OCTOBER, 1940 CIRCULAR 201

AGRICULTURAL EXPERIMENT STATION
KANSAS STATE COLLEGE OF AGRICULTURE
AND APPLIED SCIENCE
MANHATTAN, KANSAS

DEPARTMENT OF HORTICULTURE

FARM WOODLOT MANAGEMENT IN KANSAS[1]

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INTRODUCTION

The farm woodlot is a wooded portion bearing a stand of forest trees, maintained chiefly for the production of wood for domestic consumption or for sale. A woodlot of native trees is a unit of natural vegetation which has developed in response to soil and climatic factors operating over a long period. Its failure results from excessive cutting, grazing, fires, droughts, or other factors which destroy the trees and produce site conditions unfavorable for the development of future timber growth. Other reasons for

1. Contribution No. 165, Department of Horticulture.

maintaining woodlots are: Soil protection, game cover, recreation, and landscape value. The requirements of forest trees are similar to those of farm crops. The principal differences are: The longer period required for forest trees to mature, and wider choice in time of harvesting wood crops.

Planted woodlands, in which all trees are of about equal age, are usually clear cut, that is, all harvested at one time. In contrast, native woodlands, which often contain individuals ranging in age from seedlings to mature trees, may be managed to produce approximately equal annual crops of wood. Under careful management woodlots may produce annual crops indefinitely, provided the amount of wood harvested each year does not exceed the annual growth. The young timber that is always present on woodlots of this kind is the growing stock.

The natural conditions present in undisturbed timber serve as a guide that may be followed in successful woodlot management. Trees in native woodlands usually vary widely in age. The older trees reach maturity, then become decadent and die. Seedlings appear in the openings and close the gap in the forest canopy. Tree crowns and the windbreak effect protect the soil from desiccation and forest debris enriches the soil. In the natural woodlot small trees and shrubs normally form an understory which further protects the soil from the drying influence of sun and wind. If this example of natural conditions is maintained in farm woodlots, the selective cutting of trees will not cause serious drying of the soil surface or depletion of the soil fertility.

EXTENT AND CONDITION OF WOODLOTS IN KANSAS

Kansas woodlands comprise 1,073,000 acres of native timber and 165,000 acres of forest plantations, according to a survey completed in 1936.[2] This timber is found chiefly in the eastern third of the state along stream courses or on rough upland which is not adapted for the production of cultivated crops.

In 1935 Kansas woodlots produced 23,300,000 board feet of lumber, 995,000 cords of fuel wood and 5,300,000 fence posts. The estimated consumption of lumber in the state for that year was 381,000,000 board feet. These figures show that Kansas produces only about six percent of its annual lumber requirements.

Most of the native timber is used locally for lumber, fence posts, or fuel. A significant contribution to farm income in some sections of the state is derived from the sale of fence posts and walnut logs. In addition to these valuable wood products, woodland trees retard soil erosion, afford shelter for livestock and improve the appearance of the countryside.

The period required to grow a crop of trees from seed or seedlings to maturity is called a rotation. The rotation required for

2. Ware, E. R., and Smith, Lloyd F., Woodlands of Kansas. Kan. Agr. Expt. Sta. Bul. 285, 1939.

fence post plantations is 8 to 12 years; a rotation of 30 to 40 years is required for large trees such as cottonwood, black walnut and the oaks, if they are to attain saw-log size.

The yields from existing woodlots can be greatly increased by the adoption of better management practices. A serious mistake of the past has been to cut the most valuable trees and leave the culls. This system of cutting has resulted in the accumulation of inferior trees to the exclusion of the better species in many woodlots. The cull trees are suitable only for fuel and occupy land that should be growing merchantable logs. Continuous cutting of the better species reduces the supply of seed available to establish natural reproduction of the more valuable trees. For this reason it is now necessary in Kansas to supplement natural reproduction by planting desirable species in many of the depleted woodlots.

Heavy grazing is a serious menace to the productivity of farm woodlots in this state. Livestock injure large trees, kill the young trees, and pack the soil and prevent the accumulation of a ground cover of fallen leaves and branches. Grazing also reduces water absorption by the soil. Undoubtedly grazing has been a major factor in the destruction of native timber in Kansas.

Most of the native timber in this state is on land unsuited for cultivation. The woodlands are restricted chiefly to overflow land along streams or to steep slopes and hillsides with thin soils. On this rough land woodlands serve the dual purpose of wood production and soil erosion control. Timber on land subject to rapid erosion should never be clear cut. When timber so placed is cut, only a part of the trees should be removed in any one year; because when the trees are removed in a series of partial cuttings a protective cover of trees will be retained on the land at all times. When the timber is completely destroyed on such hillsides, the establishment of new timber growth is extremely difficult because of the thin soil and a deficiency of soil moisture due to increased loss of water through evaporation.

GROWING A NEW WOODLOT

Many farms in the eastern half of Kansas have small, irregular tracts of land that could be planted profitably to forest trees for the production of fuel, fence posts, or lumber. Overflow lands bordering streams, deep sandy soils, and rough broken tracts are suitable for woodlot planting. Woodlots on such lands will contribute to the reduction of soil erosion on these most critical farm lands where a cover of vegetation is essential for the protection of the soil. Tracts of land with thin or rocky soils are sufficiently fertile to support adapted woodlot trees. In addition such soils are likely to yield a greater return in wood than from any other type of crop.

Soil Preparation.— Soil moisture is usually the most important factor in establishing woodlots in Kansas. Tillable soils should be worked deeply before planting, preferably in the fall, as fall plow-

ing is beneficial in that more of the winter precipitation is absorbed and stored in the soil. In western Kansas, soils should be summer fallowed one year before trees are planted and planting should be deferred unless the soil is moist to a depth of three feet at planting time. Plowing should be on the contour on hillsides and later the tree rows should follow the contour in order to reduce erosion of surface soil. Soils bordering streams which normally contain subsoil moisture may be planted without soil preparation. Old woodlots usually will not require cultivation unless a grass sod has formed. In general, planting trees in sod on upland soils cannot be recommended under Kansas conditions.

FIG. 1.—Hardy catalpa seedlings properly protected from drying by storing in a trench.

Source of Planting Stock.—Most species of broadleaved trees are grown from seed in a nursery. The seedlings are kept in the nursery one growing season and then lifted for field planting, at which time they will have attained a height of 18 to 24 inches. Evergreen stock which grows more slowly in early life will be 2 or 3 years old and only 6 to 12 inches high when planted in the field. In general, nursery-grown stock is more vigorous than native seedlings and shows a higher survival after transplanting, but cottonwood is an exception in this respect. In favorable years satisfactory cottonwood stock may be secured from overflow lands near stream courses. These seedlings may be pulled by hand and used for field planting.

Forest planting stock may be obtained from reliable commercial nurseries or from the State Forest Nursery at the Fort Hays Branch of the Kansas Agricultural Experiment Station. The state of Kansas cooperates with the federal government in making forest planting stock available to farmers from the Fort Hays Branch Experiment Station. All shipments of forest trees must bear an inspection tag showing that the nursery from which they came was inspected for insect pests and diseases. Orders for stock from the state nursery should be placed before February 1 to insure that adequate stock will be available when the planting season begins.

