts. The small trees sprout freely from the stump. Where ties, posts, or small timber trees are desired, the system of regeneration by sprouts (coppice) is practicable. For the best success of this method the stumps should be cut low and smooth.

Small edible acorns are borne in abundance nearly every year; they may be collected and stratified in moist sand, or may be planted at once. The acorns mature in one year.

Natural reproduction is usually fairly plentiful, as the acorns germinate on fresh soil, or even more readily on beds of leaves. In parts of the South young seedlings spring up in old fields, either under the shade of the parent trees or in open exposures, and form a large percentage of the young growth after removal of the Tulip-tree, Shortleaf Pine, and large White Oak. Frequently, however, especially in the North, White Oak is replaced by less valuable species. Natural regeneration can be assisted by protecting the acorns from the wild creatures which feed upon them, and the seedlings from destruction by cattle and fire. Broadcast sowing of the acorns in the fall is often practicable. It is generally not advisable to raise White Oak seedlings in the nursery because of the difficulty of transplanting them, unless expensive root pruning methods be practiced.

Fall planting of the acorns in the permanent site as soon as they

mature is advisable for extensive operations. The acorns germinate soon after they fall from the trees in autumn, hence they should be gathered immediately and planted before the developing sprouts are large enough to be injured by handling.

Planting may be done in shallow furrows or in holes dug by a spade or grub hoe. Three to four acorns should be placed in each hill, and covered about 2 inches deep and the dirt pressed down firmly with a hoe or by the foot. The spacing of the hills will vary with the region and local conditions; 6 feet apart each way will usually give satisfactory results. If the proposed planting site is on tillable land it may be advisable to prepare the ground for spring planting and combine a crop of corn with the acorns. Should this plan be followed, the acorns should be stratified over winter in a box of moist sand in a cool, airy place. In planting, prepare the ground as for corn, mark it in check rows, and plant acorns in alternate hills each way. Cultivation may be continued for several years until the seedlings cover the ground, or after two or three years the intervening spaces may be planted to some shade-enduring species, which will fill the lower story under the high oak canopy.

Either as coppice or seedling forests the White Oak does well in pure stands, and likewise makes a splendid development in mixtures. Norway Spruce, White Pine, European Larch, White Elm, White Ash, Sugar Maple, Tulip-tree, and Black Walnut may be combined with White Oak.

ENEMIES.

All oaks are subject to insect infestation, and many cases of serious damage have been reported. The immature leaves in spring are occasionally disfigured by a fungous disease. In case of serious insect attack the Division of Entomology of the Department of Agriculture should be notified and specimens of the insect sent in for identification and suggestions for its destruction or control.

POSSIBILITIES AND USES.

White Oak wood ranks among the best for general usefulness. It is being rapidly exhausted and no steps are being taken for its reproduction. The reason it is not used by tree planters more extensively is principally because of its slow growth. Measurements made at Sewanee, Tenn., show that White Oak in the forest requires an average of about ten years for every 1 inch of diameter accretion, proving that it requires more than one hundred years for a tree at Sewanee to attain a diameter of 10 inches. The average height growth for the same time is about 8 inches a year. Under the more favorable conditions that usually prevail in a planted forest the rate of growth would probably be more rapid; yet at the best the growth of the White Oak

is slow. For ornament the tree is very desirable because of its form and hardiness.

Plantations of White Oak would give a very low margin of profit. The natural reproduction of the species should, however, be encouraged and protected. Coppice forests of White Oak, managed with the view of yielding ties and posts, can with small expense be made profitable, if near a market.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

WHITE PINE (Pinus strobus).

DISTRIBUTION.

The natural range of the White Pine is from Newfoundland and Nova Scotia west to eastern Manitoba and south throughout the Great Lake region to the headwaters of the Mississippi, with scattering trees extending to northern Illinois and Iowa. In its eastern range it extends south along the Atlantic Coast to southern New England, and in the Appalachian Mountains to Alabama and Georgia. It is found in greatest abundance in the St. Lawrence Valley and in the region surrounding the Great Lakes. It prefers a cool, moist climate, and can not endure excessive heat and drought.

The range for the economic planting of the White Pine in North America is the same as its natural range, and may possibly be extended beyond these limits to Ohio, Indiana, Illinois, Iowa, Missouri, and eastern Kansas and Nebraska. It is an essentially valuable tree for planting on the cleared and cut-over areas of New England, New York, Pennsylvania, New Jersey, Virginia, the Appalachian Mountains, and the Lake States.

MANNER OF OCCURRENCE.

In the western part of its range it grows mixed with hardwoods on rich, deep soils. It is also found in both pure and mixed stands on moderately fertile sandy soil, and competes with the Jack and Red Pines on the sandy barrens of the Lake region. In the East it reaches its greatest development on the flats and lower mountain slopes of Maine, New Hampshire, and northern New York. Here it was formerly often found 4 to 6 feet in diameter and sometimes 200 to 250 feet high. Most of the original stand has been removed, so that now the virgin White Pine is largely restricted to private forest preserves. Throughout its eastern range it thrives on soils of every character, growing with the Red Pine and the Red Spruce on tenacious clays, and with the Pitch Pine on the poorest sands. Its growth in the sandy region is, however, slower and its life shorter than in richer soils. The White Pine can not withstand salt ocean winds, and hence is not adapted to planting on the sea shore.

WOOD—ECONOMIC USES.

The wood of the White Pine is soft, light, smooth, straight-grained, and easily worked, but is not durable in contact with the soil. The tree produces a high percentage of heartwood, the finest quality of which retails at from $50 to $100 per 1,000 feet. Seasoned timber weighs about half as much as green and is more than twice as strong. The wood of the White Pine is more uniform and shrinks less than that of any other pine. It has been extensively used in construction, and has had a greater influence on the lumber markets of the United States than any other wood.

GROWTH AND REPRODUCTION.

The growth of the White Pine seedling in the forest is very different from that of the nursery-grown tree. In the forest the growth for the first six or eight years is very slow, seldom averaging an increase in height of more than 6 inches annually. Where conditions for growth are favorable, from the eighth to the fifteenth year the annual growth averages about 14 inches, after which it begins to decrease until at the end of the first century the average is almost one foot per year. After this time its rate of growth rapidly declines, averaging about a third of a foot for the second century.

In the nursery the growth is much more rapid than in the forest, for better conditions are present there, and more rapid growth is encouraged. Thomas Meehan & Sons give the following sizes in height for White Pine seedlings: One-year-old seedlings, 2 to 3 inches; two-year-old, 4 to 6 inches; three-year-old, 12 to 15 inches; four-year-old, 24 to 36 inches.

The late Mr. Robert Douglas, of Waukegan, Ill., wrote:

> White Pine seedlings one year old are 1 to 2 inches high and altogether too small and tender for transplanting. At two years old they are much stronger, from 3 to 5 inches high, with fine fibrous roots and in fine condition for transplanting. At three years old they are 6 to 9 inches high and should not be allowed to stand another year, as they would add about 10 inches to their height during the next year and would not be suitable for planting.
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> The first season after transplanting the White Pine will not increase much in height, but will establish itself, extending its roots and forming a strong terminal bud.

Actual measurements made by the Bureau of Forestry in many planted groves prove the figures of both Thomas Meehan & Sons and of the late Robert Douglas to be correct. The annual growth frequently reaches 40 inches between the eighth and sixteenth years. After the thirtieth year the growth of the planted trees becomes similar to that in the natural forest and continues so throughout the subsequent life of the tree.

White Pine reproduces very readily from seed, which matures in September of the second year. A good seed year occurs once in three to five years. The cones should be collected before they begin to open,

which may be done either by picking them from the standing trees, or cutting the branches, or felling such trees as are to be lumbered that season. The cones should be spread out on a sheet or flooring, where they will have the sun and yet may be protected from rain and excessive wind. Within about a week the cones will open, allowing the seed to drop out. A thorough stirring will completely separate the seed, and the cones may then be raked away. Two bushels of cones yield on the average 1 pound of seeds, about 28,000. Seventy-five per cent of these should germinate, and with proper care 40 per cent should survive the seedling stage of the young pine. The plantation should usually be started from nursery-grown trees and not from seed. The two-year-old seedling is in most cases the best size for planting in the East and Northeast, and in the prairie States the four-year-old, once-transplanted tree. The White Pine seedling has a fibrous root system, which adapts it to easy transplanting.

The foliage and branches of the White Pine endure considerable shade, hence the natural pruning of the side branches is slow, even when crowded. Because of this the tree when planted for commercial purposes should always be grown in plantations sufficiently dense to cause the early shedding of the lower limbs. In most cases 6 by 6 feet, or 1,210 trees per acre, is a desirable density. In the cut-over districts of its natural habitat the White Pine may sometimes be grown successfully by sowing the seed on the snow.

ENEMIES.

When young, White Pine, owing to the thinness of its bark, is very susceptible to injuries from fire. A number of methods of protection are in practice, of which the following are the most satisfactory: For large areas the fire patrol or the fire line; for small areas the removal and burning of all debris, or the burning annually of a fire line around the borders of the forest. The fire patrol consists of a corps of forest police, whose duty it is to extinguish immediately any fire that may start. The fire line is usually a satisfactory method of protection, but is expensive, and in its establishment there is some danger of starting a forest fire. On the burned forest land the best method of restocking with White Pine is to plant three-year-old seedlings the year succeeding the fire.

A very injurious fungus must be guarded against in the early growth of the White Pine. Where the soil is allowed to become soaked, or where sufficient light and air are withheld, the ideal conditions for the action of this fungus exist, and the usual result is the "damping off" of large numbers of the young trees. In the shaded seed-bed, when the quantity of rain is sufficient to endanger the young trees, the "damping off" may usually be prevented by raising one side of the shade so that it may act as a partial roof.

Perhaps the most serious menace to White Pine is *Pissodes strobi*, a weevil. This insect deposits its eggs in the terminal shoot of the tree in July and August. Early the following spring the eggs hatch and the larva, a small, whitish grub, begins its work of boring into the tender tissue of the previous year's growth. It continues this for several weeks, then changes into the pupal, or rest, stage. As a rule the growth of two years is killed by the larvæ produced by a single adult. As many as 200 larvæ have been found in a single shoot.

The trees are most liable to the attack of the weevil between the fifth and twentieth years. The worst effect of the weevil is a crooked stem, greatly retarded in growth; but this is usually overcome in later years if the density of the forest is sufficient. No practicable remedy is yet known. Trees on which two leaders, or terminal branches, have developed as a result of weevil's attack should have the smaller of the two, or the one having the least satisfactory development, removed. This may frequently be done to advantage even on large tracts by the use of long-handled pruning shears. In case of serious attack, specimens should be sent to the Division of Entomology for identification and suggestion as to control.

There are a number of borers which attack the White Pine, and some are of considerable economic importance. Bark-beetles are frequently injurious. Their presence is usually indicated by the exudation of sap. Methods of remedying the harm are practicable only where a limited number of trees are to be dealt with. Some forms of borers may be cut out or killed by probing with a strong wire.

ASSOCIATED SPECIES.

Owing to its shade enduring qualities the White Pine is adapted for planting either in pure plantations or in mixtures. In nature its development is equally good alone and in mixtures with other trees. Its rapidity of growth, long continued, makes it, in the end, the dominant tree. It thrives associated with maple, Beech, birch, Basswood, Cucumber-tree, hickory, Wild Cherry, oak, Chestnut, Hemlock, and Pitch and Red Pines. In the pineries of Michigan, Wisconsin, and Minnesota it grows with the Red and Jack Pines. In the coniferous forests of New England and Canada it is found with Red and Black Spruce, Hemlock, Arborvitæ, Larch, and Red and Pitch Pines.

In plantations White Pine makes the most perfect forest conditions when planted alone, but it is also adapted to growth with a number of other species, of which the following are more important: Sugar Maple, Red and White Oaks, hickory, Chestnut, Tulip-tree, and European Larch. Sugar Maple, within its range, is probably the most desirable tree for mixture with the White Pine. It has a similar height growth, and is cheaper than most other trees, several nurseries selling 6 to 12 inch seedlings at $2 to $3 per thousand. The slower growing oak and

hickory should be given the advantage of one to three years' growth in the plantation before planting the pine.

For commercial planting, owing to its cheapness, its simplicity, and its adaptability to a large part of the range of the species, the following method of mixture is advised:

[6 feet by 6 feet.]

P	M	P	M	P	M	P	M
M	M	M	M	M	M	M	M
P	M	P	M	P	M	P	M
M	M	M	M	M	M	M	M
P	M	P	M	P	M	P	M

P=White Pine. M=Sugar Maple.

According to this plan the pines, which will form the eventual stand, are placed 12 by 12 feet, or 302 to the acre. With the pine are planted 908 Sugar Maples, making a total of 1,210 trees per acre. Under ordinary conditions this method may be practiced at a cost for seedlings of less than $3 per acre.

Thus far little planting has been done for commercial purposes, owing to the cost of establishing the forest, but with the present better knowledge of inexpensive methods, practical planting may be accomplished throughout a large portion of the range where land may be had cheap.

NOTABLE PLANTATIONS.

Following is a record of several important White Pine plantations in the United States:

In May, 1872, transplanted nursery-grown White Pine four years old from seed were planted on the grounds of the Illinois University, the trees being set 4 by 4 feet. In 1900 the trees were 38 to 41 feet high, and 974 were still living per acre, varying in diameter from 3 to 10 inches.

In 1875, 3 acres were planted to White Pine, European Larch, Boxelder, Green Ash, and Cottonwood at the Iowa Agricultural College. The original planting was 3½ by 3½ feet, and the trees now average 10 by 10 feet. The White Pine was 30 feet high and averaged 8.7 inches in diameter in 1900.

In 1853, at North Middleboro, Mass., 13 acres were sown to White Pine in seed spots 6 by 6 feet, on waste and otherwise useless land. The planting and land cost a total of $5 to $7 per acre, and in 1891 the entire stumpage was sold for box boards at $4 per cord, net. The cut amounted to 40 cords per acre, thus making a return of $160 per acre.

At Bridgewater, Mass., a plantation 48 years old from the young 3-year-old seedlings had in 1901 an average of 57 feet in height and 11.9 inches in diameter.

Between twenty-seven and thirty years ago 75 acres of White Pine were planted 4 by 4 feet near Moultonboro, N. H., at a cost of $6 per acre total outlay. The young trees were forest gathered seedlings. The portion planted

twenty-seven years ago has since been thinned once, and in 1901 had an average of 5.18 inches in diameter and 43.5 feet in height.

At Greenfield Hill, Conn., 15 acres were planted fifteen years ago to young nursery-grown White Pine. The trees in 1901 averaged 4.2 inches in diameter and 28.3 feet in height, an average annual height growth of almost 2 feet.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

NORWAY SPRUCE (Picea excelsa).

