

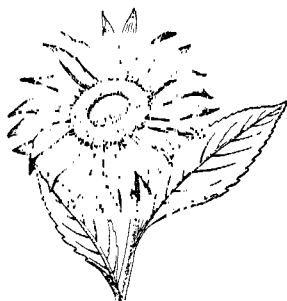
# AGRICULTURAL EXPERIMENT STATION

KANSAS STATE COLLEGE OF AGRICULTURE  
AND APPLIED SCIENCE

MANHATTAN, KANSAS

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## WOODLANDS OF KANSAS



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# WOODLANDS OF KANSAS'

E. R. WARE<sup>2</sup> AND LLOYD F. SMITH<sup>3</sup>

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## PURPOSE OF THE STUDY

Kansas never was a forest state. Even in the early days before white settlement, forests covered only about 4,480,000 acres,<sup>4</sup> or 8.5 percent, of its present land area. Today only 1,073,000 acres of natural forests remain. Clearing of timberland for agriculture has been offset only slightly by the establishment of 165,000 acres of forest plantings on farms and by the spread of natural timber to some stream borders and slopes formerly untimbered. Only 2.4 percent of the state's total area is now forested.

For both climatic and economic reasons, Kansas could never become self-sufficient as regards lumber and heavy construction timbers. The forests of the state contribute only six percent of its present lumber requirements; the remaining 94 percent is imported from the timber regions of the West and South. The only forest products that could be supplied entirely from forests of the state are fuel wood and fence posts. Yet the financial value of the products harvested is not insignificant, amounting on an average to \$4,600,000 a year.

The greatest value of Kansas forests lies not in financial returns from timber utilization, but in protection to field crops and in making living conditions more comfortable on farms. It has been demonstrated over and over that, under certain conditions, belts of timber protecting fields from severe winds increase the yield of field crops and at times avert crop failures. On areas having sandy soils, forest plantings check blowing and drifting. Like contour tillage and strip cropping on sloping farmland, trees are necessary on steep hillsides and along stream banks to prevent surface soil from washing and drainage channels from becoming gullies. In nature, this rôle has been assigned to trees. At the same time, trees serve as a haven for the diminishing wildlife population. Trees suitably located in relation to farm dwellings add to the comfort of the occupants by sheltering them from wind and sun; in addition, they afford intangible social values that contribute greatly to human happiness. Forest plantations, therefore, are intimately interwoven with farm life in the state and must be considered an integral part of farm economy.

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1. Contribution No. 152 from the Department of Horticulture, Kansas Agricultural Experiment Station. In cooperation with the Lake States Forest Experiment Station, Forest Service, United States Department of Agriculture.

2. Late Associate Forester, Rocky Mountain Region, United States Forest Service.

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4. American Forests and Forest Products, p. 6. United States Department of Agriculture, Forest Service, Statistical Bul. 21. 1937.

The drought of recent years has focused attention as nothing ever did before on the protective value of shelterbelts. In 1934, the federal government inaugurated as a drought-relief measure the Prairie States forestry project, under which 5,000 acres were planted to trees in Kansas prior to January 1, 1937.<sup>5</sup> In connection with this project, and as a part of the national forest survey authorized by congress in 1928, a forest survey of Kansas was made in 1937, not so much for the purpose of determining the timber resources of the state as to determine the proper relation of farm forestry to other features of farm management. The survey was made by the Kansas State College in cooperation with the Forest Service, United States Department of Agriculture. The results are presented in this bulletin.

### HOW THE SURVEY WAS MADE

In the forest survey of Kansas, the field work was divided into four phases: (1) Inventory of natural timber; (2) inventory of tree plantations; (3) study of forest growth; and (4) study of timber utilization and depletion. The work was done by a crew of ten men with one supervisor. A sampling method was used whereby every fourth township on parallel lines run at intervals of 24 miles was studied. The aggregate area sampled was 3,492,560 acres, or 6.67 percent of the state's total land area.