It is often difficult to obtain the true species of tree desired when it is ordered under the common name. For example, if one orders locust, either honey locust *(Gleditsia triacanthos)* or black locust *(Robinia pseudoacacia)* might be supplied. The two trees are very different and are usually planted for different purposes. Confusion in ordering trees may be avoided by using the scientific name for each kind ordered. These names are given with the common names and descriptions in the appendix to this circular.

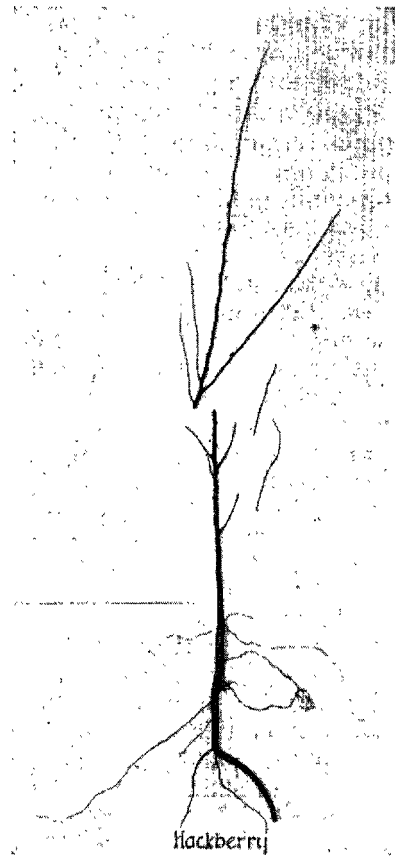

FIG. 2.—A seedling tree properly pruned for field planting. Most of the leaf buds are on the portion of the stem that has been removed.

Storing Planting Stock.— As soon as trees for planting are received from the nursery, the package should be opened, the roots moistened and then stored in a cool, moist place. Trees should not be permitted to freeze in the package before planting. If the trees cannot be planted for several days after they are received, they should be heeled in with the roots and a portion of the stem covered with soil. A shaded location is preferable for this type of storage. Tree roots must be kept moist at all times to avoid losses. Figure 1 illustrates properly heeled-in young trees.

Pruning Seedlings. — Approximately one-half of the stems of most brondleaved trees should be removed by pruning before the

trees are planted. Pruning reduces the number of leaves which draw upon the roots for water, so the stem is less likely to dry out before the new root system becomes established.

Oak and walnut seedlings usually are not pruned at planting time because of the relatively small stem in seedlings of this group. Evergreen stock is not pruned at planting time. It is not necessary to prune tree roots except those that have been broken or otherwise injured. A seedling hackberry tree properly pruned for field planting is shown in figure 2

Planting Methods. — In Kansas early spring is the proper time for planting all forest trees and planting should start as soon as the frost is out of the soil and before the leaves appear on the trees. In general, the planting season extends from February 15 to April 15, but the early part of this period usually results in better stands of trees.

In field planting, the tree roots must be protected from drying by sun and wind, for the fine roots of evergreens may be killed by exposing them only a few minutes to the air on a warm day. Usually, the trees are carried in a pail or basket with moist straw or burlap packed around the roots. If trees are placed in water they should not be left for more than a few hours. The roots of evergreens may be protected by dipping them in thin mud. A film of mud adheres to the roots and protects them from drying for a short time.

Deep plowing before planting reduces the labor required in the planting operation, and also aids in the absorption and retention of rainfall. The tree rows may be marked with a plow or lister and the trees planted in the furrow. Straight rows aid in subsequent cultivation of new plantations.

In planting small trees the hole should be large enough to provide space for the entire tree root. The planting holes should have perpendicular sides. A long-handled shovel with a straight blade and tapered point is the best planting tool on cultivated soils. A grub hoe or mattock is most efficient for planting on stony soils or in replanting old woodlots. Systematic procedure in tree planting will avoid unnecessary labor and increase the rate of planting. A planting crew of two men can plant most efficiently under farm conditions. One man digs the holes and the other plants the trees. In planting, the tree is held in the center of the hole with the left hand while soil is pulled over the roots with the right.

Forest trees should be set at approximately the same depth as they grew in the nursery. After the hole has been half filled the soil is firmly packed with the heel. Then the remaining portion of the hole is filled and the top soil packed firmly about the tree. Packing the soil firmly prevents the roots from drying out before growth starts.

Number of Trees Per Acre. — The number of trees required to plant one acre depends upon the species planted and the purpose

for which the trees are grown. Spacing in fence-post plantations is closer than in plantations for the production of saw logs. Table 1 shows the number of trees required per acre for the various spacing distances indicated. The spacing distances recommended for a list of more important species when planted for different products are indicated in table 2.

TABLE 1.—NUMBER OF TREES REQUIRED PER ACRE FOR DIFFERENT SPACING DISTANCES

Spacing, feet.	Number trees per acre.	Spacing, feet.	Number trees per acre.
4 × 4	2,722	8 × 8	681
4 × 6	1,815	8 × 10	545
4 × 8	1,361	9 × 9	538
5 × 5	1,742	10 × 10	436
5 × 6	1,452	10 × 12	363
6 × 6	1,210	12 × 12	302
6 × 8	908	10 × 14	311
6 × 10	726	10 × 16	272

TABLE 2.—SUGGESTED SPACING DISTANCES FOR A NUMBER OF IMPORTANT TREES FOR WOODLOT PLANTING IN KANSAS

SPECIES.	Purpose.	Spacing, feet.
Western yellow pine	Logs	8 × 8
Austrian pine	Logs	8 × 8
Scotch pine	Logs	8 × 8
Red cedar	Posts	4 × 8
Cottonwood	Logs	10 × 10
Black walnut	Logs	8 × 8
Bur oak	Logs	8 × 8
Red oak	Logs	8 × 8
Black locust	Posts	4 × 8
Hardy catalpa	Posts	4 × 8
Green ash	Logs	8 × 8
White ash	Logs	8 × 8
Hackberry	Logs	8 × 8
Honey locust	Posts	4 × 8
Osage orange	Posts	4 × 8

Planting Tree Seeds.— The seed of black walnut, oaks and hickories can be collected in the autumn and planted in the woodlot. Acorns and hickory nuts should be planted immediately after collection, as a short period of dry storage in the autumn will dry out the seed of these species and kill them. Walnut seed will not dry out as quickly as acorns, but it should be planted in the autumn, as freezing the seed in the soil is necessary to obtain early germination in the spring. If walnuts are planted before the first of December, they usually germinate promptly in the spring.

The seed of these nut trees should be planted approximately four inches deep. It is important to pack the soil firmly over the seed. In general, two seeds should be placed in each hole and the holes spaced about four feet apart in field planting. The heaviest loss of seed planted in the field is caused by squirrels and other rodents which dig up the seed for food during the winter.