DISTRIBUTION.

The Norway Spruce does not occur naturally on the American continent, but it is a native of northern Europe and Asia. It is a tree of cold regions, and in its native home is found from the lowlands on the shores of the Baltic and the low mountain slopes of the Scandinavian peninsula to altitudes of 6,000 feet in the Alps. It has become distributed by planting far beyond its natural limits. It was introduced into England in the sixteenth century, and has been grown as an ornamental tree in the United States for many years.

The boundaries of the regions in which Norway Spruce may be planted for profit in this country are not yet known. As a rule, the species thrives throughout the entire Northeast, and southward in the higher, cooler localities; in the West favorable results have been attained with it only in the eastern part of the prairie region in the more protected places. In South Dakota Norway Spruce does not succeed because of its lack of hardiness and its inability to endure open exposures. In southwestern Minnesota it is nearly as hardy as White Spruce, but its foliage is apt to turn brown in winter.

CHARACTERISTICS OF GROWTH.

In all situations the Norway Spruce develops a straight, undivided trunk, with small, slender branches, which become somewhat drooping with advancing age. In the open the limbs persist almost to the ground, and in young or middle-aged trees form a symmetrical, conical crown. In old age the head becomes somewhat scraggly. In the crowded forest the crown retains its conical form, but is restricted to the upper one-third or one-fourth of the stem, the lower limbs being undeveloped or broken off by the crowding. The root system is shallow; hence the trees are not wind firm when exposed. While young, the tree is capable of enduring heavy shade. The growth during the first decade is rather slow; then comes a rapid growth of both height and diameter, followed by a gradual decline. Figures from Germany show that a full stocked stand of Norway Spruce in a 100-year rotation makes an average annual volume accretion of 154 cubic feet per hectare

in the best sites and 56 cubic feet on the poorest, while the individual tree on the first-class site at the end of a 100-year rotation has added to its volume at a mean average rate of 0.487 cubic foot annually. The same source of information indicates that the maximum height increment of single trees occurs in the thirty-eighth year, while the average annual height increment is greatest in the fifty-ninth year.

WOOD; ECONOMIC USES.

In this country practical use has never been made of the wood of Norway Spruce. The timber is light, soft, nonresinous, works well, splits easily, seasons without serious warping, and is fairly durable. Its greatest use abroad is for timber, fuel, and paper pulp. In this country its excellence for paper pulp will constitute its chief value, and will be the inducement for extensive economic planting. The timber is excellent for general construction purposes also, and may be used as a substitute for White Pine.

SOIL AND SITE.

A rich, deep soil is not demanded by the Norway Spruce, although on the richer soils the rate of growth is more rapid. The tree will grow well in a fresh, shallow soil, moderately porous, even though it be not fertile, and will thrive with a moderate amount of moisture. Drought or a naturally dry soil, it will not endure. It withstands the cold of winter, but is somewhat susceptible to late frosts.

PROPAGATION.

The Norway Spruce is a heavy seeder; it bears a full crop every two or three years. The cones mature in September or October and should be picked during the fall and placed in a dry place where they will open. The seeds may easily be shaken from the open cones and should be placed in porous bags and kept in a cool, dry place during the winter. If carefully stored, the germinating power may be retained for from three to five years; the vitality will be retained longer if the wings are not detached. Where fruiting trees are at hand, seed collecting by the local planter is feasible. If purchased from dealers the cost will range from $1.50 to $2 per pound. It is advisable to send samples of purchased seeds to the Seed Laboratory of the Department of Agriculture for identification and to determine what per cent of them will germinate. Of fresh seeds, more than 75 per cent should germinate.

Forest plantations should always be started from seedlings or transplants grown in a nursery rather than by direct sowing of the seeds on the proposed site. Seedlings may be purchased for $5 to $10 per thousand, but should be grown in home nursery beds whenever possi-

ble. Bulletin No. 29 of the Bureau of Forestry gives adequate instruction in all phases of nursery practice.

The nursery or seed beds should be located on high, well-drained ground, where the soil is moist, finely pulverized, and of moderate fertility; an old garden spot is often a desirable site. The beds may be made in the form of small rectangles with paths between, or long and narrow, as best suits the fancy or conditions, care being taken not to make them too wide for convenient shading or weeding. Sowing in drills is usually preferable to broadcast sowing because of the ease of weeding. The latter method, however, will give a larger number of seedlings per bed. The shallow drills should be 6 to 12 inches apart; the seeds should be scattered one-fourth to one-half inch apart in the row, covered not over one-fourth inch deep with fine moist earth, and the soil over the entire bed pressed down firmly by a roller, or with a board. The 65,000 seeds contained in a pound will cover at least 1,500 linear feet of seed drill. The surface of the bed should be kept damp by mulching with chaff, moss, or sawdust, or by direct application of water in case natural conditions do not supply sufficient moisture. Germination should occur within three or five weeks, and during the first year the plants should attain a height of $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. The seedlings may be placed in the plantation in the spring when two years old, but it is better to transplant them to nursery rows at that age and delay their transfer to the forest site for a year.

The seedlings demand partial shade during the first year. The second year it may be dispensed with except during times of drought or protracted sunshine. The half shade is best; it is secured by lath screens temporarily fastened on posts 18 to 24 inches above the bed, or permanently placed at a height of from 5 to 6 feet so as to allow a person to work underneath. For small temporary beds a covering of brush is often sufficient.

In the plantation the trees should be set 4 to 6 feet apart each way and the soil packed firmly about the roots. In planting, two men can work together to best advantage, one going ahead making the holes with a spade or grub-hoe, the other following and setting the plants. The roots should be kept constantly wet, because even a momentary drying is fatal.

The Norway Spruce succeeds in pure stands or may be advantageously mixed with other species. The best associate species are White and Red Pine, European Larch, Chestnut, Black Locust, Tulip-tree, and Black Walnut. The Norway Spruce cleans its bole well in forest stands, preserves the soil fertility, and makes a perfect forest floor.

ENEMIES.

So far as known the Norway Spruce in this country has never been seriously infested by fungi. Long-continued drought, hot winds, and

late frosts are sources of injury, while the shallow root system makes the tree liable to be thrown by wind unless inured to its exposed position. In case such destructive agencies as insects or fungi appear, specimens, accompanied by an account of the character of the injury, should be sent to the Department of Agriculture for identification and recommendations.

POSSIBILITIES AND USES.

The Norway Spruce is best known and most widely used for shade and ornament and deserves continued extension for such purposes. The tree is shapely in youth, but becomes scraggly in old age near the seacoast and in smoky cities. For economic planting no foreign conifer promises quicker and more desirable returns, while none of the native eastern trees except White Pine seem more fitted for general planting. On the waste lands of New York, Pennsylvania, and New England the Norway Spruce and White Pine in mixture form one of the most promising combinations for planting on rough, brush land. But little is as yet known as to the behavior of the Norway Spruce when grown as a forest in this country, yet indications are that the trees come to maturity here earlier than abroad. If this be true the importance of the tree will increase greatly since one of the prime uses of the wood is for pulp, and if a merchantable stand can be grown in 50 to 70 years, instead of 100 as abroad, more extensive planting will result.

PLANTATIONS.

A large Norway Spruce plantation is owned by H. G. Russell of East Greenwich, R. I. Measurements made when the trees were 23 years old showed for several thousand trees an average diameter of 6.7 inches, or an average annual diameter growth of 0.29 inch. Height measurements made on 144 trees showed an average of 32 feet.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

TAMARACK (Larix laricina).

DISTRIBUTION AND MANNER OF OCCURRENCE.

The Tamarack, American Larch, Hackmatack, or Juniper, as it is variously called, has its southern limit in northern Pennsylvania, Indiana, and Illinois, and extends northward to the Arctic Circle and westward to central Minnesota. Occasionally it creeps down the mountain ranges into Pennsylvania and New Jersey. It may be planted in cold, moist situations throughout the Northern States from the Atlantic to the Mississippi.

The Tamarack is most plentiful in the swamps and silted lake beds of northern regions, where it occurs in dense pure stands or mixed with the Arborvitæ and Black Spruce over vast areas of swamp land. In such situations it is of very slow growth and of stunted form. Better trees grow on the edge of swamps and along the banks of sluggish streams in mixture with Balsam Fir, Black Spruce, Black Ash, and Arborvitæ, where the moisture is not excessive. Although more common on lowlands, in places it creeps up the mountain sides, and on Katahdin in Maine is found at an elevation of 4,000 feet. By far the better trees are found on the rich, light, alluvial soils of the upland, but the trees are far less abundant than on wetter, stiffer soils, where the competition with the spruces and other species is not so keen.

SOIL AND SITE.

Few trees can endure such variable moisture conditions as the Tamarack, but despite its ability to live on wet or dry soils, its form of growth is greatly influenced by the site. In swamps where standing water covers the roots and excludes the air, the tree little more than maintains its existence. A tree has been found which attained a diameter of only 1½ inches in forty-eight years. On rich soil of moderate moisture the growth is quite rapid. In such a situation a tree has been found which grew to a height of 44¼ feet, with a diameter of 11 inches, in thirty-eight years. The soil best adapted for the growth of the Tamarack is rich, moist, alluvial loam, such as occurs along the banks of streams and on the borders of lakes and marshes.

CHARACTERISTICS OF FORM AND GROWTH.

The Tamarack grown in the forest has a slender, upright bole and a narrow, pyramidal head. In the open this regular form is lost and the crown becomes open and irregular. The roots which are developed in the deep mud of the northern swamps are very long, tough, and stringy. They were once used by the Indians for withes. On drier land strong knees are sometimes developed by a large root starting downward and then taking a lateral direction. Such roots are of value in shipbuilding. The tall, slender boles of the mature trees make excellent spars and masts and have been extensively used as such.

The Tamarack demands much light for growth. In plantations, when mixed with other trees, it should always form the upper story.

THE WOOD—ITS ECONOMIC USES.

The wood closely resembles the best hard pine and is used for about the same purposes. It is heavy, hard, resinous, rather coarse-grained, durable in contact with the soil, and is used in shipbuilding, and for fence posts, ties, telegraph and telephone poles, and in the manufacture of canoes. Lumbermen recognize two varieties of Tamarack, the Red and the White, the distinction being based on the color of the heartwood. The red-hearted trees have less sapwood, and are produced on colder, less favorable soil than the white variety.

PROPAGATION.

Reproduction of the Tamarack is by seeds, which are borne in small upright cones that fall during the second year. The seeds are about one-eighth inch long, pale, winged, and are produced plentifully. The cones should be collected in the fall when they mature and stored in a dry, cool place. When the seeds are wanted for planting, the cones should be spread in the sun until the scales open sufficiently to allow the seeds to fall out. Shaking the cones or pounding them with a stick will help in the separation of the seeds.

Tamarack reproduces rather slowly because of its intolerance of shade, although in swamps, where other species are unable to enter into competition with it, it holds its own. On the borders of swamps and marshes a fair stand of young trees frequently occurs. In cutting over a Tamarack swamp, it will always pay to leave enough trees to seed the ground, unless it is to be cleared for agricultural land.

For general planting nursery-grown trees are best, although in the swamps of Wisconsin and Minnesota large quantities of seedlings can be easily obtained. Unscrupulous dealers have often placed these pulled seedlings of our native Tamarack on the market as European Larch. In starting a forest nursery of this species the general direc-

tions given in Bulletin No. 29, Bureau of Forestry, for the growing of conifers may be followed.

The seeds should be sown in the spring in carefully prepared beds in shallow drills 6 inches apart, and covered lightly with fine moist earth. The surface of the bed should be pressed down firmly and kept moist by covering with a thin mulch of chaff or sawdust. This mulch should be removed as soon as the seeds begin to break the ground. In one year the seedlings should be 2 to 3 inches high, and the second spring should be transplanted to nursery rows. When three years old the transplants may be transferred to the field. All transplanting must be done when the trees are dormant, and as the Tamarack starts the earliest of any of the conifers it must be given first attention.

In the plantation the trees should be set from 4 to 6 feet apart. They may be set in a pure stand or mixed with Black Ash, Balsam Fir, hemlock, or spruce, care being taken that the Tamarack is not overtopped and deprived of light.

ENEMIES.

About twenty years ago much of the mature Tamarack of the Northeast was killed by the larvæ of a sawfly. The ravages were then discontinued and a large quantity of second growth sprang into existence. In 1901, however, the sawfly appeared again and did serious injury to the young trees of the Adirondacks. In case of serious attack, specimens should be sent to the Division of Entomology for identification and suggestions as to control. In very wet situations a fungus known as *Trametes pini* attacks the Tamarack and so honeycombs the wood that the tree blows down.

POSSIBILITIES AND USES.

The Tamarack may occasionally be used to advantage for variety planting on lawns or where the soil is moist, or for commercial purposes in swampy land, around sloughs, and along lake shores. On dry land it should not be used, and for soils of a moderate degree of moisture we have far more valuable trees. Hence Tamarack should be planted only in cold, wet locations where more valuable species will not thrive.

No large commercial plantations of Tamarack are known to exist.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

TULIP-TREE, WHITEWOOD, or YELLOW POPLAR (Liriodendron tulipifera).

DISTRIBUTION.

The Tulip-tree is distributed sparingly through southern New England and New York; it is more plentiful on the southern shore of Lake Erie and westward through northern Indiana and Illinois. To the southward it is found in Alabama and the other Gulf States to northern Florida. It is rare west of the Mississippi except in northeastern Arkansas and southeastern Missouri. It is most abundant and of largest size in the south central part of its range, especially in Tennessee, Kentucky, and the western Carolinas, and in the basin of the Ohio River and its tributaries.

The tree is hardy east of the Mississippi except in the colder portions of the Northern States, and thrives in a great variety of upland soils. The range for economic planting, broadly stated, includes all of the States east of the Mississippi, although the conditions of soil and site in some localities make its development better than elsewhere. Near the western limits of its range it is sometimes injured by sun scald.

SOIL AND SITE.

The Tulip-tree is most common and attains its finest development on deep, fertile, rather moist loam, or rich sandy soil, in which is mixed a considerable quantity of humus. In the South and in the Ohio Valley the soil in which the largest and best Tulip-trees once grew is of great value for agricultural purposes; hence the forests of these regions have been destroyed and not replaced. The Tulip-tree will maintain itself in heavy clay and hard rocky soils, but such soils are not favorable to it and almost always cause a marked diminution in the characteristic development of the species, especially in height growth and quality of the timber. The tree is found growing in exposed situations, but reaches greater size in sheltered ravines and valleys, and in protected coves along water courses. It is never found growing in standing water, but will endure very moist soil.

MANNER OF OCCURRENCE.