Natural timber was sampled by taking a one-fifth-acre plot for every 20 acres of timber in the townships examined. Lines were run in cardinal directions and plots spaced two chains apart. For each plot the cover type and site quality were recorded and trees were tallied by species, diameter class, and condition. Additional information obtained included age of stand, character of ground cover, and whether grazed or ungrazed. Merchantable heights of sample trees on each plot were measured with a hypsometer. Special crews collected stem and top measurements on current logging operations for use in volume-table construction. Grade-of-log studies were made in connection with this work.

All plantings of 50 or more trees on farms in the sample townships were studied in detail. The data taken for each included purpose, size, age, condition, soil type, watertable level, topography, ground cover, quantity of wood products harvested, and additional plantings needed on the same farm. In the eastern two-thirds of the state, all trees in every fifth plantation were tallied by species and diameter class, and by condition; in the western third, the trees in every plantation were thus recorded. Measurements of sample trees in each plantation were made and recorded for use in constructing volume tables.

Growth was studied in the sampled townships of the eastern third of the state, in connection with the inventory of natural stands. Borings were made in trees selected at random, and measurements

5. An additional 18,111 acres have been planted up to January 1, 1939, and a total of 13,528,521 trees have been set out in Kansas under the project.

were taken of the width of the annual growth rings for the preceding ten years.

Information on utilization of wood on farms was obtained directly from farmers; sawmills utilization data were obtained from county agents and from mill operators. Estimates of consumption of lumber and other forest products in construction, in factories, and otherwise, grew out of a nation-wide study based on a canvass of selected counties.

### EARLY SETTLEMENT AND BEGINNINGS OF FORESTRY

Because of a general belief that only forest land could be farmed successfully, the timber-covered alluvial valleys of the rivers were the first lands in Kansas to be settled; and a large proportion of this class of land was cleared of its timber. Wood for the construction of houses and fences, and for fuel, was indispensable to the early settlers.

As unoccupied valley land became increasingly scarce or impossible to obtain, the late arrivals were forced to settle on the prairie. Early trials demonstrated that the upland regions could be farmed. Adoption of the windmill to provide domestic and stock water, the invention of barbed wire to solve fencing problems, and the introduction of rapid transportation by railroads all aided materially in the swift conquest of the prairie by settlers.

The immigrants who settled in Kansas were for the most part American-born white citizens, and the foreign-born settlers were chiefly natives of the countries of northwestern Europe. It can readily be understood that settlers who came from the well-timbered states to the east or from the forest-minded countries of northern Europe had a strong desire to grow trees. In addition, the federal and Kansas governments encouraged tree planting.

In 1865, the Kansas legislature passed an act providing a bounty of 50 cents an acre for any person who planted and cultivated five or more acres of trees, to be paid annually out of the treasury of the county in which the planting was located, for a term of twenty-five years beginning two years after the trees were planted. On March 2, 1868, an amendment, to this law raised the bounty to two dollars per acre, and also provided a bounty of two dollars for each half mile of trees planted not more than a rod apart along any public highway and cultivated and protected for three years. A later amendment, in 1872, required that the plantation included at least 160 trees to the acre, and allowed bounty payments beginning with 1872 to continue twenty-five years. This act was repealed in 1874.

The timber culture act, passed by congress in 1873, provided that a person could obtain title to 160 acres of land by planting 40 acres of it with trees spaced not more than 12 feet apart. An 1878 amendment reduced the area required to be planted from 40 to 10 acres. It was after this amendment that most of the entries under this law