The principal advantage in planting seed directly in the field is that this method avoids transplanting species with long tap roots. Walnuts, oaks, and hickories have tap-root systems and are difficult to transplant successfully.

Cost of Forest Plantations.— The cost of planting an acre of trees varies greatly, depending upon the expense of soil preparation, labor costs, the kind of stock used, and the number of trees required to plant an acre. At present, the cost of most of the trees suitable for woodlot planting ranges from approximately $7 to $12 a thousand. If the trees are spaced 8 by 8 feet, 681 trees will be required to plant an acre. At this spacing and with planting cost at $10 per thousand the stock for planting one acre will be $6.81.

TREES FOR LUMBER PRODUCTION

The principal trees planted for lumber production in Kansas are cottonwood, black walnut, bur oak, and red oak. Other species that will produce saw logs, but are planted less frequently for this purpose, are hackberry, slipperly elm, American elm, western yellow pine, and Austrian pine.

Cottonwood grows rapidly on adapted soils and produces large yields of wood per acre. It should be planted on overflow lands along streams or in sections with deep sandy soils. In plantations cottonwood should be spaced approximately 10 by 10 feet. Frequent thinnings will be required in these plantations to maintain the proper density for rapid growth.

Black walnut produces wood of high technical quality which has many uses and is in good demand on the market. Walnut is adapted for deep, fertile soils which have a constant supply of subsoil moisture. The most valuable walnut trees are grown on overflow lands along the rivers in the eastern third of the state. Walnut should not be planted on the upland except on deep, fertile soils. Walnut plantations may be started either from seed or from nursery stock. If nursery stock is used, the trees should be spaced 8 feet apart each way.

Bur oak and red oak are adapted for planting in the eastern half of the state. The wood of these species is used for flooring, bridge planks, railroad tics, fence posts, and many other purposes where strength and durability are required. High-quality logs sell readily at satisfactory prices. These oaks will thrive on upland soils in eastern Kansas; however, the growth rate is better on moist locations. Bur oak is one of the most drought resistant of the native trees. In general, nursery stock is more satisfactory for establishing oak plantations than planting the seed in the field. A spacing of 8 by 8 feet is usually best for these oak species.

TREES FOR POST PRODUCTION

The principal species planted for the production of fence posts in Kansas are hardy catalpa, black locust, osage orange, mulberry, and red cedar. In post plantations the most satisfactory spacing is usually 4 by 8 feet. This distance between the rows provides space for cultivation with farm implements until the trees are fully established. Post plantations should be dense enough to promote straight growth of the tree stems.

Catalpa wood is resistant to decay when in contact with the soil. It is not as strong as osage orange or black locust, but it holds staples better than the harder woods. Hardy catalpa thrives on deep, moist soils or on sandy soils with subsoil moisture. The moist, sandy soils in the Arkansas River Valley are well adapted for the growth of catalpa. Landowners should insist on hardy

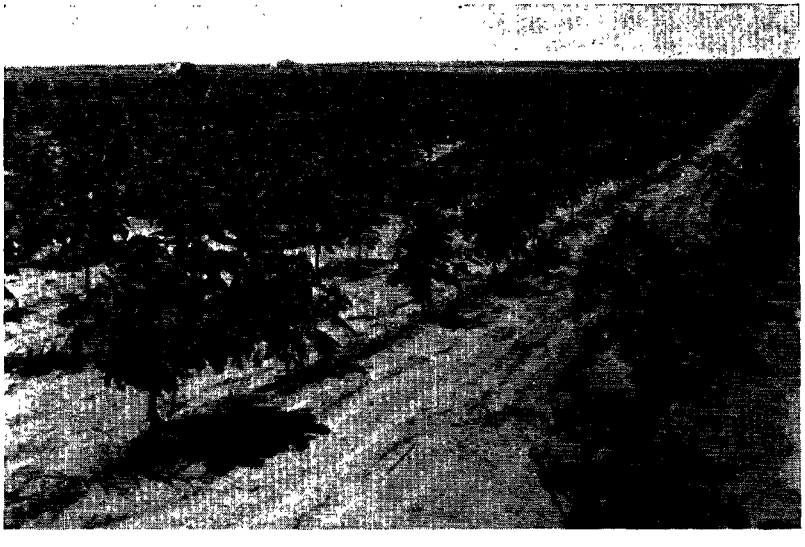

FIG. 3.—A two-year-old plantation of hardy catalpa established for fence posts and erosion control in Kingman county.

catalpa *(Catalpa speciosa)* stock when ordering catalpa seedlings for fence-post plantations. The common catalpa, which closely resembles hardy catalpa, is almost worthless for post production. A thrifty, young, hardy catalpa plantation is shown in figure 3.

Black locust is strong, hard, and durable in contact with the soil. This tree grows rapidly, is hardy when planted on a wide range of soil, and develops a straight trunk in plantations. The chief objection is its susceptibility to attacks by the black locust borer. This borer usually is not serious in plantations on fertile soils where the growth rate is rapid. On poor soils or in crowded stands, borers may seriously damage the wood for posts and greatly reduce the rate of growth.

Osage orange is strong and extremely durable in contact with the soil. It has been planted extensively in Kansas for hedge fences and also maintained as clipped hedges around fields. Osage orange will succeed on thin soils, but the rate of growth is slow on such soils. This tree develops a spreading crown in the open, but it will form a straight trunk and high crown in post plantations. Osage orange in plantations will become large enough for post within 10 to 15 years when planted in eastern or central Kansas.

Mulberry is strong and resists decay in contact with the soil. The wood is not as hard as Osage orange, but it holds the staples well. Mulberry thrives well on upland in the central part of the state. This tree makes a moderate rate of growth and will attain a size suitable for fence posts in 10 to 15 years after planting.

Red cedar is durable in contact with the soil, but the wood is relatively weak, and red cedar fence posts are not adapted for use in fences where great strength is required. Red cedar thrives on most of the soils in the state. The growth rate is moderate on good soils, but slow on poor soils. A period of approximately 15 to 20 years is required to grow red cedar to post size.

PLANTINGS TO CONTROL SOIL EROSION

Forest trees are effective in holding the soil in place on certain areas subject to pronounced erosion. Trees are generally planted in gullies, on steep slopes and along stream banks to retard erosion. Forest plantations are often made in connection with check dams and other engineering structures built to check erosion.

Before planting trees in gullies, certain definite steps must be made in preparation of the area for planting. In deep gullies check dams should be built to slow down the rate of water movement. Steep banks should be sloped back to prevent their caving in after the trees are planted. Gullies in pastures should be fenced to protect the trees from livestock.

The principal forest species used for planting gullies are black locust, mulberry, and osage orange. Black locust is the best of these species because it grows rapidly, is very hardy, and develops

an extensive root system which holds the soil. In gully planting the trees are spaced approximately 4 by 4 feet apart. This spacing may be varied to meet special conditions. Usually machine cultivation is impossible for trees that are planted in gullies. For this reason heavy losses are likely to occur when the soil dries rapidly in summer. Small basins left about the trees at planting time will increase the amount of moisture available to carry the trees through dry periods. Hand hoeing will also be beneficial where labor is available for that purpose.