The Tulip-tree is scattered by single trees or clumps of trees throughout the forest. In specially favored localities in the South it is often the principal growth, but is not usually the predominant tree over extensive areas. In the North it occurs more sparingly than in the South. It is generally associated with other deciduous trees, such as Chestnut, the oaks, walnuts, hickories, maples, Black Cherry, Locust,

and Beech. On the South Atlantic coastal plain it occurs with Sweet Gum, Black Cherry, Black Gum, Swamp Chestnut Oak, and Water Oak, or in peaty soils with the White Cedar (*Chamæcyparis thyoides*).

CHARACTERISTICS OF FORM AND GROWTH.

The growth of the Tulip-tree is rapid when compared with that of the hardwoods with which it grows; it is also long-lived, specimens having been cut 320 years old. During the first forty or fifty years the height growth is from 1 to 2 feet annually, with a diameter growth of one-tenth to one-fourth inch, or even more in favorable situations. Measurements made on sixteen trees averaging 28.1 inches showed an average rate of growth of 1 inch every six years. After passing fifty years, the rate of growth begins to decrease until it practically ceases when the tree is very old. The average height is from 70 to 100 feet, with a diameter of from 3 to 6 feet; but much larger trees are often found, some with a height of 190 feet and a diameter of 10 feet having been reported.

The Tulip-tree of the forest has a small pyramidal head held aloft by an exceptionally straight, cylindrical trunk, which in the forests of the Carolinas and Tennessee is often free from branches for 80 to 100 feet. The tree must have plenty of light; it will not endure dense shade, but when crowded often pushes its crown up above the trees around it. If too closely crowded and overtopped it is sure to succumb.

When grown in the open its form does not change so radically as does that of most other hardwoods under like conditions. Although the tree grown in the open is broader and more limby, the main axis is usually maintained and the limbs grow out symmetrically. The root system possesses both tap roots and a considerable development of the lateral roots. The tap roots make early transplanting rather difficult, but the young trees grow rapidly when once established.

THE WOOD—ITS ECONOMIC USES.

The wood is usually light, but varies in weight; it is soft, tough but not strong, of fine texture, and when well seasoned is durable in contact with the ground. It shrinks considerably but seasons without injury, and works and stands exceedingly well. The sapwood is thin, light in color, and decays rapidly. The wood is used for siding, paneling, interior finishing, and in the manufacture of toys, boxes, culinary woodenware, etc. With the diminution of the White Pine supply Tulip-tree is much used in its place. It makes a fair wood pulp, and is the tree from which most of our postal cards are made. The lumbermen recognize two kinds of Tulip timber, viz, white and yellow. The difference in color is caused mainly by the difference in site conditions. On dry, gravelly soil the wood produced is lighter in color, less durable, and harder to work, and is called "White Poplar." The "Yellow Poplar" is grown on rich alluvial or sandstone soil, where trees of mature age have little sapwood and a rich, yellow heartwood,

which is highly prized because of its fine grain and easy working qualities.

PROPAGATION.

Natural reproduction is fairly good on open land in Kentucky, Virginia, Maryland, and southern Pennsylvania. A forest growth may be maintained in these regions if proper care is taken in cutting to regenerate towards the prevailing wind, to leave seed trees in the cut-over area, and to break the surface soil so that it will form a favorable seedbed. The seedlings which spring up in these moist open fields grow with surprising rapidity, often making a growth in height of 4 to 6 feet annually. Farther south, through Tennessee and the Carolinas, natural regeneration is rarely seen except occasionally in open pastures where the mineral soil has been freely exposed and there is plenty of light. The young seedlings can not endure shade even to a limited extent. Sprouts grow from the stump, but should not be depended upon for reproduction. Seeds are produced in considerable numbers almost yearly, and the small percentage of perfect ones germinate freely if they fall upon a moist mineral soil. They will not start in a bed of pure humus. The seeds are borne in a cone-like fruit 1 to 2 inches long. The scales are really carpels, but only a few of the 50 to 60 in each cone are productive. Young trees are apt to produce seeds which are absolutely worthless, while on old trees only the highest limbs and the center carpels are productive of good seed.

Artificial propagation should be entirely by seeds. Where a forest growth has recently been removed from land which it is desired to reclothe with Tulip-tree, fair results may be attained by breaking the surface soil in the fall with a brush or harrow and sowing the seeds broadcast over the area.

Nursery culture and the use of carefully-grown seedlings or transplants is the surer but more expensive method of propagating the Tulip-tree. The seed should be collected in the fall when mature, and may be sown as soon as obtained or stratified in sand for spring planting. Fall stratification is advisable, since the seeds will then germinate the following spring; otherwise, if sown in the spring, they are very liable not to come up until the following spring.

The seed should be sown thickly in a bed of light, rich, sandy soil and covered to a depth of one-half inch. The bed should be kept evenly moist, with more moisture at first than later and should be completely shaded until the plants begin to appear. Subsequently there need be only partial protection, which is especially needed during the middle of the day, when the sun is hottest. Seedlings may stand in the seed-bed for from one to two years, but should not remain longer, because the tap root develops greatly with but few lateral roots, which makes transplanting difficult. It thus becomes advisable to move the seedlings when one year old to nursery rows, which stimulates them to

a vigorous root development, insuring success in transplanting. Seedlings may be shifted yearly in the nursery until three or four years old, which causes a beneficial thickening of the root system, but such prolonged care is usually too expensive to be practical. If trees two years old or more are to be moved for the first time, it is often advisable to cut back the stem to the ground, taking care to move the roots intact; this will cause vigorous sprouts to spring up. Such practice is sometimes resorted to with younger seedlings.

Transplanting from the nursery to the permanent site may be done most successfully in the spring. Fall transplanting, although often fairly successful, usually gives a lower average of success than spring planting. The work should be done before the buds start, but may be attempted after the leaves are out if the stem be cut back in the way mentioned above.

When grown for forest purposes, the Tulip-tree should be mixed with other deciduous species, but should be given a start or planted with slow-growing trees so that it may not be overtopped. When planted for a ground cover or for economic purposes, the trees should be set about 6 feet apart each way. Within its range the Tulip-tree does not demand special preparation of the ground prior to planting, unless it be where there is an unusually tough sward, in which case the grass should be broken and turned under. In setting the trees the sod should be broken in a little circle and the tree set in the center of the broken ground, care being taken to pack the dirt firmly around the roots. The roots should never be allowed to become dry. If the plantation is in a sheltered valley or rich bottom land, the Tulip-tree may be planted as the predominant tree of the mixture. If it is in an exposed situation the species with which it grows should be in excess, so as to give the needed protection from high winds and frost. The desirable species for such a mixture include most of our moderately shade-enduring hardwoods, such as the maples, oaks, Chestnut, hickories, walnuts, etc. There seems no reason why the Norway Spruce and some of the pines would not also make desirable associate trees for the Tulip-tree.

POSSIBILITIES AND USES.

For shade and ornament the Tulip-tree possesses great merit and is deserving of very general propagation. It is to be especially recommended for cities where bituminous coal is burned. It comes into leaf early, holds its foliage until late in the fall, and has few disfiguring insect enemies, while in general shape and manner of growth it leaves little to be desired. Forest planting of the Tulip-tree for economic purposes has never been attempted, but judging from the form and rate of growth of the natural forest-grown tree, and the value of the wood, few trees would be more profitable for such a purpose.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

BLACK WALNUT (Juglans nigra).

DISTRIBUTION.

The Black Walnut is one of the most broadly distributed and most valuable of our deciduous trees. It produces both valuable timber and palatable nuts. In nature it grows sparingly from southwestern New England westward through New York, Ontario, Michigan, and Wisconsin to southern Minnesota; thence southward, with central Nebraska and Kansas as the western limit, to south-central Texas and Florida. It does not appear along the Gulf or the South Atlantic seaboard, and is much more abundant in the Central than in the Eastern States.

The natural range has been increased by planting both to the east and west. In Rhode Island, eastern Massachusetts, and southern New Hampshire and Maine, the tree was probably not native, but has been planted in small quantities for its nuts, and grows well. West of the Mississippi, plantations have been made as far west as Salt Lake City, southern Idaho, and southern California, with evident success. In southern California the Black Walnut is reported as growing well in Santa Barbara County, but as the trees are propagated there primarily for their nuts, other species, as the Persian Walnut, are usually grown. In central Nebraska, western Kansas, and in the Panhandle of Texas as far west as Claude, plantations of Black Walnut have been successfully made.

MANNER OF OCCURRENCE.

Although of fair size wherever found, the Black Walnut attains its best development in the deep hollows of the western slope of the southern Alleghenies, on the rich bottom lands along the Mississippi and Ohio rivers, and in Arkansas, Missouri, eastern Nebraska, Kansas, and Indian Territory. In the mountains of the Carolinas and Tennessee, it occurs in mixture with the oaks and Chestnut, while in the original

hardwood forests in the river valleys of Ohio, Indiana, Illinois, and Kentucky, it was found associated with the maples, hickories, oaks, Basswood, Cherry, and other hardwoods of the region, although not always intermingling closely with them. West of the Mississippi the Walnut is confined to river valleys and moist situations. In this western region it is found associated with the Coffeetree, Green Ash, Hackberry, Basswood, and White Elm.

The Walnut is nowhere a gregarious tree, but usually occurs in scattered groups or as isolated individuals among the associated species. Within the limits of its range there are regions where it is almost unknown, while within a few miles it may be common, although conditions in both regions seem identical.

SOIL AND SITE.

The ideal conditions for growth are found in the rich, moist soil of bottom lands or on fertile hillsides where protected from cold, sweeping winds. A soil formation of lime or sandy loam, containing a large quantity of humus, overlying a deep subsoil of gravel and a water table in which the long tap roots can find a continual supply of moisture, furnish the best conditions for growth. The surface soil should be moist but not wet and the subsoil porous.

While not especially adapted to varying conditions the Black Walnut will grow in many localities outside of its natural range, but its form and rate of growth are appreciably affected by its environment. Throughout the entire Middle West, south of the forty-fifth parallel, planting on limited areas may be attempted with fair prospects of success on all fertile prairie land and in coves, valleys, and extensive bottom lands where the requisite moisture is present and partial protection from the wind can be given. This latter requirement may be secured by starting the plantation in the lee of a natural windbreak, or by planting a shelter belt of hardy, rapid-growing species on the exposed sides. The most favorable range for economic planting is in the fertile valleys of the Ohio and Mississippi rivers and their tributaries, and on the bottom lands of the Carolinas, Georgia, Tennessee, Kentucky, Missouri, eastern Nebraska, Kansas, and Oklahoma. On upland soils, especially in the West, where there is a stiff subsoil, the species makes slow growth. In the southwestern plains the dry, hot weather of summer is often injurious, while in Minnesota and the Dakotas the cold of winter often kills back the season's shoots.

CHARACTERISTICS OF FORM AND GROWTH.

When grown in the open the Black Walnut is a broad, spreading tree, with a massive crown, a very short trunk, and a general form similar to the oaks and the Chestnut of the clearings. In the forest

the trunk lengthens into a tall, tapering column, often with hardly a suggestion of a limb for 50 to 60 feet, and surmounted by a much reduced crown. On the lower mountain slopes of the Carolinas a height of 110 feet, with a diameter of 5 to 6 feet, is often attained. West of the Mississippi the average size is less and the length of clear trunk shorter. The usual size of the mature forest-grown tree is a height of from 80 to 100 feet, with a diameter of 30 to 50 inches. A low, spreading tree in the open not infrequently has a trunk over 6 feet in diameter.

In good soil the rate of growth is rapid and is long-continued up to mature age, with a gradual decrease at the end. In the best situations planted trees occasionally make an annual accretion of a full inch in their diameter, but on the average an increase of one-fourth to one-third inch is all that may be expected. The sapwood of mature trees is thin and whitish, while the heart is a dark chocolate-brown, often nearly black in places—the characteristic that adds so greatly to the value of the wood for fine panels and decorative work. Unfortunately, however, this dark color is not developed until the tree is 70 to 80 years old. A tree 12 to 15 years old will begin to produce nuts, and will make lumber in forty years, but the wood at this age is a dirty yellowish-brown and not of especial value. The tap root is long and heavy, with few lateral branches, and, as it grows almost straight down, does not exhaust the surface soil around the tree as do the shallow rooting species. The foliage is thin and the tree essentially light-needing.

THE WOOD—ITS ECONOMIC USES.

The wood of the Walnut is rather heavy, and of medium hardness and strength. It shrinks moderately in drying, works well, has a beautiful color and grain, takes a fine polish, and, because of these qualities, has long been highly valued as a cabinet and furniture wood. Formerly very plentiful, it was used by the early settlers for fence rails and fuel. Of late years the great demand for the timber for furniture, veneering, gunstocks, piano cases, interior decorating, etc., has practically exhausted the supply. With the diminution of supplies other woods were substituted, until now walnut is no longer the most fashionable wood but has yielded much of its prestige to the lighter-colored oak. At present the market abroad is better than at home, hence about 80 per cent of the present yearly cut of 38,680,000 feet, board measure, is exported.

Although very scarce and in great demand the price of lumber is not higher now than twenty years ago. At present from $75 to $100 per thousand is paid for the best grades of lumber, and $35 to $50 for medium grades. The average value of the lumber manufactured in 1900 as given by the last census was only $37 per thousand. Occasion-

ally large trees of unusual soundness and superior grain have sold for fabulous prices, as high as $3,000 having been paid by veneer manufacturers for one tree.

PROPAGATION.

Under natural forest conditions the Black Walnut does not reproduce readily, and becomes almost extinct wherever lumbered clear. The tree does not reproduce by suckers and only sparingly from stump sprouts; the squirrels usually destroy many of the fallen nuts; and the young trees are killed by dense shade; hence, the tendency toward natural reproduction is not great. By taking care in cutting to leave seed trees, and to protect the fallen nuts from harm, natural seeding might be greatly assisted. On moist open land a fair stand of seedlings may often be obtained by simply sowing the nuts broadcast in the fall or early spring.

For extensive and satisfactory propagation of the species, artificial planting is the only sure method. Because of the long tap roots and consequent difficulty in transplanting, nursery culture is in general not advisable. It can, however, be made successful if root pruning is practiced and great care taken in moving the plants. Nursery culture, if attempted, should be conducted as follows:

The nuts should be planted in nursery rows 3 feet apart and 1 foot apart in the row, and covered 1 to 1½ inches deep. A preliminary freezing of the nuts will be beneficial rather than injurious. The plants in one year should have attained a height of 12 to 14 inches, and may be first transplanted in the spring when one year old, or left in the nursery rows and the roots pruned by means of a spade or tree digger. If transplanted, the roots may be shortened after the tree is removed, but if to be placed directly into the permanent site, they should be left unpruned. The safest plan is to transplant the tree yearly in the nursery, shortening the roots each time, but this is often too long and expensive a process, hence a direct transfer to the plantation is usually best. The plants may be set in furrows, or in holes dug with a spade, always taking care to keep the roots moist and to pack the earth firmly around them.