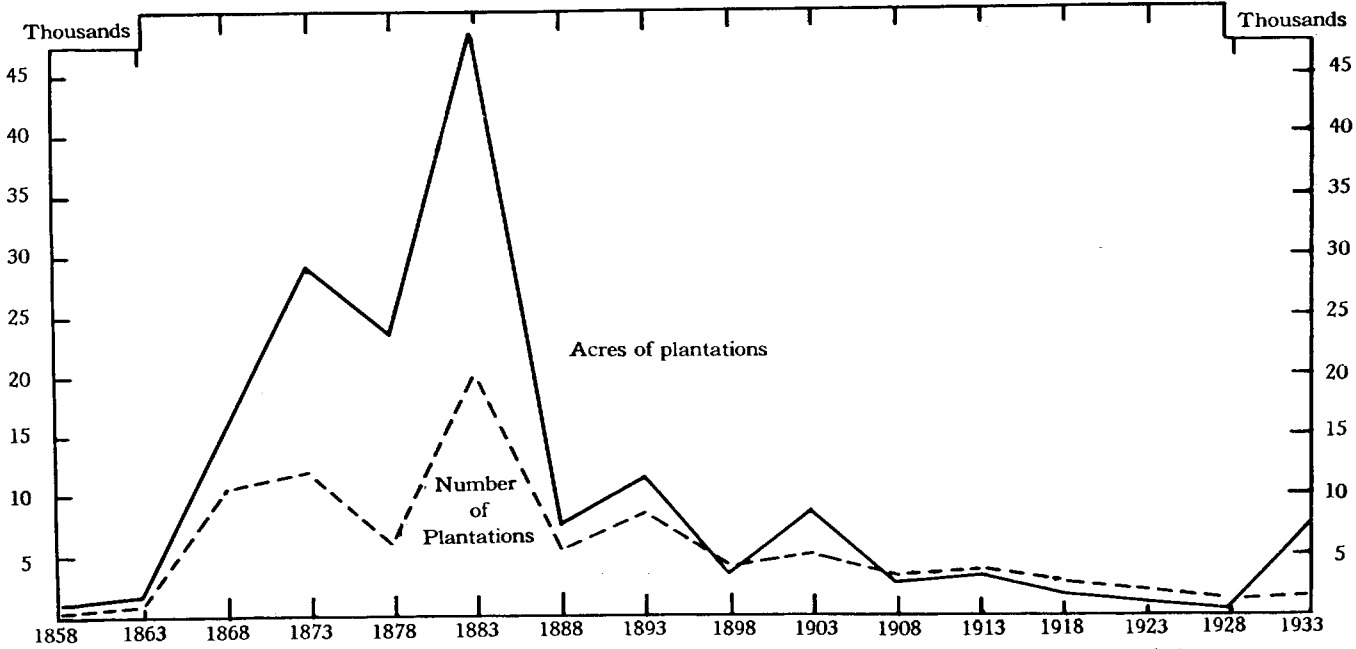


FIG. 1.—Progress of forest planting showing number and acreage of plantations by five-year periods.

were made. The timber culture act was repealed in 1891. In all, 2,005,831 acres of land were patented in Kansas under this act.<sup>6</sup> The survey has shown that one-eighth of the original "tree claim" plantings are still in evidence on the ground and that one-twentieth of the original planted acreage remains forested.

Settlement of the open prairie, whether under provisions of the homestead act, the timber culture act, or other acts, or by outright purchase, created a general if not united movement, in Kansas for tree planting. By 1908, a total of 175,023 acres had been planted to trees.<sup>7</sup> This is slightly in excess of the present acreage of planted trees; planting since that time has about maintained the acreage against inroads made by old age and drought, and losses due to lack of care.

Figure 1 shows the trend of tree planting in Kansas. Of the plantations now existing, 75 percent by acreage and 58 percent by number were established prior to 1888. The earlier plantations contained, on the average, several acres each. Since 1908, new plantations have averaged less than one acre, with the exception of the recently planted shelterbelt strips, which have averaged eight acres.

The state has cooperated with the United States Department of Agriculture in distributing forest-tree planting stock since 1928, under an agreement authorized by the Clarke-McNary act of 1924. This act authorizes the federal government to contribute a portion of the funds required to grow or purchase and distribute forest trees adapted for farm planting. The remainder of the expense incurred under such an agreement is borne by the state. Forest-tree seedlings suitable for farm woodlands and windbreaks are distributed by the Fort Hays Branch Experiment Station, at Hays, Kan. In 1928, the year in which state distribution began, approximately 10,000 trees were planted under this program. The demand has increased steadily since that year, and in 1937 a total of 310,000 trees were distributed. Some of the trees are produced in state nurseries and the remainder are procured from federal or commercial nurseries.