Cottonwood and black willow are commonly planted on wet soils to prevent a change in the stream channel and to protect stream banks at bends in the channel. Both of these species can be started from cuttings if they are planted in moist soil. The cuttings are made of one-year-old wood and cut about one foot long. They are placed upright in the soil with about one-third of the cutting above the surface. They should be planted early in the spring to enable roots to form before the top of the cutting dries out.

IMPROVEMENT WORK IN EXISTING WOODLOTS

Thinning the Woodlot.— Thinnings are made in young timber stands to regulate the number of trees and to increase the rate of growth of the best individuals. Woodlots that are properly thinned will have the correct number of trees per acre for thrifty growth at all times. Thinnings will gradually reduce the number of trees until the stand is mature. At each thinning the small and poorly formed trees should be removed to provide additional space for the more valuable individuals.

When the trees are small a fully stocked native woodlot will contain several thousand trees on each acre. Only a part of these trees will reach maturity, as the more thrifty trees will overtop the weaker ones and eventually kill them through competition. Close spacing in young woodlots is necessary to bring about development of straight stems and cause natural pruning of the lower branches. These branches form large knots in the trunk which reduce the quality of wood for lumber production. If dense stands are not thinned, growth will be reduced and all the trees may be killed by drought in dry periods. The first thinning in a young woodlot should be made soon after the tree crowns meet. In small farm woodlots thinnings can be made profitably at frequent intervals and the wood used for fuel or posts. The small and crooked trees should be removed in the first thinning and in this way straight and thrifty trees are given more space to develop. Thinnings should be heaviest on the poorer soils and in the drier sections of the state. Light thinnings at frequent intervals promote better growth than heavy thinnings made less frequently. In heavy thinnings the openings between trees are larger and weeds are likely to develop in these openings. The value of the wood removed in

thinnings usually will equal the cost of the labor required to make this type of cutting. The trees to be removed should be carefully marked before cutting is begun. The owner should have clearly in mind the trees which are to be reserved for the final crop. A woodlot of pine that has been marked for thinning is shown in figure 4.

FIG. 4.—A dense pine plantation after the inferior trees were marked for thinning. All trees are of the same age, but differ greatly in size.

Improvement Cuttings.—Old woodlots that have not been properly managed usually have many crooked, dying or overmature trees of low value. These occupy space that should be devoted to young trees of good form and of species which will yield profitable logs in the future. The inferior trees and those of undesirable species should be cut to provide more space for the valuable trees. These defective trees usually can be converted into fuel wood or fence posts. A woodlot in need of an improvement cutting is shown in figure 5. This woodlot has not been managed for maximum production. It contains dead and overmature trees which should be removed to release the young growth present.

Historical Trees.—Overmature trees are frequently left in the woods because of their large crowns and poorly formed trunks. Such trees usually are of low value and a large amount of labor is required to work them up for fuel. A few of these large trees, such as the sycamore in figure 6, should be reserved because of their unusual size and historical value.

FIG. 5.—A woodlot in Pottawatomie county in need of an improvement cutting. The dead elm in center and overmature oak in background should be cut to provide growing space for small trees.

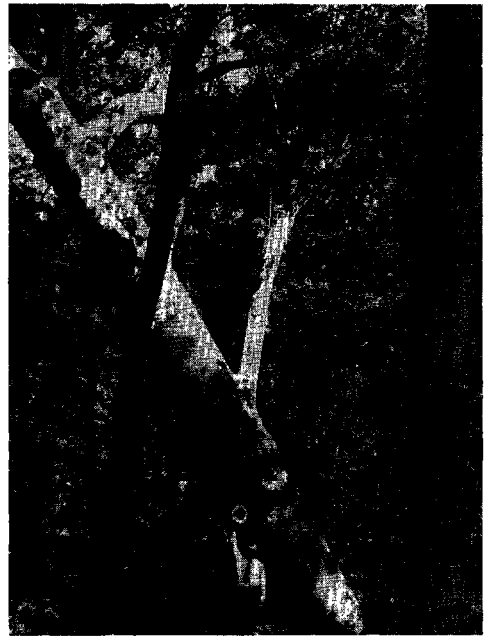

FIG. 6.—A large sycamore tree in Miami county. Unusual trees such as this should be preserved for their historical value.

Esthetic Woodlot Species. — Seasonal color is one of the striking features of many of the native woodlands. Some of the more attractive woodland plants that should be preserved for esthetic values are redbud, wild plum, wild cherry, hawthorn, wahoo, papaw, smilax, and bittersweet. Protecting them from fire and grazing will aid the existing specimens of these shrubs and provide conditions suitable for their natural reproduction. They can be introduced into new woodlands by planting either the seed or seedling plants.

PROTECTION OF WOODLOTS

Protection is an essential part of woodlot management. Adequate protection is necessary in order that the investment in young timber may not be lost due to preventable causes. The most important agencies that damage Kansas woodlots are livestock, insects, diseases, fires, and rodents.

GRAZING

Approximately 68 percent of the native woodlands in Kansas are subject to some form of grazing, according to the 1935 census report. Livestock in the woodlands destroy young tree growth, change the soil structure and injure the older trees. When livestock is permitted access to an ungrazed woodlot, the seedlings and shrubs are destroyed first. Next the lower branches on the older trees are eaten. Later a browse line appears in the woods and extends as high as the animals can reach. Destruction of the undergrowth

FIG. 7.—An ungrazed woodlot in Pottawatomie county showing thirfty undergrowth of young trees and shrubs.

exposes the soil to the drying influence of the sun and wind. Later a grass sod develops as the woods become more open.

If grazing is continued the older trees die back in the tops and within a few years most of them perish. The grass sod utilizes the available soil moisture and tree seedlings are unable to become established. In ungrazed woods, the soil is open and porous in contrast to the packed condition of the surface soil in grazed woods. In addition to unfavorable soil conditions, mechanical injury to the trees hastens the decadence and death of trees in grazed woodlots. The ungrazed woodlot shown in figure 7 supports a thrifty group of young trees and shrubs. The grazed woodlot in figure 8 shows the absence of new tree growth and shrub undergrowth.

FIG. 8.—A typical grazed woodlot with grass sod and stumps of dead trees. The woodlot is changing to a native grass pasture through the effects of grazing.

Woodland owners should realize that when a grass sod forms under the trees in native timber the grass will replace the trees and rapid decadence will occur in the timber stand. Light grazing may not seriously damage growing timber provided the practice is not continued, but heavy grazing undoubtedly has been the principal cause of the recent heavy mortality in Kansas woodlots.

Protection from grazing is especially important in newly planted woodlots. Animals may destroy all of the young trees within a short time. Trees that are damaged even slightly are likely to be retarded and to produce low-quality wood. Land that is bearing a native growth of timber should be fenced to exclude livestock if the owner intends to maintain the area permanently in timber.