In general the better plan is to omit nursery culture altogether and plant the nuts in their permanent place in the plantation. Either fall or spring planting may be practiced, but spring planting is usually best. The nuts may be stored over winter by stratifying them in moist sand or leaves in a sheltered place out of doors. Layers of sand about 3 inches deep, alternating with single layers of nuts, will give the desired proportion. Boards should be placed around the edge and the top protected so that burrowing rodents can not get at the nuts. The sand should be kept moist, and the whole mass allowed to freeze.

In the East a furrow or a series of holes the proper distance apart

will be sufficient for the reception of the seeds. On the plains and prairies of the West, greater care in preparing the soil is essential. The sod should be broken and corn or some other common crop grown for at least the first two years. The second spring the nuts may be planted in shallow furrows and covered with a plow to a depth of 2 or 3 inches and the ground well firmed down. The rows should be straight in at least one direction, to facilitate cultivation. During the first three or four years corn may be grown between the rows, and the whole carefully cultivated until the trees are high enough to shade the ground. The distance apart at which the trees are planted varies in different localities from 4 to 10 feet each way.

Since the Black Walnut is a long-lived, light-needing tree, it may with advantage be combined in the plantation with thick-foliaged, slower-growing species. From 60 to 75 per cent of shade-enduring species should be used in the mixture and allowed to grow until they clear the lower limbs from the Walnut and stimulate it to a rapid upward growth, when they should be removed and the long-lived species left to finish its rotation alone. Desirable trees for such a mixture are the Hardy Catalpa, Hackberry, Osage Orange, Boxelder, and Green Ash. When the Walnut and another species are thus combined, the Walnut should be allowed to get a growth of two to three years before the other species is added, in order that the Walnut may not be overtopped.

ENEMIES.

Along the northern limit of its range the Walnut is very susceptible to sun scald and should be protected from the wind and sun by hardier species. Many tree defoliators and borers attack the Walnut, but it is seldom that they do serious damage, since they are mostly of local distribution and their ravages limited in extent. In case insects appear in numbers sufficient to work harm, it is advised that specimens accompanied by a full description of their work be sent in to the Division of Entomology of the Department of Agriculture for identification.

POSSIBILITIES AND USES.

Much has been said as to the vast possibilities of commercial Black Walnut culture, but the profits from such projects often have been prospective rather than real. The fact remains, however, that the Black Walnut is a most valuable tree, and possesses many characters which commend it for general planting. For roadside planting it is often a desirable tree, but its ornamental value is injured by its habit of coming into full leaf late and dropping its leaves early, and by the fact that in the East it is often disfigured by the fall web worm. As a forest tree in commercial plantations its use is to be encouraged wherever conditions of soil and site are adapted to its needs.

NOTABLE PLANTATIONS.

Two plats of Black Walnut are growing near Farlington, Kans., one pure and one mixed with Black Cherry. They were set in 1878. When measured seventeen years later the trees in the pure stand averaged 24 feet high, with a diameter of 3.8 inches, 3 feet from the ground. In the mixed plat the trees were 30 feet high and 4.1 inches in diameter. This plantation is on upland.

At Hutchinson, Kans., in the valley of the Arkansas River, Judge Houck planted Black Walnut seeds in 1887, on sandy loam, with a water table within 10 to 14 feet of the surface. In 1895, when 8 years old, 200 of the trees averaged 25 feet in height, while many specimens 8 inches in diameter 3 feet from the ground were found.

Mr. Dowd, Cass County, Nebr., has Black Walnut trees growing in loess soil which are 20 years old and 40 feet high, with diameters ranging from 12 to 14 inches.

Joseph Cook, one-half mile west of Mynard, Cass County, Nebr., has a two-acre grove, 25 years old, on bottom land along a small creek. The trees are 6.5 to 11 inches in diameter and about 40 feet high.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

RED CEDAR (Juniperus virginiana).

DISTRIBUTION.

The red cedar is the most widely distributed coniferous tree in the United States. It is found from Nova Scotia to central South Dakota, and south to northern Florida and eastern Texas. Over much of this territory, however, it occurs only as occasional trees or in small patches. It is most abundant and best developed south of the Ohio River. The densest stands are in the foothills of the Cumberland Mountains and the basin of the Tennessee River in Tennessee and Alabama. These regions are the present commercial sources of red cedar, but the supply of good timber is being rapidly exhausted.

Because of its wide range, the red cedar grows in association with a large number of broadleaf species. Only over limited areas in the regions of its best development does it form pure forests. The range for planting is even wider than the natural one, as the cedar is particularly well adapted to planting on the semiarid plains where there are no native trees and few broadleaf species succeed.

SOIL AND CLIMATE.

There is scarcely any tree which exhibits greater indifference to soil and climate than the red cedar. It is found in every kind of situation—from dry, rocky ridges to fertile bottomlands. In the territory where the red cedar is at home the annual rainfall ranges from 20 to 60 inches, and its wide distribution shows that it endures great extremes of heat and cold.

In the South a light, loamy, calcareous soil is considered best adapted to the cedar, while along the Platte River in Nebraska it grows excellently on sandy islands where cottonwoods and willows thrive, and where underground moisture is but 3 to 4 feet below the surface. It will grow well on the common upland soil of the Great Plains.

CHARACTERISTICS OF FORM AND GROWTH.

The red cedar is a medium-sized tree. In the South it sometimes attains a diameter of 3 feet and a height of 100 feet, while near its northern limit a height of 30 feet is seldom exceeded. In favorable

situations it is long lived, and often reaches an age of several centuries. Normally its growth is rather slow, but the rate varies correspondingly with the widely divergent conditions under which it occurs. In favorable situations an inch of diameter increase may take place in three years, while with less congenial surroundings fifteen years or more may be required for the same growth. The red cedar is so tenacious of life that it will hang on and keep alive in the cleft of a rock with no visible soil, where the growth is so slow that the annual rings can be counted only with the aid of a microscope. The height growth does not ordinarily exceed a foot a year during the period of most rapid development, which is the first twenty to thirty years of life.

The form of the red cedar is as variable as its situation. It ranges from the low, irregular, bushy type of the West to the conical and spire-shaped crowns of southern New England, Virginia, and Maryland, which, to the stranger, are always suggestive of the pruning knife. Forest-grown trees produce a good clear length well suited for telegraph poles. The rapid taper causes considerable loss of material when red cedar is used for saw-timber.

ECONOMIC USES.

The wood of the red cedar is light and soft, with a fine, compact, even grain, susceptible of a high finish. The great resistance of the wood to decay makes it highly valuable for posts, telegraph poles, piles, and railroad ties. It is used for many purposes in naval construction and in the various arts and industries. The lead-pencil industry requires the product of more than 125,000 trees annually, for which only the best class of timber can be used.

Red cedar is much used in ornamental planting. It stands pruning well, and so is occasionally made into a sheared evergreen hedge. Its dense growth and ability to endure great climatic extremes make it a valuable tree for windbreaks on the plains. The rapidly diminishing natural supplies of red cedar render it certain that in congenial situations commercial planting will eventually bring good returns. It does not need many years in which to grow to fence-post size, and the price it commands is excellent. The formation of heartwood begins early, and trees 10 inches in diameter will furnish pencil wood. Commercial planting thus far has been delayed by the high price of the seedlings and the failures which often attend transplanting, but the increasing demand for the wood will doubtless lead to cheaper and more efficient methods of propagation.

PROPAGATION.

The red cedar reproduces only by seed, which the pistillate trees bear in great abundance. In nature, birds are largely responsible for the distribution of the seed. Many observers believe that the passage of the seed through the alimentary canal of the bird helps its germination,

and there seems to be considerable basis for this view. In the East, avenues of cedar along the public roads are formed by birds which drop the seed from adjacent fences, and in some of the older cottonwood groves of Kansas and Nebraska young cedars are coming in by hundreds through the same agency. Whatever the part may be which birds take in aiding the natural reproduction of the red cedar, the artificial germination of the seeds is one of the troublesome problems of nurserymen. It ordinarily takes two years.

The following treatment has been recommended: When the berries ripen in the fall, pick and soak them for some time in warm water, then mix with sand and keep moist until the following year. They may be planted in the fall a year from the time they were gathered, or kept until the following spring. Germination should take place in a few weeks after sowing. A partial shading of the seedbed until about the 1st of August is essential; after that time the little seedling can stand full sunlight. The height growth of the first season is from 2 to 4 inches.

A fungous disease called "damping off" sometimes causes thousands of the little trees to wilt and die when they are a few weeks old. It is best prevented by not allowing the seedbed to get too moist, and by keeping up a free circulation of air. The seedlings should be transplanted once or twice in the nursery, to give better root development, before they are transferred to the permanent situation. All seedlings attacked by the fungus must be burned, and beds in which diseased plants occur should not be again used for the same purpose.

Even though the price be high, the ordinary planter will do better to buy red cedar nursery stock than to attempt to grow his own. The best size for transplanting to the forest site is 10 to 12 inches in height. Nursery-transplanted trees of this size may cost as much as 25 cents each, so the planter can save much by buying one-year-old seedlings from a nursery and transplanting them to a temporary nursery of his own for a year or two before setting in the plantation. One-year-old red cedar seedlings are quoted as low as $4 per thousand at some of the nurseries.

There is much diversity of opinion as to whether the red cedar and other conifers should be transplanted in the spring or the summer, but the best practice unquestionably favors spring planting. If conditions of soil and moisture are right, the planter will make no mistake in transplanting his red cedar at corn-planting time, whatever his locality. The important thing to be observed is to allow no drying out of the roots during the operation. If the roots once get dry, the trees will die, no matter how great the subsequent supply of water. When a shipment of red cedar is received, the roots should be immediately dipped into a puddle of earth and water. The trees should then be taken to a shady place and heeled in until the time to set. The setting should be care-

fully done and the earth firmly packed about the roots so as to give good contact and exclude the air.

Wild seedlings are not easily transplanted unless taken when small. A wild seedling 2 feet in height is likely to be 10 or 12 years old, and to have poorer roots than a nursery-grown tree.

While the red cedar grows best in the sunlight, it frequently comes up in the shade of other trees and grows well for a number of years. It is suitable for planting in mixtures with light-demanding trees, such as cottonwood, western yellow pine, and white or green ash. Growing more slowly than these trees, it casts a perfect shade over the ground, thus keeping out grass and weeds, while it is little injured by the light shade of its associates. When the cedar needs more room, the associates should be removed. For pure plantations on dry upland soil spacing 4 feet by 4 feet is advisable. On better or more moist soil, or where cultivation is given for a number of years, 4 feet by 6 or 8 feet is best. Red cedar will live and grow in dense prairie sod, but it quickly and profitably responds to cultivation.

ENEMIES.

Fire is extremely dangerous to the red cedar on account of both the thin bark and the shallow root system. In pure cedar forests a fire generally kills nearly all of the trees.

Red cedar is liable to attack by various forms of fungi, which cause the "cedar apple," "witches broom," white and red rot, and other injuries. A blight which is still the subject of investigation sometimes destroys thousands of good-sized trees in the nurseries. When the presence of a fungus is suspected, if specimens are sent to the Bureau of Plant Industry of the Department of Agriculture they will be examined and treatment will be suggested.

A number of destructive boring insects feed on both the living and dead trees, while the foliage is eaten by some species of caterpillars. In the West a small spider sucks the juice of the twigs and spins a web over them which catches the dust and gives the tree a very dingy appearance.

Much interesting information concerning the tree may be found in Bulletin No. 31 of the Division of Forestry, entitled "Notes on the Red Cedar." Additional information in regard to the insect enemies of this tree may be had on application to the Bureau of Entomology.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

COTTONWOOD (Populus deltoides).

DISTRIBUTION.

The natural range of the cottonwood is from central Quebec, south through western New England and New York, western Pennsylvania, and the Atlantic States south of the Potomac River, to western Florida; west to the Rocky Mountains; and from southern Alberta in Canada to northern New Mexico. In the Eastern and Southern States, the cottonwood occurs sparingly on moist soil. Along watercourses between the Mississippi River and Rocky Mountains it is one of the largest and most abundant trees, extending long tongues of forest growth into the plains on the banks of every stream. Its maximum size is reached on the Mississippi cotton lands, and westward to nearly the one-hundredth meridian.

The range for economic planting of the cottonwood comprises the river and creek valleys west of the Mississippi. If cottonwoods are planted along the stream banks in belts 200 to 300 feet wide, they will prevent the erosion of fertile bottomlands, which was so destructive in many western river bottoms during the great floods of June, 1903. Such a belt of trees will afford all the advantages of a levee without exposing the protected land to the danger of a crevasse. The trees will break up the current of any overflow that occurs, and will help to keep the main current confined to the channel of the stream.

The cottonwood should not be planted on high dry land. The site best adapted to this species is alluvial sandy loam where ground water stands within 10 or 15 feet of the surface. Except in cases where such lands are exposed to danger from overflow, the sites best adapted to the growth of cottonwood are usually so much more valuable for agriculture that the planting of this species on a large scale is not advisable. Planted in single lines along public highways or on the boundaries of fields, the cottonwood serves as an excellent windbreak without occupying much plow land, and at the same time produces valuable fuel. The cottonwood will probably stand the cold of any

part of the United States possessing a soil suitable for its growth, and will endure extreme drought, provided its roots are bathed in moisture. It is a thirsty tree, and should not be planted where the moisture supply of the soil is limited.

MANNER OF OCCURRENCE.

The cottonwood is one of the chief components of the sandbar forest growth, which clings close to the banks of streams. Whenever a new body of land is formed by a stream changing its course or by the deposit of a sandbar, the cottonwood, in association with its near relatives, the willows, is the first tree to take possession. With the aid of floods, which sow its seeds by the million, the cottonwood is often able to take possession of a sandbar or mud flat almost to the exclusion of other species. The vigor of its growth enables it to hold undisputed possession until, by crowding, the stand begins to thin out, when other more tolerant species enter and gradually change the composition of the forest. The cottonwood is extremely intolerant of shade, and never reproduces under its own shade or that of other forest trees. For this reason it must act as a pioneer of the forest, and is never found in mixtures in an old forest.

When planted, it does not form sufficient shade to keep out weeds and grasses. Hence cottonwood groves should be underplanted with boxelder, hackberry, white elm, Osage orange, or such shrubs as wild plum, choke-cherry, wild currants, and gooseberries.

ECONOMIC USES.