By 1936, the entire forested area of Kansas was approximately 1,238,000 acres, or 2.4 percent of the state's total area. This represents about two-thirds of an acre per capita. How Kansas ranked among the four northern Plain States as to forest acreage in 1936 is indicated by the following tabulation:

State.	Acre.
South Dakota .....	1,709,020 <sup>8</sup>
Kansas .....	1,238,000 <sup>9</sup>
Nebraska .....	934,327 <sup>9</sup>
North Dakota .....	575,435 <sup>9</sup>

6. Hibbard, B. H. *A History of Public Land Policies*, p. 422. New York, 1924.  
 7. Peck, A. S. *Forest Planting*, Senate Document, Vol. II, 60th Congress, 1909.  
 8. Ware, E. R. *Forests of South Dakota, Their Economic Importance and Possibilities*. U. S. Dept. Agr., Lake States Forest Expt. Sta. 1936.  
 9. U. S. Census of Agriculture, 1935, and U. S. Forest Service records of Prairie States forestry project. Areas planted under this project by January 1, 1937, totaled approximately 5,000 acres.



Kansas had one acre of forested land for every 13 acres of such land in Michigan, and for every 16 acres in Minnesota. The state's saw-timber volume was one-tenth that of Michigan.

Of the whole area in Kansas in 1936, 87 percent was naturally forested and 13 percent in plantations. (Table I.) The natural woodlands contained 94 percent of the total timber volume.

TABLE I.—AREA AND VOLUME OF TIMBER IN KANSAS IN 1936

FORESTS.	Area.		Volume.	
	Acres.	Percent.	M cu. ft.	Percent.
Natural.....	1,073,000	87	1,332,080	94
Planted.....	165,000	13	78,840	6
Totals*.....	1,238,000	100	1,410,920	100

\* Includes about 5,000 acres planted under the Prairie States forestry project.

### NATURAL FORESTS

The natural forests of Kansas, with the exception of small areas of red cedar, are composed entirely of hardwood trees. In the more humid eastern part of the state, the main drainage channels have broad bottom lands subject to annual overflow. Under natural conditions these rich, alluvial bottom lands support timber that is of the highest quality and has the largest volume per acre of any in the state. From east to west the forest growth becomes more and more closely confined to river valleys and stream banks, until along the western boundary it practically disappears. The eastern third of the state contains 75 percent of the naturally forested area; the central third, 21 percent, and the western third, 4 percent.

Moisture is undoubtedly the chief factor determining occurrence of natural forests in Kansas. The eastern third of the state receives from 30 to 42 inches of rainfall per year, the southeastern corner receiving the greatest quantity. Annual rainfall decreases uniformly to the west, ranging from 22 to 30 inches in the central third and averaging as low as 15 inches along the western boundary. The length of the growing season is favorable to tree growth throughout the state. It varies from more than 186 days in the southeastern part to 154 days in the northwestern corner.

### FOREST COVER TYPES

There are many different combinations of species in the hardwood forests of Kansas. Three distinct cover types have been recognized in the forest survey: Mixed hardwoods, cottonwoods, and blackjack post oak.

The mixed-hardwood type occupies 904,000 acres, or 84 percent of the forest area (Table II). It is a general mixture of broadleaf

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species, chief among which are American elm, slippery elm, hackberry, green ash, black walnut, bur oak, red oak, chinquapin oak, hickories, and cottonwoods. This type is found throughout the state, occurring on bottom lands, on terraces, and on upland ridges and hillsides. The species vary considerably according to geographic location and site quality. Some of the species, such as cottonwoods, American elm, green ash, and hackberries, are found throughout the state. On the other hand, many, such as the hickories and some oaks, occur only in the eastern half, and a few are restricted to the counties along the eastern border or to those in the southeastern corner. Bur oak is found generally over the state under a wide range of soil conditions, and it often predominates in stands on ridges and steep hillsides. Slippery elm is found throughout most of the eastern half of the state; it occurs most commonly along streams where there is a good supply of soil moisture.