Woodlots are commonly used for winter feed lots in order to

utilize the timber for winter protection for livestock. The concentration of livestock on a relatively small area usually kills the timber within a few years. A better method consists in building the feed lots on the protected side of the woodlot. If this plan is followed, permanent wind protection is made available without exposing the trees to damage by the livestock.

FOREST INSECTS

A large number of insect species feed on forest trees. Defoliating insects feed on the leaves and boring insects on the bark and wood. Other insects may attack the buds, roots, or seeds. When defoliating insects destroy all the leaves, the tree will be weakened and possibly killed. Vigorous trees usually recover if they are defoliated only once in a season, but young trees or those weakened by drought are likely to be killed if entirely defoliated.

Cankerworms commonly become numerous enough to defoliate forest trees and certain fruit trees. In Kansas they are most injurious to elms and hackberries. However, cankerworms may feed on the foliage of any of the native forest trees. The adult is a moth which emerges from the ground in the late winter or early spring. The female is wingless and crawls up the tree trunks to deposit the eggs on the branches and twigs. Small worms emerge from the eggs at the time the leaves appear. The worms feed on the foliage until their larval stage is complete. These worms can lower themselves by means of a thread which they spin. This insect can be controlled by banding the trees with tanglefoot or by spraying the foliage with two pounds of arsenate of lead plus one quart of a spray oil in 50 gallons of water. Usually there is not any practical control of cankerworms in woodlots because of the expense involved.

Walnut caterpillars frequently defoliate black walnut, pecans, and hickories. The adult insect is a moth. The eggs are deposited in clusters on the leaves in June or July. The caterpillars emerge and feed on the foliage. At intervals during the larval stage the caterpillars assemble in a cluster on the lower branches or the trunk. Defoliation seriously injures the trees affected. Small trees can be sprayed with arsenate of lead or the caterpillars may be destroyed by burning when they cluster together on the lower part of the tree to molt. Other important injurious pests that occur at intervals on forest trees include grasshoppers, red cedar scale, red spider, forest tent caterpillar, and bagworms.

The flat-headed borer is typical of the boring insects that attack the bark and wood of forest trees. This insect has been found in all native forest trees. It is especially injurious to American elm and slippery elm. Branches with thin bark are usually most heavily infested in the older trees. Younger trees with thin bark may be girdled and killed. Borers are more likely to attack weakened trees or those nearing maturity and losses are greatest in un-

managed woodlots in dry years. The control of borers in woodlots consists in keeping the timber in a vigorous condition through systematic thinnings and protection from fire and livestock.

The locust borer frequently attacks planted black locust trees. The larva of this insect makes large holes in the trunk and branches, causing serious damage. It causes most damage to open grown trees or to those growing under unfavorable conditions. The control consists in growing plantations dense enough to keep the trunks shaded but not too dense to permit rapid growth. Plantations on favorable sites are not as likely to be injured seriously by this insect as those growing under unfavorable conditions.

Cottonwood borers have caused some losses in young cottonwood plantations. No control measures have been developed as yet to prevent injury by this insect under forest conditions.

Termites are often present in soil where decaying wood or old stumps exist. They will damage young trees planted on such sites. Soils infested with termites should be cultivated thoroughly and the decaying stumps and wood removed before planting is begun.

In general, the control of insect damage in woodlots is obtained by maintaining the trees in a vigorous condition. This condition is brought about by keeping the stand of trees at the proper density by means of thinning. Grazing should be prohibited and dead and dying trees which may serve as breeding grounds for various insects should be removed.

DISEASES OF FOREST TREES

Few serious diseases of forest trees are generally prevalent in properly managed Kansas woodlots. Decay is a common defect of forest trees that have been injured by fires or animals. Decay may gain entrance at any point where the bark is broken and eventually affect a large part of the tree, making it unmerchantable for lumber. Decay may be reduced by controlling grazing and reducing other factors that cause injury to the trees.

TREE DAMAGE BY FIRE

Considerable damage is caused to native timber by fires that are usually started in adjacent fields or in fence rows. Fires kill young trees, destroy the leaf litter and burn the bark of older trees. Even though the trees are not killed, fire injuries are followed by decay which may destroy a large part of the lower portion of the tree. Evergreen trees are readily killed by fire, since evergreen foliage burns at any season. The heat given off by fires may kill trees even though the bark is not destroyed by the fire. A strip of cultivated land between the woodland and adjoining fields will reduce the fire hazard. The brush remaining after cutting timber should not be burned, but should be scattered and allowed to decay, as brush and leaf litter will reduce surface runoff and enrich the soil.

DAMAGE TO TREES BY RABBITS

In some sections rabbits injure young trees by feeding on the bark. The rabbit population may be reduced by hunting or by the use of poison baits. Poison baits should be used with caution, as they are also poisonous to livestock. Partial protection may be obtained by the use of repellents. Sulfurized linseed oil has been found to be a successful repellent on young trees. This mixture may be purchased through a paint dealer or prepared at home by heating raw linseed oil to 470° F. if a container five times as large as the volume of oil is used. The oil foams when the sulfur is added and one gallon of oil will produce enough foam to fill a five-gallon container. When the oil is hot, it should be removed from the flame and powdered sulfur added slowly at the rate of 12 ounces to one gallon of oil. After the sulfur is thoroughly dissolved, the mixture is allowed to cool before it is applied to the trees. This mixture should be prepared out of doors to avoid danger from fire and to avoid the disagreeable odor. It may be applied to tree stems with a paint brush or thinned with turpentine and put on with a hand spray pump. This mixture has not been entirely effective under all conditions, but in general reduces damage by rabbits if applied early in the autumn before rabbits begin feeding on trees.

HARVESTING THE WOODLOT

Timber can be harvested most economically and the quality of products obtained will be higher if correct practices are followed in cutting and preparing the wood for market. Timber should be cut before the growth rate begins to decrease greatly. It usually is not economical to cut small trees for lumber unless they are dead or in poor vigor. The proportion of wood lost in sawdust and slabs is much greater in small trees. For example, only about 45 percent of the volume of an eight-inch log can be utilized in lumber, but 65 percent of a 30-inch log is converted into boards when sawed. The higher yield of boards from large logs is one of the principal reasons that they bring a higher price per thousand board feet.

When large trees are felled an undercut should be made on the side toward which the tree will fall. The second cut is made on the opposite side from the undercut. A saw is less wasteful than an ax in cutting large trees. Precaution should be exercised in felling to avoid breakage and damage to surrounding trees.

After the tree has been felled the branches are removed and the trunk cut into sections or logs. Saw logs are usually cut into sections that are an even number of feet in length. In order to obtain the highest possible yield, attention should be given to crooks, decay, and other defects. Cuts should be so made that defects will fall near the end of the log and will be cut out with the least loss. The highest quality lumber usually is cut from the butt log. The knots are smaller and wide boards of clear lumber are obtained from this first log.

Logs should be sold or sawed soon after cutting, as they will deteriorate rapidly through checking and from insect damage if left in the woods more than a few weeks.