The wood of the cottonwood is light, soft, and spongy, often cross-grained, and is not strong nor durable in contact with the soil. Cottonwood warps badly in drying, and is therefore difficult to season, but if boards are properly piled, warping is in a great measure eliminated. It has been used largely for box boards, for backing in veneers, for the sides and bottoms of drawers, inside furnishing, cheap wagon boxes, and in other places where there is no exposure to the weather or where permanence is not required. A variety called "yellow cottonwood" or "Carolina poplar" is highly esteemed. It much resembles in color the wood of yellow poplar (tuliptree), and is used for the same purposes. Yellow cottonwood grows on the lower Ohio, Missouri, and Mississippi flood plains. It has no botanical characteristics to distinguish it from the common type. An increasing use of cottonwood, and one which is destined to consume a great deal of it, is the manufacture of paper pulp.

Cottonwood is largely used for fuel on the plains. The wood has less fuel value than an equal bulk of other woods, but on account of its rapid growth the cottonwood has a much greater heat-producing value per acre, in a given time, than other species. The following table illustrates this point:

Relative fuel values.

Species.	Prepared by Dr. C. E. Bessey, of the University of Nebraska, from measurements taken in eastern Nebraska.			Prepared by the Bureau of Forestry, from measurements taken in western Kansas.	
	Relative heat-producing values.	Relative rates of volume growth.	Relative heat-producing values per acre.	Relative rates of volume growth.	Relative heat-producing values per acre.
Cottonwood (*Populus deltoides*)	100	100	100	100	100
Black walnut (*Juglans nigra*)	104	11	12	35	36
Black jack oak (*Quercus marilandica*)	142	4	6		
Green ash (*Fraxinus lanceolata*)	150	16	24	30 [a]8	45 [a]9
Shagbark hickory (*Hicoria ovata*)	203	7	14		

[a] Trees growing in dry situations on upland prairie.

The tree has been planted extensively under the provisions of the "timber-culture act," but, owing to its inability to grow without an abundant supply of moisture in the soil or subsoil, the great majority of these planted groves have proved failures. The cottonwood is much used for ornamental planting. If cuttings from staminate trees are used, the annoyance occasioned by the cotton-covered seeds blowing all over the lawn is averted. The "Carolina poplar" sold by nurserymen is a horticultural variety of the common cottonwood that is propagated from cuttings.

GROWTH AND REPRODUCTION.

Cottonwood grows more rapidly than any other native tree within its range. It has been known to attain enormous proportions. A specimen which stood on the north bank of the Kansas River, 1 mile east of Manhattan, Kans., measured 27 feet in circumference 8 feet from the ground. When crowded, cottonwood forms a long, clear bole, and sometimes reaches 150 feet in height.

The tree produces seed abundantly, which ripen in early summer and should be immediately planted. A count of the seeds produced by a cottonwood tree 2 feet in diameter and 40 feet tall, having a spread of crown of 45 feet, made by one of Dr. Charles E. Bessey's students, showed that it produced in one season 27,993,800 seeds, weighing 40 pounds. Branches of the trees bearing seed may be cut just before the capsules open and then be allowed to dry. When the capsules begin to open, the seed may be sown by dragging the branches along the bottom of a furrow. This should be done, if possible, just before a rain. Cottonwood seedlings are so abundantly produced naturally on the sandbars of rivers that nurserymen have no trouble in supplying the demands of the market from this source. For this reason it is seldom necessary to sow the seed. The wild stock is just as serviceable as nursery-grown seedlings, and is much cheaper.

It is better to plant the seedling trees or cuttings in the final forest site than to attempt to grow the trees from seeds planted where they are to remain permanently. Seedlings can be obtained very cheaply from nurserymen, or may be collected by the planter from the sandbars along streams. During a wet season the seedlings come up spontaneously on unused farmlands, and may be gathered from this source when the ground is plowed for a spring crop. When an armful has been collected, the roots of the trees should be buried in the fresh soil for protection until they can be planted. Planting is a very simple operation. It may be advantageously performed by a man and a boy working together. The man, by driving a spade into the ground, makes a slit, into which the boy slips a tree behind the spade; the man then withdraws the spade, trampling the soil about the tree as he advances to plant the next one. The trees should be spaced 6 feet by 6 feet, making 1,210 trees per acre. Seedlings of the yellow cottonwood should be obtained from regions where it is known that this variety predominates.

ENEMIES.

Cottonwood plantations should be protected for at least five years from grazing animals, which injure them not only by eating the tender shoots and leaves, but also by trampling the ground, thereby exposing or cutting off the roots. They should be protected from fire by keeping five or six furrows around the plantation plowed and free of weeds, in order to prevent fire from getting into the grove. The cottonwood develops a deep and wide-spreading root system, hence it is seldom uprooted by storms. It is often cut down or girdled by the beaver, where this animal survives. The bark of young cottonwood branches seems to possess very desirable food qualities for this little animal. The Indians on the prairies were formerly in the habit of felling cottonwood trees to afford browsing for their ponies and cattle when grass became very scarce.

The cottonwood is subject to the attack of many of the same insects as affect willows. Some of the principal species are discussed in Bulletin No. 46, Bureau of Forestry, which will be furnished on application. In case insects appear in destructive abundance specimens should be sent to the Bureau of Entomology, in the Department of Agriculture, for identification and for information in regard to methods of control.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

SUGAR MAPLE (Acer saccharum).

DISTRIBUTION.

The sugar maple is widely distributed in the eastern United States. Its natural range is from southern Newfoundland south to northern Georgia and western Florida, and west to Lake of the Woods, Minnesota, eastern Nebraska, eastern Kansas, and eastern Texas. It is most abundant in Minnesota, Wisconsin, Michigan, New York, and Maine, and on the Appalachian slopes.

The range for economic planting extends from Minnesota to Arkansas, and east. When planted on the prairies it should be protected from the hot southwest winds.

Sugar maple prefers a fresh, well-drained soil. It grows well, however, on almost any rich soil, but will not grow in poor, dry ground.

MANNER OF OCCURRENCE.

In the northern pine belt the most common hardwoods are beech, yellow birch, and sugar maple. Other associated species in the North are white pine, red pine, white spruce, red spruce, and balsam fir, and on the lower ground white birch and red maple. Farther south sugar maple is found associated with practically all the hardwoods.

The sugar maple often forms almost pure stands, especially when young. This is owing to its shade-enduring qualities, for it is one of our most tolerant species. In places the undergrowth is entirely of sugar maple, and in many lumbered pine forests it has taken possession of the ground to the exclusion of other species, so that one of the most difficult problems in natural forest reproduction in the Adirondacks and similar regions is to obtain pine and spruce instead of sugar maple.

ECONOMIC USES.

The wood of the sugar maple is heavy, strong, compact, and very hard, but is not durable in contact with the soil. It is susceptible of fine polish, and is valuable for interior finish and flooring. "Curly" and "bird's-eye" maple, obtained from this species, are desirable for finishing and cabinet work. The wood makes charcoal of unsurpassed quality, and has also a very high fuel value.

The sap of the sugar maple contains from 2 to 6 per cent of sugar. Three to 9 per cent of the total sap content of the tree may be utilized for sugar making without injury. The annual production of maple sugar in the United States averages 45,000,000 pounds, worth about $4,000,000.

GROWTH AND REPRODUCTION.

The sugar maple is a slow-growing, long-lived tree. In favored situations in New England, New York, and the Appalachian Mountains it sometimes reaches a height of 120 feet and a diameter of 4 to 6 feet, with a trunk clear of branches for 70 feet. In the southern and western parts of its range it does not make so tall or fine a growth, and seldom exceeds 2 feet in diameter.

Sugar maple produces a large crop of seed every three to five years, though small crops are produced on different trees each year, so it is possible to obtain seed any year for planting.

The seed ripens in autumn. Only 30 to 50 per cent of the fresh seed will germinate. The seed should be collected as soon as ripe, and either sown at once or stratified in slightly damp sand and stored in a cool place over winter. A pit is dug in a well-drained place out of doors, and in it placed a box which is filled with alternating layers of sand and seed and covered with a wire screen or boards and a mulch of leaves or straw.

In starting a forest plantation of this species it is better to plant the seeds in a nursery and to transplant the trees when a year old into the permanent site than to attempt to grow the trees there from seed. The seedlings prefer some shade the first year. In the spring the ground near old trees is often thickly covered with seedlings, few or none of which survive, if left to compete with grass and weeds, but which, if transplanted and cared for, would answer well as nursery stock. One-year-old seedling transplants are from 6 to 12 inches in height, and are the most convenient for planting.

Within its range, sugar maple is probably the most desirable tree for mixture with white pine. It has a similar height growth, and is cheaper than most other trees. Several nurseries sell 6 to 12-inch seedlings at $2 to $3 per thousand.

The advantages of sugar maple are its cheapness and its adaptability to a large part of its range. For commercial planting the following method of mixture is advised:

WP	SgM	WP	SgM
SgM	SgM	SgM	SgM
WP	SgM	WP	SgM
SgM	SgM	SgM	SgM

SgM = Sugar maple. WP = White pine.

According to this arrangement the pines, which will form the eventual stand, are placed 12 feet by 12 feet, or 302 per acre. With the pine are planted 908 sugar maples, making a total of 1,210 trees per acre. Under ordinary conditions this method may be practiced at a cost for seedlings of less than $3 per acre. Sugar maple is one of the best available species for underplanting.

ENEMIES.

Wind, snow, and ice seldom do great damage to the sugar maple. Fires are apt to kill or severely injure the tree. In towns it is often severely injured by gas, dust, and smoke. Its sensitiveness in this regard often causes its failure when used as a street tree.

Sugar maple is attacked by a number of injurious insects. The trees are often killed by the large sugar maple borer, while the foliage is in some seasons severely eaten by the fall webworm and other caterpillars. Aphides quite frequently infest the sugar maple, and the cottony maple scale is often exceedingly troublesome and destructive.

In cases where the insects are injuriously abundant, specimens should be referred to the Bureau of Entomology for determination and advice as to remedial measures.

Many fungi are parasitic on the sugar maple, producing a number of diseases of varying importance. It is the host for certain timber-destroying species, several "leaf spots," and anthracnose. *Rhytisma acerinum* Fr. produces black and more or less circular and thickened blotches of considerable size on the leaves, and the mildew *Uncinula circinata* C. & P., is common. It forms a thin white mesh, with small scattered globules, usually on the under surface of the leaf.

Information concerning fungi and methods for combating them can be obtained by application to the Bureau of Plant Industry in the Department of Agriculture. Letters of inquiry should always be accompanied by specimens.

Sugar maples are often injured by too deep and frequent tapping for sugar production. The tree is weakened, fungi and insects gain entrance, and the tree fails to recover. If properly done, tapping does but little injury.

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United States Department of Agriculture,

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

SILVER MAPLE (Acer saccharinum).

DISTRIBUTION.

The silver, or soft, maple occurs naturally from New Brunswick south to western Florida and west to western Ontario, the eastern Dakotas, Nebraska, Kansas, and Indian Territory. The range for successful planting of this maple is but little greater than its natural range. Numerous trials have proved that it is not generally suitable for upland situations in the Plains region.

SOIL AND MOISTURE.

The silver maple is less hardy than either the boxelder or the cottonwood. It thrives best in river bottoms where the soil is a deep, porous alluvium. It is a moisture-loving tree and in the West succeeds only where the roots can go down to permanent water. It does well in the valleys of the Platte and Arkansas rivers, but is frequently a total failure on the adjacent uplands.

CHARACTERISTICS OF FORM AND GROWTH.

The silver maple grows rapidly, attains a large size, and is rather short-lived. In favorable situations a diameter increase of half an inch yearly is not uncommon, and cases of twice this rate have been noted. When growing in the open, the silver maple tends to fork near the ground and form large, spreading branches, with no well-defined central axis. As the wood is brittle, a tree of this shape is likely to break in the crotches at any time. The remedy is to prune the tree into proper shape while it is young. In exposed situations sun scald is quite common.

ECONOMIC USES.

The wood of the silver maple is light, and neither strong nor durable. It is easily worked, and is sometimes used for flooring and furniture, but the quality is inferior. It is worth more for fuel than for anything else, though the fuel value is not high. In localities to which it is adapted the silver maple is a good tree for shelterbelts, because of its rapid growth and large size. It has been much used for park and street planting. There are better trees for street planting, however,

since the maple is likely to break badly in heavy windstorms and is often defoliated by insects.

PROPAGATION.

Reproduction of the silver maple is by stump sprouts and seed. Sprouts spring up abundantly after cutting, and by allowing only the best sprouts to grow, new trees can soon be produced. The seed ripens in May or June, and should be planted immediately. It loses its vitality in a short time, and will not grow if it gets dry. The seed should be sown in drills in rich, moist soil. Only about an inch of covering is necessary. Thick sowing is advisable, since the proportion of germination is only 25 in 60. The height growth during the first season is from 12 to 36 inches. The seedlings should be set in the permanent plantation the following spring. For ornamental planting, older trees from 4 to 10 feet high are generally used. One-year-old seedlings of good size may be had at the nurseries for $2 to $3 per thousand, and many planters will prefer buying seedlings to raising them. Only in case of fairly large plantations is there much saving in growing the seedlings at home. A thousand seedlings can be purchased cheaper than they can be raised, if the value of one's time is considered. For other reasons, however, home-grown seedlings of forest trees are often preferable. They are at hand, ready to transplant at the most favorable opportunity with no danger of drying out, and, if grown from seed gathered in the neighborhood, are likely to be better adapted to local conditions than trees which are grown elsewhere.

Silver maple grows naturally with many hardwoods, as ashes, birches, oaks, cottonwood, willows, walnuts, etc.

When planted in dry situations it should be mixed with some ground-shading species, as it is incapable of protecting the soil from desiccation. Upon moister soils, if not planted alone, it may be mixed with walnut, catalpa, cottonwood, willows, white or black ash, black cherry, or black birch.

For dry situations.

[4 by 4 feet.]

M B M B
B B B B
M B M B
B B B B

B = Boxelder, Osage orange.
M = Silver maple.

For moist situations.

[6 by 6 feet.]

M A M A
A M A M
M A M A
A M A M

A = White willow, cottonwood, white or black ash, black birch, walnut.

ENEMIES.

The silver maple suffers from attacks by various kinds of insects, among which is the green-striped maple worm. Two forms of cottony maple scale suck the juice of the leaves, while the sixteen-legged maple borer attacks unhealthy trees and is sometimes very destructive.

Information concerning remedies for these and other injurious insects can be obtained by application to the Bureau of Entomology. It is advisable to furnish specimens when such information is desired.

FUNGI.

A number of fungi are parasitic upon the silver maple in the United States. In some instances a "leaf-scorching" and early defoliation follows such attacks. The most conspicuous, but not the most common, fungus upon maple leaves is *Rhytisma acerinum* Fr., which produces large black thickened patches of irregular outlines. Several species of timber-destroying fungi attack maples, causing peculiar discoloration of the wood and "white rot."

In cases where the presence of fungi is suspected specimens should be sent to the Bureau of Plant Industry of the Department of Agriculture for identification and advice for treatment.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

OSAGE ORANGE (Toxylon pomiferum).