MEASURING AND MARKETING SAW LOGS

Saw logs are measured in board feet. A board foot is a section of wood one foot square and one inch in thickness. Tables are available which give the number of board feet in logs before they are sawed. These tables make allowance for the portion of the log that is discarded as sawdust and slabs in sawing. The Scribner log table is commonly used for measuring logs in Kansas.

To meaurse a log, find its length in feet. Then determine the average diameter inside the bark at the small end of the log. Using these two measurernents, the board foot volume can be found in table 3.

TABLE 3. BOARD FEET CONTENTS OF LOGS

(Scribner Log Table)

Diameter in inches at small end of log.	Length of log in feet.							
	8	10	12	14	16	18	20	22
	Board feet.							
6	8	10	12	14	18	22	24	28
7	12	15	18	24	28	32	34	38
8	16	20	24	28	32	40	44	48
9	20	25	30	35	40	45	50	55
10	27	34	40	45	50	55	65	70
11	33	42	50	55	65	70	80	90
12	39	49	59	69	79	88	98	108
13	48	61	73	85	97	109	122	134
14	57	72	86	100	114	129	143	157
15	71	89	107	125	142	160	178	196
16	79	98	119	139	159	178	198	218
17	92	116	139	162	185	208	232	255
18	106	134	160	187	213	240	267	293
19	120	150	180	210	240	270	300	330
20	140	175	210	245	280	315	350	385
21	152	190	228	266	304	342	380	418
22	167	209	251	292	334	376	418	460
23	188	236	283	330	377	424	470	518
24	202	252	303	353	404	454	505	555
25	229	287	344	401	459	516	573	631
26	250	312	375	439	500	562	625	688
27	271	342	411	479	548	616	684	753
28	291	363	436	509	582	654	728	800

Straight logs with straight grain and free from defects produce the highest grades of lumber. A log that is more than one-half defective usually cannot be sold for lumber. Logs should be at least 8 feet long and 12 inches in diameter at the small end. The principal defects that lower the grade of logs are: Knots, check, shake, decay, crook, insect injuries, lightning scars, and fire scars.

MEASURING AND MARKETING FUEL WOOD

The cord is the standard unit of measurement for fuel wood and measures four feet wide, eight feet long, and four feet high. The cord contains 128 cubic feet. Fuel wood is commonly cut four feet long and stacked in the open where it is permitted to season. After seasoning, the wood is sawed to the desired length just before it is delivered to the buyer. Seasoned fuel wood cut to four-foot length is shown in figure 9.

A rick is used as the unit of wood measurement in some sections of Kansas. This unit is eight feet long, four feet high, and varies in width according to the length of the sticks. If the sticks are one foot long, the rick contains one-fourth of a cord.

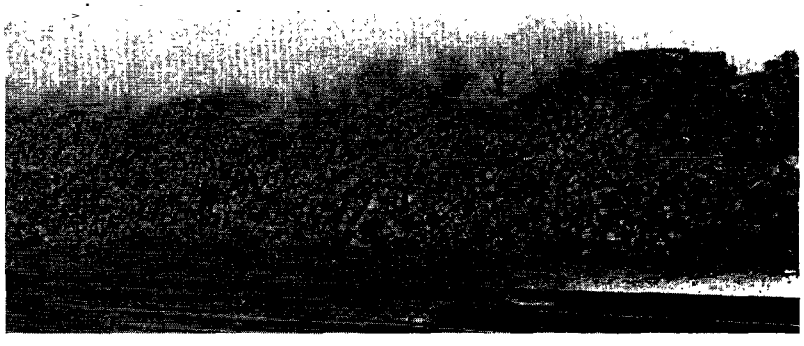

FIG. 9.—Fuel wood awaiting shipment in Linn county. The sticks are cut to four-foot lengths and the larger pieces halved or quartered.

The practice of marketing wood in wagon or truck loads is usually unsatisfactory. The amount of wood in a load varies greatly, depending upon the arrangement of the sticks and the size of the bed.

The heavier woods such as oak, hickory, ash, and osage orange are excellent for heating and bring the highest prices on the market. Seasoned wood of most species is much superior to green wood for fuel.

HARVESTING AND MARKETING FENCE POSTS

Fence posts, poles, and railroad ties are measured and sold by the individual piece. These products are usually graded according to species, dimension, straightness, and allowable defects. Fence posts may be cut at any time of the year without impairing their durability in service. If posts are cut in winter they will season more gradually and are less likely to check severely than if cut in summer.

Careful cutting of a post plantation will improve conditions for the second crop, which originates from sprouts. Stumps should be cut low with a smooth, sloping surface. The most vigorous sprouts

originate at the root collar. Burning brush on the stumps damages the roots and permits the entrance of decay in the root system. A large number of sprouts develop on each stump the first year after cutting a crop of posts. During the second year all of the sprouts except one or two of the largest to each stump should be broken off. The sprouts will be most vigorous if the trees are cut in winter when they are in a dormant condition.

Fence posts should be graded according to length, size and straightness. Posts are usually cut six and one-half feet long for fence construction. The diameter specifications depend upon the strength requirements,

Posts are usually seasoned by piling them horizontally in square piles. The first posts should be supported above the ground to permit good air circulation. This method of storing posts for seasoning is shown in figure 10.

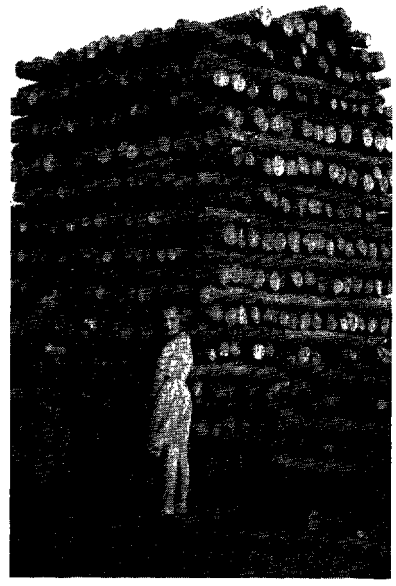

FIG. 10.—Catalpa posts in Reno county, graded and properly piled for seasoning.

High-quality posts are usually in demand and can be marketed at a profit. In sections where the production of posts is large better prices are obtained by shipping to other points. Large numbers of posts are sold annually at the community auctions. Most of the posts that are exported are shipped by truck to regions north and east of Kansas where fewer posts are produced.

PRESERVATIVE TREATMENTS OF WOOD ON THE FARM

The service period of posts and poles made from species that decay rapidly in soil can be lengthened by impregnating the wood to a depth of one-half inch or deeper with a material toxic to decay organisms. Creosote is the most commonly used material in the preservation of wood. Equipment made at home for treating fence posts is described in Farmers' Bulletin 744, "The Preservative Treatment of Farm Timbers." This method requires two steel barrels with a fireplace under one barrel to heat the creosote. The creosote is heated to 180° to 220° F. After the bark has been removed the seasoned posts are placed in the hot creosote for one to two hours.

Then they are transferred to the second barrel of creosote which is kept at 100° F. The posts remain in the creosote until it penetrates to a depth of one-half to three-fourths inch. Posts should be treated at the lower end to approximately one foot above the ground line. The average cost of creosote treatment varies from about 15 to 20 cents for each post.