DISTRIBUTION.

The natural range of the Osage orange is from the Arkansas River south through southeastern Indian Territory to southern Texas. It is an inhabitant of rich bottomlands and fertile slopes, and appears to be most abundant and attain its greatest size in the valley of the Red River in the Indian Territory. Cultivation has given it an artificial distribution over a much wider region.

The range of the Osage orange for economic planting is in the Central States, from central Illinois southward and westward to eastern Colorado and New Mexico. It is hardy as far north as Massachusetts, but winter-kills somewhat during severe seasons in Iowa, Nebraska, and northern Illinois. It adapts itself to a great variety of soil and climatic conditions, and within its planted range is surpassed in hardiness only by the red cedar. The ability of the Osage orange to endure aridity makes it one of the best trees to plant in the Plains region.

GROWTH.

The usual rate of growth under good conditions is one-quarter to one-third of an inch in diameter yearly. Height growth is very slow after the first few years, and no great height is ever reached. The Osage orange needs severe pruning or crowding by other trees in order to attain good form. The numerous thorns are troublesome, and pruning is an unpleasant task unless done regularly.

Probably the largest single plantation of Osage orange in the United States is a 10-acre block at Farlington, Kans. The trees in this block were planted in 1878, 4 feet apart each way. In 1900 the Bureau of Forestry made some measurements of this plantation. No thinning had been done, and the dense growth was penetrated with difficulty. The trees had made a thrifty growth, however, and measurements disclosed the fact that the stand contained 2,640 first-class and 2,772 second-class fence posts per acre, worth respectively $12\frac{1}{2}$ and 7 cents each, a total acreage value of $524.04. The land probably could not have been put to any other use that would have brought greater returns.

Reproduction is abundant by means of seed, suckers, and stump sprouts. When an Osage orange hedge is once established, its complete removal is a matter of much difficulty. Sprouts from the roots will come up year after year. The rapid sprout growth furnishes the best means of perpetuating a plantation for posts or fuel. The young shoots grow from the stump with such vigor that the second crop is more likely to consist of straight post timber than the first. Cuttings may be made indefinitely in this manner, with a constant renewal of the supply.

ECONOMIC USES.

While the Osage orange has been planted everywhere for hedges and is one of the best species in use for this purpose, it is also an excellent timber tree, and as such deserves more attention than it has received in the past. The wood is yellow in color, heavy, tough, hard, and strong. It is prized in cabinet work, and is valuable for use in the manufacture of carriages, machinery, and tool handles. Osage orange posts are extremely durable in contact with the soil, and the fuel value of the wood is high. Besides its value for hedges and woodlot planting, the Osage orange is one of the most desirable trees for windbreaks on the Plains. It is tolerant of shade, and so does well when planted in mixture with other species.

PROPAGATION.

The Osage orange may be propagated from root cuttings, but this is not a practical method. Propagation from seed is not difficult. The pistillate trees bear "oranges" in abundance. The fruit is a fleshy, greenish-yellow mass about twice as large as an orange. It should be collected in the fall as soon as ripe, and kept in a cool, dry place over winter. By soaking for some time in cold water, the pulp will become softened so that the seed may be extracted. The seed has a high percentage of vitality, and germinates readily without preliminary treatment of any kind. It may be planted where the trees are intended to stand, but the better plan is to sow it in nursery rows in rich, well-prepared soil. The seedlings will grow from 1 to 2 feet in height during the season, and be just right to transplant to the permanent situation the following spring. Osage orange seedlings are cheap, so that the planter who does not wish to raise his own trees can get them at nurseries at from $1 to $3 a thousand.

Plantations of Osage orange should be close set, to overcome as much as possible the tendency to profuse branching. A practical method is to have the rows 8 feet apart, with the trees 2 feet apart in the rows. Spacing 2 feet by 8 feet gives the same number of trees to the acre as 4 feet by 4 feet, while the wide rows permit of longer cultivation and much easier access when thinnings are made. The trees rarely prune themselves properly, so that hand pruning is necessary.

When mixtures are desirable, the following species[1] and arrangement can be recommended:

Mixture for rich, moist soils.
[3 feet by 6 feet.]

X O X O X O X

X O X O X O X

X O X O X O X

X O X O X O X

O=Osage orange, 1,210 per acre.
X=Cottonwood, black walnut, or hardy catalpa, 1,210 per acre.

Mixture for dry, upland soils.
[2 feet by 8 feet]

X O O O X O O O X O O O X

X O O O X O O O X O O O X

X O O O X O O O X O O O X

O=Osage orange, 2,040 per acre.
X=Black locust, honey locust, white elm, or green ash, 680 per acre.

ENEMIES.

Osage orange is usually free from any serious attack from either fungi or insects. A specimen with a rotten heart is seldom or never found. If the presence of a parasitic fungus is suspected information concerning it may be obtained by referring a specimen to the Bureau of Plant Industry in the Department of Agriculture. The sapwood is sometimes riddled by borers. Their attack, however, seldom kills the tree or retards very seriously its growth. If injury is noted, however, specimens of the insects and examples of their work should be sent to the Bureau of Entomology in the Department of Agriculture, for identification and suggestions as to remedies.

Fire is the greatest enemy of Osage orange, and plantations should be protected while young by plowing four or five furrows around their boundaries and keeping them clean of weeds. The strip kept plowed for a fire guard serves also to prevent the trees from drawing too much sustenance from the adjoining field crops. Where it is possible to grow alfalfa, this may advantageously be sown on a strip a rod or more in width bordering the hedge or planted forest as soon as the trees are too large for continued cultivation. Since alfalfa roots deeply and the Osage orange superficially, the forage plant will not be seriously injured by the trees, and will be producing a valuable feed crop at the same time that its almost evergreen foliage furnishes the trees protection against fires.

If the trees are accidentally burned, they should be cut immediately in order to allow the new sprouts room to develop. The injury is thus reduced to the amount of wood consumed. If they are left uncut the roots are liable to become weakened by disease germs gaining entrance through the dead wood.

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[1]All the species herein recommended may be purchased from reliable dealers at rates ranging from $1 to $8 per thousand.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

HONEY LOCUST (Gleditsia triacanthos).

DISTRIBUTION.

The natural range of the honey locust is from western New York and Pennsylvania south to Georgia, and west to eastern South Dakota, Nebraska, and Texas. In the West it usually grows in the river bottoms, where moisture is plentiful and the soil rich. Farther east, as in Illinois, it occurs in the prairie groves of oak, walnut, hickory, and other species. It does not ordinarily form pure stands, but throughout its wide distribution constitutes one of the minor constituents of the forest.

For economic planting its range is Iowa, Nebraska, Missouri, Kansas, western Oklahoma, and northwestern Texas. It is interesting to note that in some regions as one leaves the most favorable growth of the black locust, that of the honey locust is entered. From the southern line of Kansas southward the former is the better tree, while to the northward the latter does finely. The honey locust is one of the hardiest trees for planting on the uplands of western Kansas and Nebraska. In southern Minnesota it occasionally winter-kills.

CHARACTERISTICS OF FORM AND GROWTH.

In southern Indiana and Illinois, where the honey locust attains its best development, trees 140 feet high and 6 feet in diameter have been noted. Growth is quite rapid; in favorable situations it makes an annual average height growth of 1 to 2 feet and a diameter increase of one-third to one-half inch. Under adverse conditions, seven or eight years may be required for an inch of diameter growth. It is very intolerant of shade, but has a tendency, when not crowded, to produce long branches near the ground, which makes it an excellent tree for hedges and windbreaks. It does not sucker from the roots. With a little pruning, the honey locust develops a smooth, symmetrical trunk and a spreading crown with delicate foliage that gives a pleasing ornamental effect. The large clusters of thorns are sometimes objectionable, but they are easily removed. In the natural state some trees do not bear thorns, and nurserymen are beginning to propagate a thornless variety.

ECONOMIC USES.

The wood of the honey locust is coarse-grained, heavy, hard, strong, and fairly durable in contact with the soil. It is used chiefly for fuel, fence posts, and poles. The honey locust serves its most useful purpose, however, as a living tree, since within its range other species can be grown which are more valuable for their wood, but less desirable for permanent trees.

The honey locust is useful for hedges, windbreaks, and in general for planting to improve the surroundings in a naturally treeless region. It is the principal street tree in many western towns, and is a growing favorite for this purpose wherever its good qualities are known.

SOIL AND MOISTURE.

The common soil of the Plains and prairie regions is well suited to the honey locust. The fact that it has grown successfully in western Kansas, where the annual rainfall is less than 20 inches, shows that it can withstand much aridity. It does not do well in gravelly situations, or on too heavy clay, but needs a fairly rich soil of considerable depth. It is very fond of a limy soil.

PROPAGATION.

The honey locust produces seed abundantly, and is easily propagated. The pods ripen in the fall, and after they become dry and brittle the seed may be thrashed out without difficulty. The seeds should be kept in dry storage over winter and treated with hot water before sowing in the spring. Boiling water has been recommended by some nurserymen, but it sometimes kills the germs and is not necessary in any case. Uniformly good results are obtained by covering the seeds with water at an initial temperature of 175° to 190° F. and letting them stand until most of them swell. The swollen seeds are then removed, and the operation is repeated with the remainder. Seeds which have become very dry may require soaking for two or three days.

As soon as taken from the water the swollen seeds should be sown in moist, rich soil. Only a shallow covering of earth should be given; an inch or two is sufficient. With a favorable season the height growth will be a foot or more, and the little seedlings will be just the right size to transplant to the permanent situation the following spring. The planter who intends to put out any considerable number will generally secure better results by raising his own seedlings than by ordering them from a nursery, since with home-grown trees at hand he can take advantage of the most favorable conditions for transplanting and need not dig up his seedlings until he is ready to use them. In case of an unfavorable season for transplanting, they may be left in the nursery row another year. Where possible, it is good practice to gather seed from healthy

plantations in the neighborhood, since trees grown from such seed are likely to be more closely adapted to local conditions than those brought from a distance.

Spacing in honey locust planting depends upon the situation and the purpose of the plantation. If cultivation is to be given for a number of years, wide spacing is necessary. For shelterbelts the trees may be set 4 feet by 8 feet to advantage. By adopting a method of unequal spacing, with wide spaces between the rows to permit easy cultivation and access to the plantation, while setting the trees close together in the rows, a large number to the acre can be conveniently planted. Spacing 2 feet by 8 feet gives the same number of trees as 4 feet by 4 feet, while facilitating both cultivation while the trees are small and thinning when they get large enough to crowd each other. If the planter does not intend to give much cultivation, he should plant closely, distributing the trees evenly over the ground and setting them close enough together so that they may establish forest conditions of shade and litter in a few years, and thus keep out weeds.

ENEMIES.

The honey locust is not so generally injured by borers as is the black locust, and thus far has been a uniformly healthy tree under cultivation. During the winter rabbits sometimes gnaw the bark of the young trees badly, but this danger is soon outgrown.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

HACKBERRY (Celtis occidentalis).

DISTRIBUTION.

The hackberry occurs naturally from Massachusetts to Oregon, and from Canada to New Mexico and Florida. It seldom forms pure forests, but grows in mixtures with many other species. It can be recommended for planting anywhere within its natural range, while its great hardiness and adaptability to varying soil and climatic conditions make it an excellent tree for the Plains region.

CHARACTERISTICS OF FORM AND GROWTH.

In general appearance the hackberry resembles the white elm, but it is smaller, while the fruit, warty bark, finely divided branches, and thin, taper-pointed leaves, divided unequally by the midrib, are easy means of identification. The rate of growth is rather slow, particularly for the first few years from seed. In favorable situations the diameter increase is one-fourth to one-third of an inch annually. Hackberry trees are sometimes found in situations so adverse that fifteen years or more are required for an inch of diameter growth. It is characteristic of the species that it will live and bear seed year after year in places where almost any other tree would die.

In rich alluvial soil the hackberry occasionally attains a height of 100 feet and a diameter of 3 feet, but the ordinary size is about half as great. It is a long-lived tree, and should be planted only where slow and persistent growth is desired. It is shade-enduring, and so does well in mixed plantations.

The hackberry maintains a good ground cover for many years, and is, therefore, a good tree for planting with light-demanding trees, such as green or red ash or cottonwood. The following diagram illustrates a good arrangement for forest plantations in the northern prairie States.

Mixture for northern prairie States.

[5 feet by 5 feet.]

Hb X Hb X

Hb X Hb X

Hb X Hb X

Hb X Hb X

Hb=Hackberry. X=Green or red ash or cottonwood.

Hackberry is one of the best species for windbreaks on land too high for cottonwood in western Minnesota, North and South Dakota, and northern Nebraska. The trees should be planted in a double row, with the rows 3 feet apart and the trees 4 feet apart in each row. The trees of the second row should be set opposite the middle of the spaces separating those of the first row, as illustrated in the following diagram:

Spacing for windbreak.
[4 feet by 3 feet.]

Hb Hb Hb Hb Hb Hb Hb Hb Hb Hb

Hb Hb Hb Hb Hb Hb Hb Hb Hb

Hb=Hackberry.

ECONOMIC USES.

The wood of the hackberry is straight-grained, light, and elastic. It is used chiefly for fuel and in the manufacture of cheap furniture. It is not durable in contact with the soil, and not strong. Were the qualities of the wood the only consideration, the hackberry would be little planted. But as a living tree the hackberry has much to recommend it. It does finely under cultivation, often growing better than in its natural state. It is best adapted to street and yard planting, as it appears well, makes a good shade, and is of medium size. Its use for this purpose has by no means equaled its merit. Some Western towns, however, have learned to appreciate the hackberry. In Columbus, Nebr., for example, it is planted as the principal street tree with excellent effect.

SOIL AND MOISTURE.

As shown by its wide range, the hackberry will live in almost any kind of soil, and with a very small amount of moisture. Like other species, however, it responds quickly to good conditions, and reaches its best development in river bottoms where the soil is rich and moisture abundant.

PROPAGATION.

The hackberry bears seed abundantly, and is propagated by this means. The fruit is a brownish drupe about the size of a pea. The thin, fleshy layer which covers the stone dries down and is not removed before planting. The seed ripens in the fall, and may be sown at once. If spring sowing is preferred, the seed should be stratified in sand and kept buried over winter in a well-drained place out-of-doors. A box filled with alternating layers of sand and seed and sunk even with the surface of the ground is a good method of stratification. When filled, the box should be covered with a wire screen or boards to keep out mice and then mulched with leaves or straw to prevent sudden changes in temperature.

The seed should be sown in drills in good, rich soil, covered about an inch deep, and the soil firmly pressed down upon it. This gives better contact, and excludes the air so that the moisture is retained longer. If there is danger of the seed drying out before it germinates, it should be covered 2 or 3 inches deep until germination occurs, after which the surface layer of earth should be raked off, leaving an inch of covering.