Another preservative treatment consists in the use of a solution of zinc chloride. A description of this method can be obtained from the State Forester at the Kansas Agricultural Experiment Station.

The heartwood of durable species, such as osage orange, black locust, red cedar, and hardy catalpa, usually does not require preservative treatment. The relative durability of the heartwood of a few woods commonly used on the farm to decay is as follows: High resistance to decay, osage orange, black locust, hardy catalpa, eastern red cedar, southern cypress, western red cedar, and black walnut; moderate resistance, bur oak, white oak, honey locust, southern yellow pine, and douglas fir; low resistance, red oak, hickory, sugar maple, and white ash; very low resistance, black willow, cottonwood, basswood, and soft maple.

SPECIES FOR WOODLOT PLANTING

Western yellow pine *(Pinus ponderosa)* is a hardy evergreen in nearly all parts of the state on upland soils. It makes a moderate rate of growth after the first few years and attains a large size. This pine thrives on sandy or gravelly soil, but it should not be planted on wet lands or on sites subject to overflow. The long needles are borne in groups of either two or three. The wood lies between the hard pines and the soft pines in hardness. It is excellent for construction purposes. This pine should be planted more extensively both for wind protection and for its evergreen foliage.

Austrian pine *(Pinus nigra)* is an evergreen tree which has been introduced from Europe. It is similar to the western yellow pine in form and rate of growth. The needles are borne in groups of two. Austrian pine is adapted to nearly all sections of the state, but does not thrive as well on poor soil as does the western yellow pine. Austrian pine is better adapted than western yellow pine for planting on heavy soils. After becoming fully established, Austrian pine will increase about two feet in height each year on favorable sites. The wood is moderately hard and suitable for construction purposes.

Scotch pine *(Pinus sylvestris)* is a native evergreen of northern Europe. It is adapted for planting only in the eastern one-third of the state. Scotch pine grows well on fertile upland soils and increases in height growth rapidly in early life. The bluish-green needles are short and occur two in a cluster. Many Scotch pine trees tend to develop crooked trunks; they do not grow as

rapidly under unfavorable conditions as the other two pines, and are less resistant to drought and high summer temperatures.

Red cedar *(Juniperus virginiana)* is the only native evergreen tree in Kansas. It is adapted to all sections of the state and will grow on practically all soils except those subject to overflow. The best growth is secured on deep fertile soils, but red cedar will succeed on even the poorest soils after it becomes established. Red cedar grows more rapidly in early life than the pines and is more easily started. On good soils red cedar will normally increase about two feet in height each year. The wood is very durable in contact with the soil. It is used for posts, poles, pencil stock, cedar chests, and lumber to line moth-proof closets. Red cedar seed is eaten by birds and the trees serve as cover for birds during storms.

Red cedar should not be planted within two miles of a commercial apple orchard as it may transmit the cedar rust disease to the apple trees.

Cottonwood *(Populus deltoides)* is native to all sections of the state. Its growth is rapid and it attains a large size on favorable locations. Height may increase five feet a year on good soils. Cottonwood is not generally suited for planting on thin upland soils. It grows well on bottom lands even though such land is subject to overflow. On good sites in full-stocked stands, the trees are straight and of good form for saw logs. Cottonwood should be planted more generally on sandy soils and on moist soils adjacent to stream courses. The wood is strong, tough, and of medium weight when seasoned. It is suitable for dimension stock and other interior construction. Cottonwood is used extensively for boxes, crates, and packing cases.

Black walnut *(Juglans nigra)* is a native tree which occurs on deep moist soils along many of the streams in the eastern one-half of the state. Walnut is not adapted for planting in the western one-half of the state. It should be planted only on deep, fertile bottom-land or upland sites with deep soils in eastern Kansas. Walnut develops best in mixed plantation. White ash can be grown successfully with walnut. The growth rate of walnut is rapid on good sites and the trees reach a large size. Walnut is the most valuable native tree for gunstocks, furniture, veneer, wood turning, and many other uses.

The logs must be at least 12 inches in diameter to be merchantable. Walnut plantations should be made on good soils that will produce large trees. Plantations may be started from seed or from seedling trees.

Bur oak *(Quercus macrocarpa)* is native in the eastern two-thirds of the state. This tree occurs on deep, fertile soil near streams and also on the upland. The growth rate is good on fertile moist soils and the trees reach a large size under favorable conditions. Heavy seed crops are produced frequently. Squirrels and

other small animals feed on the acorns. The wood is hard and strong. It has many uses and logs of good quality are readily marketed. Plantations can be started with seedlings or with seed. Bur oak is a very drought-resistant, tree and the best oak for woodlot planting in Kansas.

Red oak *(Quercus borealis maxima)* is a native tree in the eastern part of the state. It reaches a large size and develops a straight trunk suitable for saw logs when grown in woodlots. Red oak is less drought resistant than bur oak and should be planted only on fertile soils in the eastern one-half of the state. The wood is hard, heavy, and strong. It is adapted for furniture, flooring, beams, bridge planks, posts, and railroad ties. Red oak is well adapted for planting in mixture with black walnut. Plantations may be started from seed or seedling trees. The acorns are eaten by many animals.

Black locust *(Robinia pseudoacacia)* is not native in Kansas. It is a medium-sized tree and develops a straight form in plantations. The growth rate is very rapid in early life. This tree is especially adapted for planting in gullies to reduce erosion and for planting on sandy soils. Trees that grow slowly or those planted in the open are subject to damage by the locust borer. This type of injury is reduced by spacing the trees close enough to shade the stems. Black locust wood is strong and durable in the soil and for this reason it is one of the best fence-post trees. Thickets of locust which develop from sprouts of older trees provide good cover for quail and rabbits.

Hardy catalpa *(Catalpa speciosa)* is not native in Kansas, but it is planted extensively in the eastern two-thirds of the state for the production of fence posts. Catalpa is a medium-sized tree at maturity, and the rate of growth is rapid in early life. This tree should be planted on deep, fertile soils or deep, sandy soils, as it does not thrive when planted on hard, upland soils. The wood is moderately hard and, when properly seasoned, durable in contact with the soil. The principal use of catalpa wood is for fence posts, poles, stakes, and fuel. Hardy catalpa is not generally seriously damaged by insects and disease in Kansas. In certain sections, rabbits damage young plantations severely. In the northern part of the state new growth is occasionally frozen back by late spring or early fall frosts.

Green ash *(Fraxinus pennsylvanica lanceolata)* is native in the eastern part of the state and is found along some of the streams in western Kansas. This ash is a medium-sized tree at maturity. The rate of growth is slow, but the tree is very drought resistant even on hard, upland soils. It is one of the better woodlot trees for planting on upland in the western one-half of the state. The wood is hard and strong. Since the trees are usually small, the wood is used chiefly for posts or fuel. A number of wood-boring insects damage the older trees severely in drought periods.

White ash *(Fraxinus americana)* is native in the eastern part of the state on moist soils. It is adapted for moist or wet soils such as are found near streams. White ash attains a large size on good soils and develops a good form under woodlot conditions. The wood is hard, strong, and used for tool handles, and in the manufacture of a large number of small articles.

Hackberry *(Celtis occidentalis)* occurs in native woodlands throughout a large part of the state. It makes a moderate rate of growth and reaches a large size under favorable conditions. The best growth is on deep, fertile soils, but hackberry will succeed on the less fertile upland soils. It withstands drought more successfully than most of the other native trees. The wood is moderately hard and strong. The principal uses of hackberry wood are for lumber, posts, and fuel. The berries of this tree are retained late in the winter and are eaten by birds.

Honey locust *(Gleditsia triacanthos)* is a medium-sized tree native in the eastern part of the state. It grows rapidly in early life and is very resistant to insects and disease. It will grow on unfavorable soils and is drought resistant. Honey locust can be planted for woodlots to best advantage in the western one-half of the state. The wood is moderately hard and strong. When properly seasoned, the heartwood is durable in contact with the soil.

Osage orange *(Toxylon pomiferum)* is a small tree native to Arkansas, Oklahoma, and Texas. It was planted extensively in Kansas for hedge fences before the introduction of barbed wire for fence construction. Osage orange is hardy even on thin soils and in general survives drought conditions satisfactorily. The wood is hard and strong and the most resistant of the adapted woods for fence posts. Osage orange can be planted to advantage in the central and western sections of the state for post production. The wood is also excellent for fuel. Squirrels eat the seeds which are borne within the so-called "hedge apples." Osage orange plantations provide excellent protection for quail and other birds.

Mulberry *(Morus alba).* This mulberry is a tree of medium size that is commonly planted for the production of fence posts, fuel, hedges, and for windbreaks. It makes the best development in the south central part of the state. The root system is widespreading and the tree is moderately drought resistant even on these soils. The heartwood is hard, strong, and durable in the soil. Straight trees can be worked into good fence posts. Trees in plantations for post production should be closely spaced in order to bring about the development of straight stems. Mulberry fruit is excellent food for birds.

TABLE 4.—A PARTIAL LIST OF FOREST TREES FOR KANSAS FARM PLANTING

COMMON NAME.	Botanical name.	Height (feet).	*Area:					
	Evergreens		1,	2,	3,	4,	5,	6
Rocky mountain red cedar,	Juniperus scopulorum	20–30	×	×	×	×	×	×
Eastern red cedar	Juniperus virginiana	30–40	×	×	×	×	×	×
Austrian pine	Pinus nigra	50–65	×	×	×	×	×	×
Western yellow pine	Pinus ponderosa	50–70	×	×	×	×	×	×
Scotch pine	Pinus sylvestris	50–65	×	×	×	—	—	—
Douglas fir	Pseudotsuga taxifolia	50–60	×	—	—	—	—	—
Chinese arborvitae	Thuja orientalis	20–30	×	×	×	×	—	—
	Broad-leaved Trees							
Sugar maple	Acer saccharum	60–80	×	×	—	—	—	—
Silver maple	Acer saccharinum	60–80	×	×	×	×	—	—
Hardy catalpa	Catalpa speciosa	30–40	—	×	×	×	—	—
Hackberry	Celtis occidentalis	40–50	×	×	×	×	×	×
Redbud	Cercis canadensis	10–30	×	×	×	×	×	×
Persimmon	Diospyros virginiana	25–30	×	×	×	×	—	—
Russian olive	Elaeaganus angustifolia	15–30	×	×	×	×	×	×
White ash	Fraxinus americana	50–65	×	×	×	×	—	—
Green ash	Fraxinus pennsylvanica lanceolata	30–60	—	—	×	×	×	×
Honey locust	Gleditsia triacanthos	30–50	×	×	×	×	×	×
Kentucky coffee tree	Gymnocladus dioicus	30–40	×	×	×	×	—	—
Shellbark hickory	Hicoria laciniosa	60–80	×	×	×	×	—	—
Shagbark hickory	Hicoria ovata	50–80	×	×	×	×	—	—
Pecan	Hicoria pecan	40–65	×	×	—	×	—	—
Black walnut	Juglans nigra	50–80	×	×	×	×	—	—
Mulberry	Morus alba	20–30	×	×	×	×	×	×
Sycamore	Platanus occidentalis	50–80	×	×	×	×	—	—
Cottonwood	Populus deltoides	65–100	×	×	×	×	×	×
Lombardy poplar	Populus nigra var. italica	50–80	×	×	—	—	—	—
Apricot	Prunus armeniaca	15–30	—	—	×	×	×	×
Wild plum	Prunus americana	15–30	×	×	×	×	×	×
Black cherry	Prunus serotina	30–50	×	×	—	—	—	—
Choke cherry	Prunus virginiana	15–25	×	×	×	×	×	×
White oak	Quercus alba	50–85	×	×	×	×	—	—
Red oak	Quercus borealis maxima	50–80	×	×	×	×	—	—
Shingle oak	Quercus imbricaria	40–50	×	×	×	—	—	—
Bur oak	Quercus macrocarpa	40–80	×	×	×	×	—	—
Pin oak	Quercus palustris	40–50	×	×	×	×	—	—
Black oak	Quercus velutina	40–80	×	×	×	×	—	—
Black locust	Robinia pseudoacacia	25–40	×	×	×	×	×	×
Osage orange	Toxylon pomiferum	25–30	×	×	×	×	—	×
American elm	Ulmus americana	40–65	×	×	×	×	×	×
Slippery elm	Ulmus fulva	30–50	×	×	×	×	—	—
Chinese elm	Ulmus pumila	35–50	—	—	×	×	×	×
Black willow	Salix nigra	20–30	×	×	×	×	×	×

*Areas refer to those shown on map in figure 11.

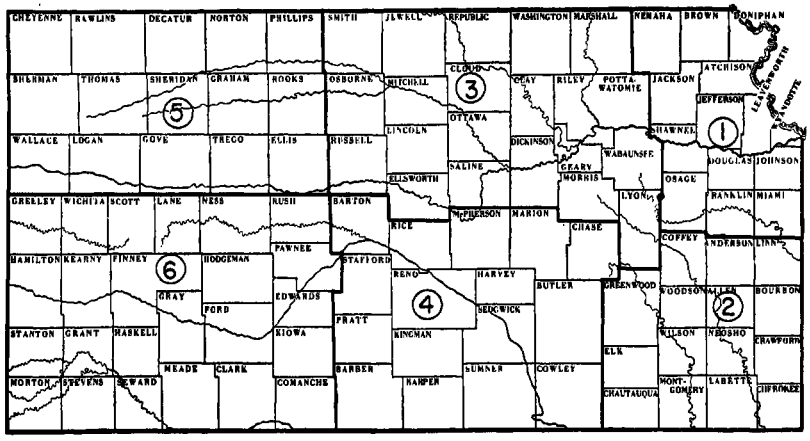

FIG. 11.—Planting areas for forest trees

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