As hackberry seedlings grow only from 6 to 12 inches during the first season, they should be allowed to stand in the nursery until two years old before transplanting to the permanent situation.

ENEMIES.

The hackberry is generally a healthy tree and has few serious enemies. The Fifth Report of the United States Entomological Commission (1890), in an incomplete list, enumerates 54 insects that prey upon the hackberry.

In case harmful insects appear in threatening numbers, specimens accompanied by a full description of their depredations should be sent to the Bureau of Entomology in the Department of Agriculture for identification.

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NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

HARDY CATALPA (Catalpa speciosa).

DISTRIBUTION.

The hardy catalpa in its natural range was confined to a very limited region, extending from the valley of the Vermilion River, in Illinois, through southern Illinois and Indiana, western Kentucky and Tennessee, southeastern Missouri, and northeastern Arkansas. It was apparently distributed by back waters along the overflow lands of the Wabash River, up nearby creeks, and down the Ohio and Mississippi rivers as far as New Madrid, Mo. In southeastern Missouri it meets the common catalpa (*Catalpa catalpa*). The latter species is indigenous to southwestern Georgia, western Florida, central Alabama, and Mississippi, but is widely naturalized and cultivated east of the Rocky Mountains, growing as far north as eastern New England. The principal differences between the two species, as seen by the tree planter, are that the common catalpa is of a less erect habit and the trunk more inclined to branch. The quality of their wood is practically the same.

The hardy catalpa thrives as far north as Iowa, Nebraska, southern Michigan, and southern Massachusetts, and westward to eastern Nebraska, central Kansas, and central Oklahoma. It has done well on irrigated land in Colorado and Utah where the soil is free from alkali. Its range for economic planting is in the fertile alluvial river bottoms of the Middle West, south of the forty-first parallel of latitude.

SOIL AND MOISTURE.

The catalpa is very strongly influenced by the soil upon which it grows. A deep, fertile, porous soil is essential to good growth, and if there is permanent water within 10 or 15 feet of the surface, so much the better. These conditions exist in the valleys of the Wabash in Indiana and Illinois, the Platte in Nebraska, the Arkansas in Kansas, and many other streams in the Middle West. It is not adapted to stiff clay soils, or to soils having a tenacious gumbo subsoil. But although an impervious layer of clay near the surface prevents successful growth, clay which is not too dense and occurs beneath several feet of good soil forms a beneficial soil foundation, retaining fertility and moisture. It will pay to use the richest soil obtainable for catalpa growing. In

the Farlington forest, near Fort Scott, Kans., the returns on the best soil are nearly five times as great as on the poorest. An annual rainfall of at least 25 inches is essential to profitable growth of catalpa, unless it can send its roots down to the water table. It will not tolerate a strongly alkaline soil.

CHARACTERISTICS OF FORM AND GROWTH.

The catalpa matures early, and is small to medium in size. In particularly favorable situations native catalpa trees have been known to attain a height of 100 feet and a diameter of 4 feet. Under cultivation, the hardy catalpa is one of the most rapid-growing trees planted in the West, but it does not often attain the dimensions that fit it for saw-logs. A height growth of 2½ feet and a diameter increase of one-half inch annually for the first ten to fifteen years is not unusual.

Because of its failure to form a terminal bud, the catalpa has a very decided natural tendency to crooked growth, and often develops a short trunk with bifurcating large branches close to the ground. If given plenty of room, it ordinarily becomes a spreading, round-topped tree. In dense stands, owing to its intolerance, the lower side branches are killed by the shade, but if they become more than half an inch in diameter they cling to the tree for years after they die, thus delaying the complete pruning of the bole. New wood is deposited around the dead branch, but does not close tightly about or unite with it. The holes thus formed by the persistence of dead branches lead straight into the heart of the tree, and conduct the germs of decay into the trunk. If fungus spores gain entrance, the heart decays, and eventually the tree breaks down, a complete ruin. The tendency to crooked growth and the failure properly to shed its limbs are the two most troublesome natural characteristics of the catalpa, but the right kind of treatment will overcome these defects to a large degree.

THE WOOD—ITS ECONOMIC USES.

The rapid growth, durability in contact with the soil, lightness, elasticity, and high fuel value of catalpa wood make the tree one of the most valuable for economic planting. Catalpa wood cut from the living tree is almost immune from attack by fungous diseases, and is one of the most durable timbers known. When used for fence posts it often remains sound for thirty to forty years. Even in young trees nearly 75 per cent of the wood is heartwood, so that when used for posts the decay of the sapwood does not materially affect the value of the post. The catalpa has been planted principally for fence posts, telegraph poles, and railway ties. The rich coloring of the wood makes it also well suited for cabinet work.

In Kansas there are three plantations of hardy catalpa of over 400 acres each, besides many smaller ones. Returns from these plantations show

that they are yielding greater profits per acre than could be derived from ordinary farm crops on the same land in the same length of time.

PROPAGATION.

The catalpa reproduces by seed and by sprouts from the stump. One-year-old seedlings can be obtained at the leading nurseries at from $2 to $4 per thousand. The price of the seed runs from 35 cents to $1 per pound. There are nearly 20,000 seeds in a pound, and the percentage of germination is from 40 to 75. In a commercial plantation it is much cheaper for the planter to raise his own seedlings. The cost of trees grown on the farm in the Munger plantation, at Eureka, Kans., was 50 cents per thousand, while those from a nursery, with freight added, cost about $4 per thousand. The cost of establishing the Yaggy plantation, near Hutchinson, Kans., with home-grown trees, including cutting back and two years' tillage, was $11.70 per acre; the cost of establishing the Farlington forest by contract with a nurseryman, including the same amount of tillage but no cutting back, was $30 per acre. In long-time investments, like forest planting, heavy initial expenses, reckoned at compound interest, count up immensely against final profits, and should consequently be made as light as is consistent with securing good conditions.

The seed ripens in the fall, and should be kept over winter in the pods in cool, dry storage. In the spring it should be thickly sown in nursery rows in well-prepared, mellow soil and covered one-half inch to 1 inch in depth. The rows should be far enough apart to allow thorough cultivation. Germination may be hastened by immersing the seed in warm water and letting it soak for twenty-four hours before sowing. In favorable locations the seedlings will grow 2 to 3 feet in height the first summer, and be of suitable size to transplant to the permanent situation the following spring.

Some of the leading catalpa plantations were planted 4 feet by 4 feet, and experience has proved that they were not too thick. At this distance the trees do not crowd seriously for eight or ten years, after which they need thinning. Many trees are then of suitable size for posts, and may be cut with good returns. In four to six years more all the trees should be of marketable size. The plantation may then be cut clear and a new forest started from the stump sprouts, or it may be again thinned and the best trees left standing to produce telegraph poles or railroad ties. Good telegraph poles are grown in twenty to thirty years, according to the adaptability of the soil for this species. For convenience in cultivation, however, many prefer spacing the trees from 3 feet by 5 feet to 4 feet by 6 feet.

Close planting is desirable in order to obtain a large yield from the plantation in a few years, and is necessary to crowd the tenacious side branches from the trunk and give the tree a better form. The planter

who sets his trees thinly on the ground must do much pruning to secure clean, straight boles. Some planters prefer this, but the more profitable method is that of thicker planting and less pruning.

While most of the catalpa plantations throughout the country are planted pure, an associate tree seems to be very desirable, providing it is one that has a somewhat slower rate of height growth than the catalpa. The associate tree serves two useful purposes. First, it shades the ground, thus retaining soil moisture and preventing growth of weeds and grass; and, second, by growing up close under the catalpa it kills off the side branches while they are young, so that a long, smooth trunk is produced. The associate tree should also have some value in itself. The species best adapted to this use in the West are the Russian mulberry and Osage orange.

Cutting back the young trees to the ground during winter, two or three seasons after planting, and training up a single sprout from the stump, greatly hasten height growth and prevent side branches from forming on the lower part of the trunk. A number of sprouts will spring up from the stump during the season following the cutting back, all of which should be removed several months later except the most vigorous one. The survivor will make a straight, branchless growth of 8 to 10 feet the first season. The following year it will produce side branches, but not on the growth made the first year. The main advantage of cutting back is that, without retarding ultimate height growth, it prevents side branches to a distance of from 8 to 10 feet above the ground. It accomplishes the same object as pruning, at less expense.

ENEMIES.

The hardy catalpa is, as a rule, singularly free from destructive diseases. A number of parasitic fungi grow in the green leaves, but they are rarely numerous enough to cause alarm. Root rot is unknown. No fungus has yet been found that will grow in the wood after it has been cut from the tree and seasoned. The wood of living trees is destroyed by two fungi, one of which causes a soft rot, and the other a brown rot. The soft rot is common; the other is found only occasionally. The fungus enters the tree through the holes caused by rotting branches, and destroys the heartwood very rapidly. The wood is changed to a soft, spongy mass that is incapable of standing any strain, so that broken trees are common in infected plantations. Trees that are only partially rotten may be cut and used for posts, since the fungus ceases to work as soon as the tree is cut.

Soft rot of the catalpa can not be checked after a tree is infected, but proper treatment of the plantation will prevent it. Methods of planting, cutting back, or pruning which produce a clean, straight growth of the tree free from low side branches give the fungus no chance to enter, unless a wound is caused in some unusual way.

The catalpa is often injured by strong, steady winds which whip off the leaves, dry out the soil, and cause crooked and deformed growth. Plantations should, therefore, be protected by setting out several rows of hardier species along the exposed sides, a mixture of species being best. A good combination would be two rows of Russian mulberry adjoining the plantation, with a row of cottonwood on the outside. The mulberry should be planted 4 feet by 4 feet, and the cottonwood 8 feet by 8 feet.

Protection from fires should be given by plowing a fire guard of half a dozen furrows around the plantation each year. If the plantation is large, it is better to divide it into blocks of 40 to 50 acres each by means of lanes 15 to 20 feet wide. These lanes should be kept plowed, so that fire can not spread from one block to another. This system also gives easy access to the interior of the plantation.

The catalpa is subject to violent attacks of leaf-eating insects. Should these or other insects appear, specimens should be forwarded to the Bureau of Entomology in the Department of Agriculture, for identification and suggestion of remedy.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

RUSSIAN MULBERRY (Morus alba tatarica).

DISTRIBUTION.

The Russian mulberry is a hardy variety of the Asiatic white mulberry. It was introduced into the Western States by the Russian Mennonites about thirty years ago and has become widely distributed over the Plains region. The range for its economic planting is southern Nebraska, Kansas, Oklahoma, and Indian Territory. It can not endure the cold winters of the Dakotas, and the leading shoots are often frozen back in Kansas.

CHARACTERISTICS OF FORM AND GROWTH.

The habit of growth of the Russian mulberry is low and bushy, hence severe pruning is required to make it develop a good trunk. Height and diameter growth are fairly rapid. A tree of this species growing near Fairbury, Nebr., was found to measure 8 inches in diameter and 20 feet in height when 8 years old, but this growth is somewhat exceptional. Russian mulberry never attains great size, although it is said to reach 3 feet in diameter and 50 or 60 feet in height. In favorable situations it will produce fence-post timbers in ten years or less. The natural form of the tree makes it well suited to form a low, dense windbreak when left unpruned. It stands pruning well and may be made into an excellent sheared hedge.

ECONOMIC USES.

The Russian mulberry serves a number of useful purposes. The wood is heavy, elastic, coarse-grained, and moderately strong. It splits easily and, when seasoned, makes a very durable fence post. It also has a high fuel value. While the fruit is of inferior quality, it is much used for domestic purposes in the absence of better kinds. Many horticulturists like to have a mulberry windbreak around their orchards. Aside from being a protection from the wind, the berries furnish food for birds, so that they are less likely to eat the more valuable fruit in the orchard. It is a good tree to plant in the farm woodlot for posts and fuel.

The Russian mulberry will grow on either sandy or clay soils and can

live through almost any amount of drought and neglect. It grows best on rich, loamy soil where the water table is 10 to 15 feet below the surface, but even in very dry situations growth is fairly rapid. These qualities adapt it to both upland and valley situations in the semiarid regions. It is decidedly tolerant of shade and can therefore be used for underplanting or mixing with more rapid-growing species to increase height growth and aid natural pruning.

PROPAGATION.

Reproduction of the Russian mulberry takes place both by stump sprouts and by seed. Renewal after cutting is a simple matter. A quick-growing stump sprout will have better form than the original tree, and all the treatment that is necessary is to remove the surplus sprouts and give the best ones a chance to develop. Mulberry can also be reproduced by cuttings, but propagation from seed is easier, and produces better plants.

Fruit is borne abundantly. The seed may be separated by crushing and washing the berries. After drying, the seed should be kept in a cool, dry place until a week or ten days prior to sowing. In case of very unfavorable conditions the seed may be sown as soon as it ripens, but generally the better practice is to wait until the following spring, so that the seedlings will have an entire season in which to grow before the coming of cold weather. The seed should be sown in good moist soil, and covered about one-half inch deep. One to two weeks or longer are required for its germination. Better results are obtained by mixing the seed with moist sand and keeping the mixture in a warm place until germination begins. The sand and seed can then be sown on a well-prepared bed. The seed can be given more even distribution by sprinkling the bed after it is sown. The bed should then be covered with one-eighth inch of sifted loam. The growth during the first season will be enough to make the little trees of proper size to transplant to the permanent situation the next spring. Planters who do not care to raise their own trees can get them cheaply at nurseries which handle forest seedlings. The price for one-year-old seedlings runs from $1 to $3 a thousand, depending upon the size and the nursery dealt with.

The Russian mulberry should be close-planted in order to overcome as much as possible its inherent tendency to branched and crooked growth. For windbreaks it should be planted at about 2-foot intervals. For timber plantations it may be set 4 feet by 4 feet. The best method, however, is to have the rows 8 feet apart and the trees 2 to 3 feet apart in the rows. This spacing permits of easy cultivation, and at the same time gives a large number of trees to the acre. Cultivation should be given for at least three years after planting, and until the ground is entirely shaded.

ENEMIES.

The Russian mulberry is attacked by a number of fungi, only a few of which, however, are of economic importance. If injury by a fungus is suspected, the Bureau of Plant Industry of the Department of Agriculture should be consulted regarding a possible method of treatment, specimens being submitted for examination. Insects are sometimes destructive, particularly in the semiarid plains, where swarms of locusts sometimes devour the foliage and even strip the bark from the trees. The fall webworm sometimes attacks the trees. Its leaves also serve as food for the silkworm (*Bombex mori*). When insect injury is serious, the Bureau of Entomology of the Department of Agriculture should be consulted regarding methods of control, specimens of the insects and their work being forwarded for identification.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

BEECH (Fagus atropunicea).

DISTRIBUTION.

The natural range of the beech is from Nova Scotia to northern Wisconsin; south to western Florida, and west to southeastern Missouri and Texas. It reaches its maximum development on the slopes of the Allegheny Mountains and in the valley of the lower Ohio River. It occurs in mixture with most of the trees included in its range.

The range for economic planting corresponds closely with its natural range.

SOIL.

The beech prefers fresh, cool, and rich soil. In the North it is found upon the slopes of mountains, where it sometimes forms pure stands; in the South it grows along the margins of swamps, or in bottomlands along streams. It grows well on limy or chalky soils.

GROWTH AND REPRODUCTION.

The beech is a moderately rapid-growing tree, sometimes, under favorable conditions, reaching the height of 120 feet. In dense forests it produces a tall, straight, slender trunk, which is adapted for economic purposes. The tree is shade-enduring, and the lower limbs persist for a long time. The open-grown tree forms a short, conical trunk, with many small limbs branching from it. The lower ones droop towards the ground, and if not pruned the tree forms an elongated dome which is very ornamental for parks or lawns. The light-colored bark and fine spray of delicate branches make it even more beautiful in winter than when in full leaf.

The beech usually forms the understory in the mixed stands where it occurs. It reproduces well in shade from the seed, as well as from root suckers. The several nursery varieties are propagated by grafting.

The beech is adapted for planting under evergreens such as white, red, or pitch pines, or it may be planted in company with the yellow poplar, black walnut, ashes, or oaks. When planted with less tolerant trees, the beech acts beneficially by shading the ground, and at the same time aiding natural pruning and increasing the height growth of associ-

ated species. Beech is also adapted for planting on cut-over lands where reforestation is desirable.

If planted in pure stands, 8 feet by 8 feet is a good distance to set the seedlings. This requires 680 seedlings per acre.

If planted in mixtures, the following diagram illustrates a good plan:

[6 feet by 6 feet.]

P B P B

B B B B

P B P B

B B B B

P = White, red, or pitch pine, yellow poplar, ashes, or oaks.
B = Beech.

This plan requires 908 beeches and 302 of the other species, or a total of 1,210 trees, to the acre.

Beech trees produce an abundant crop of nuts every two or three years. The three-cornered nuts ripen in the fall and drop soon after the first severe frost. If allowed to dry out, the nuts become rancid and the germs die. To prepare them for planting they should be stratified through the winter. A pit is dug and lined with mouse-proof material, or a large box is placed in it. Alternate layers of moist sand and nuts are then laid in and covered on top with a wire screen or boards. A mulch of leaves or straw mixed with some earth is thrown over the filled pit. Before the nuts are placed in the pit they should be fumigated with carbon bisulphide to kill the worms that may infest them. This may be done by placing them in a box, boring a hole through the cover, and pouring in some liquid carbon bisulphide. The hole should then be immediately plugged and left closed for two or three days. This will completely kill all insects without injuring the seed.

In the spring, as soon as the frost is out of the ground, the nuts should be planted, either directly in the permanent site, in which case three or four should be planted in each hole, or in a seedbed, from which the seedlings should be transplanted when a year old. In a seedbed the nuts, of which about 80 per cent should germinate, should be sown about 2 inches apart in rows. If they have not dried out during the winter, they should sprout in a few days. Care should be taken to keep weeds out by giving frequent cultivation. After a seed year young seedlings appear in large numbers in beech woods and may be dug up and transplanted, or they may be obtained at a reasonable price from nurserymen.

ECONOMIC USES.

Beech wood is hard, heavy, strong, and stiff. It is not durable in contact with the soil. It is fine grained and seasons with very little checking. It is used considerably in the manufacture of carpen-

tools and machinery. On account of its great hardness and stiffness it is admirably adapted for flooring in machine shops where rigidity is demanded, for, although strong, it will break before it bends much. For ordinary flooring it is so hard that it soon becomes very slippery and is, therefore, objectionable. It takes a beautiful polish and should be used in cabinetwork. It makes an excellent fuel.

ENEMIES.

The beech is one of our healthiest trees, being comparatively free from severe injury by insects or fungi, although many species of the latter occur upon it. A few common insects that prey upon it are the fall webworm and forest tent caterpillar, as well as other caterpillars which do considerable damage to the foliage. Plant-lice and scale insects are sometimes abundant, especially upon cultivated beech.

Whenever insects of any kind occur in destructive numbers, specimens should be referred to the Bureau of Entomology of the Department of Agriculture for determination and advice regarding means of control.

Information concerning the numerous fungi and methods for combating their attacks can be obtained by application to the Bureau of Plant Industry of the Department of Agriculture. Letters of inquiry should always be accompanied by specimens. Beech drops are low annual plants parisitic upon the roots of beech trees.

Owing to the thinness of its bark, the beech is very susceptible to injuries from fire, and plantations should be well protected by fire lines.

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United States Department of Agriculture,

BUREAU OF FORESTRY.

NOTES ON FOREST TREES SUITABLE FOR PLANTING IN THE UNITED STATES.

WHITE WILLOW (Salix alba).

DISTRIBUTION.

The natural range of the white willow is, in the old world, from southern Scandinavia to the Mediterranean, and through Siberia, western Asia, and northern Africa. It was introduced into the United States very early in the settlement of this country. It is now naturalized from the St. Lawrence Valley to the Potomac and westward.

For economic planting white willow has a large range, extending through the Northern States and south to Virginia, Kentucky, Tennessee, Missouri, Kansas, and Colorado.

SOIL.

White willow prefers a moist or wet rich, alluvial, sandy loam. It is, however, sufficiently hardy to thrive on high dry prairies of the Dakotas. It is injured by hot dry winds, and is occasionally killed back by the winters in the northern portions of North Dakota and Minnesota.

GROWTH AND REPRODUCTION.

White willow is a rapid-growing tree, reaching the height of 80 feet and a diameter of 4 to 6 feet. In its natural range it propagates largely from seed. The common and least expensive method of propagation is by cuttings, which root very readily. Cuttings may be of any convenient size; even branches or poles large enough for posts may be used. Cuttings should be taken from healthy, vigorous trees, since they root best from such trees. It is generally best to make cuttings in the fall, after growth ceases, and to keep them over winter buried in a cool cellar or in a well-drained soil out of doors. Cuttings can also be successfully rooted if made early in the spring, before growth starts. Clean two-year-old wood or strong, well-ripened one-year-old wood should be selected for cuttings, and the cuts should be made smooth with a sharp knife. They are best made 8 to 10 inches long, from twigs varying from one-fourth to three-fourths inch in diameter. Larger cuttings root as well, but are more bulky to handle. The ground which is to be planted should be thoroughly cultivated and made mellow. The cuttings should be planted with only the upper two buds exposed, and with

the soil pressed closely around their bases. If the land is wet, the ground should not be packed by tramping, but if it is dry, the cuttings can not be too firmly placed in the soil. Weeds must be kept out until the ground is well shaded by the trees. Willows should not be planted near tile drains, because their roots will enter and clog them.

The white willow is a light-demanding tree. While it does well in mixture with the cottonwood, it thrives best in pure plantations and in single rows where it can monopolize the situation. When crowded, the white willow produces a slender, straight trunk that may be utilized on the farm for poles or fence rails.

The following diagrams illustrate two arrangements of the trees in willow plantations:

Mixture of willow and cottonwood.

[3 feet by 6 feet.]

Cw WW Cw WW Cw WW Cw
WW Cw WW Cw WW Cw WW
Cw WW Cw WW Cw WW Cw
WW Cw WW Cw WW Cw WW

WW=White willow; Cw=Cottonwood.

Required number of trees per acre.

White willow	1,210
Cottonwood	1,210
Total	2,420

Pure willow plantation.

[2 feet by 8 feet.]

WW WW WW WW WW WW WW
WW WW WW WW WW WW WW
WW WW WW WW WW WW WW
WW WW WW WW WW WW WW

WW=White willow.

Required number of trees per acre.

White willow	2,720

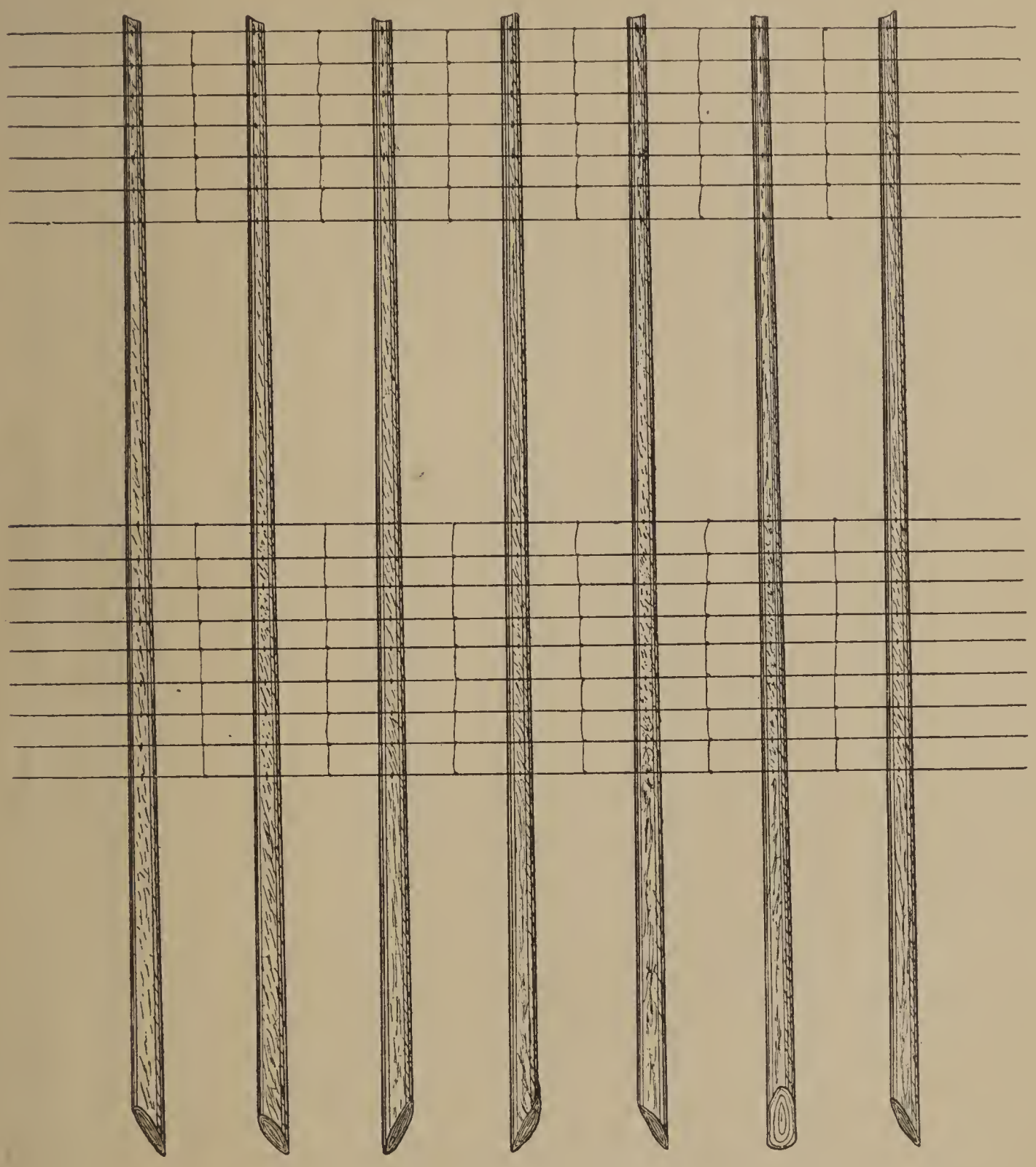
ECONOMIC USES.

The wood of the white willow is very soft, light, flexible, and fairly strong. It is used for cricket and baseball bats, in turnery and cooperage, and for charcoal used in the manufacture of gunpowder. It is very generally used for fence posts on the northwestern plains, but is of only medium durability. Its principal use is for fuel, but it also yields straight, light poles which are useful for many farm purposes.

The white willow has been planted very extensively in Iowa, Nebraska, Minnesota, North Dakota, and South Dakota. For the cold northern

prairies it is well adapted to planting in single rows for a windbreak or snow-catcher.

The white willow is well adapted for reclaiming or holding the soil along streams. It is far more serviceable for this purpose than walls of masonry, and the facility with which it reproduces itself, both naturally and artificially, by seed, suckers, sprouts, and cuttings, makes its use very simple and inexpensive. Where the banks cave in so rapidly that



Revetment for protecting river bank.

the tree has no chance to gain a foothold, the following scheme, proposed by Mr. E. Bayles, of Linwood, Kans., is excellent. Green willow poles of the native or introduced species, 18 to 20 feet long, are procured in the spring, just after the ice goes out of the streams. These poles are laid on the bank, 2 feet apart, with their butts all pointing towards the river. Woven-wire fencing is then stretched along over the

poles and stapled fast to each. Sections of this wire 100 feet long can be handled to best advantage. After the wire has been securely fastened to the poles, they are all pushed over the bank together, so that the butts of the poles will fall and sink into the soft mud at the water's edge. As the bank caves off, some of the falling soil will lodge on the woven wire, partially burying and weighting down the poles, which will consequently strike root and grow. The wire will serve to hold the poles together until they have become firmly rooted. The ends of the woven wire should be made fast to wire cables running back over the bank some distance, and fastened to posts firmly set in the ground. The caving and erosion of the bank will soon round off its top edge, and the growing willows will catch the soil as it rolls down the declivity, causing a bank to form of just the right slope to resist the erosion most effectually. The diagram on page 3 illustrates the method of constructing such a revetment for the protection of caving river banks.

A variety of the white willow known as the Russian golden willow resists much more cold than the common form, and is able to endure the winters of Manitoba.

ENEMIES.

With the exception of the oaks, the willow is said to be infested with more insects than any other tree in North America. Most of these are leaf-eating insects, but there are a few borers, gall-producers, and scales. Should insects appear in alarming numbers, specimens accompanied by a full description of their work should be sent to the Bureau of Entomology, Department of Agriculture, for identification and information in regard to methods of control.

A discussion of the insects which attack the willow is given in Bulletin No. 46, of the Bureau of Forestry, which is sent free upon application.

Willows are subject to a number of fungous diseases, some of considerable economic importance, as the "rust" and the "red rot." *Uncinula salicis* Winter, a common mildew, sometimes covers the leaves late in the season with a white web. In the spring and early fall small branches are often covered with *Trimmatostroma americanum* Thümen, the black spores of which will blacken the hand of a person breaking off one of the infected branches. When a fungus is believed to be present, specimens should be sent to the Bureau of Plant Industry, Department of Agriculture, where examinations are made and methods of treatment suggested.

Willow groves or windbreaks may be protected from fire by plowing several furrows around them.

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