TABLE II.—AREA OF FOREST COVER TYPES IN KANSAS IN 1936, BY SIZE CLASS OF STAND

FOREST COVER TYPE.	Extent of stands of indicated class.					
	Old-growth saw timber.	Second-growth saw timber.	Cord-wood.	Restock-ing.	Total.	
	Acres.	Acres.	Acres.	Acres.	Acres.	Percent.
Mixed hardwoods:						
Upland.....	53,800	19,300	126,600	20,300	220,000	20.5
Terrace.....	215,000	49,500	208,700	30,800	504,000	46.9
Bottom land.....	79,000	22,200	69,400	9,400	180,000	16.8
Totals.....	347,800	91,000	404,700	60,500	904,000	84.2
Cottonwood.....	38,700	18,700	43,600	6,000	107,000	10.0
Blackjack post oak.....			49,500	12,500	62,000	5.8
Totals.....	386,500	109,700	497,800	79,000	1,073,000	100.0
Percent.....	36.0	10.2	46.4	7.4	100.0	.....

Plates 1 and 2 show aerial view of typical mixed hardwoods in different sections of the state.

The cottonwood type, the characteristic cover on the flat, sandy bottom land of the Kansas and Arkansas rivers, occupies 107,000 acres, or 10 percent, of the total forest area. In stands of this type, cottonwoods form about 75 percent of the total number of trees. Among the other species, the most important numerically, are box-elder, mulberry, willow, American elm, green ash, and soft maple. These smaller trees occur as an understory to the tall cottonwoods. Their combined cubic volume in average saw-timber stands is only about 3 percent of the total.

The blackjack post-oak type is found chiefly on rocky soils in the southeastern part of the state, and particularly in the southern part of the Flint Hills. It occurs in small patches, scattered widely over other sections of the eastern part of the state. This type covers 62,-



—Agricultural Adjustment Administration.

PLATE 1.—Mixed hardwood type on loess soil in Doniphan county



PLATE 2.—Mixed hardwood type consisting principally of oaks in pasture ravines in Riley county.

—Agricultural Adjustment Administration.

000 acres, or 6 percent of the total forest area. For the most part it occupies upland ridges and slopes. The trees are stunted, only occasionally do they exceed eight inches in breast-height diameter, and about 90 percent of them are less than six inches in diameter. The type is notable in that the two characteristic species, on an average make up 93 percent, and blackjack oak 40 percent of the stand. In the more favorable locations other species occur in mixture, the most important of which are hickories, black walnut, red oak, hawthorn, American elm, and slippery elm.

Of the natural forests 26 percent, including the blackjack post oak and some of the mixed-hardwood stands, are on upland areas; 47 percent, all mixed hardwoods, are on terraces; and 27 percent are on bottom lands (Table II). Of those on the uplands, mixed hardwoods form 78 percent, and blackjack post oak 22 percent. The trees on the uplands grow more slowly and are smaller, on the average, than those on bottom lands and terraces. Upland forests contain only 14 percent of the total volume of saw timber in Kansas. The hardwood terraces, which are comparable to the best farming land, provide good sites for forest growth. The terrace forests contain 52 percent of the total saw-timber volume. Of the forests on bottom lands, mixed hardwoods form 63 percent and cottonwoods, 37 percent. These sites produce the most rapid growth of any of the forest lands. Bottom-land forests contain 34 percent of the saw-timber volume.

#### TIMBER SIZE AND VOLUME

Old-growth saw-timber stands in Kansas extend over 386,500 acres, or 36 percent of the state's 1,073,000 acres of naturally forested land, and second-growth saw timber occupies an additional 109,700 acres, or 10 percent (Table II). Cordwood stands occupy 497,800 acres, or 46 percent of the total; thus their extent equals that of old-growth and second-growth saw timber combined.

The fact that restocking areas make up only 8 percent of the naturally forested land in Kansas is largely attributed to two factors. First, unless the land is being cleared for farming, logging operations remove only the higher-quality trees of the most valuable species. This method of cutting materially reduces the quality of the stand, but does not greatly reduce its total volume. As a result of such cutting, one-fourth of the cubic volume in live trees of sawlog size is not merchantable as saw timber. Second, many of the species reproduce by sprouting, and stands that have been reduced in volume are quickly restored.

Of particular interest is the diameter-class distribution of trees in natural stands. When basal area per acre was calculated for each diameter class, it was found that the average natural stand in Kansas contains 22 percent of 2- to 8-inch trees, 53 percent of 10- to 16-inch trees, and 25 percent of trees having diameters of 18 inches or more (figure 2).

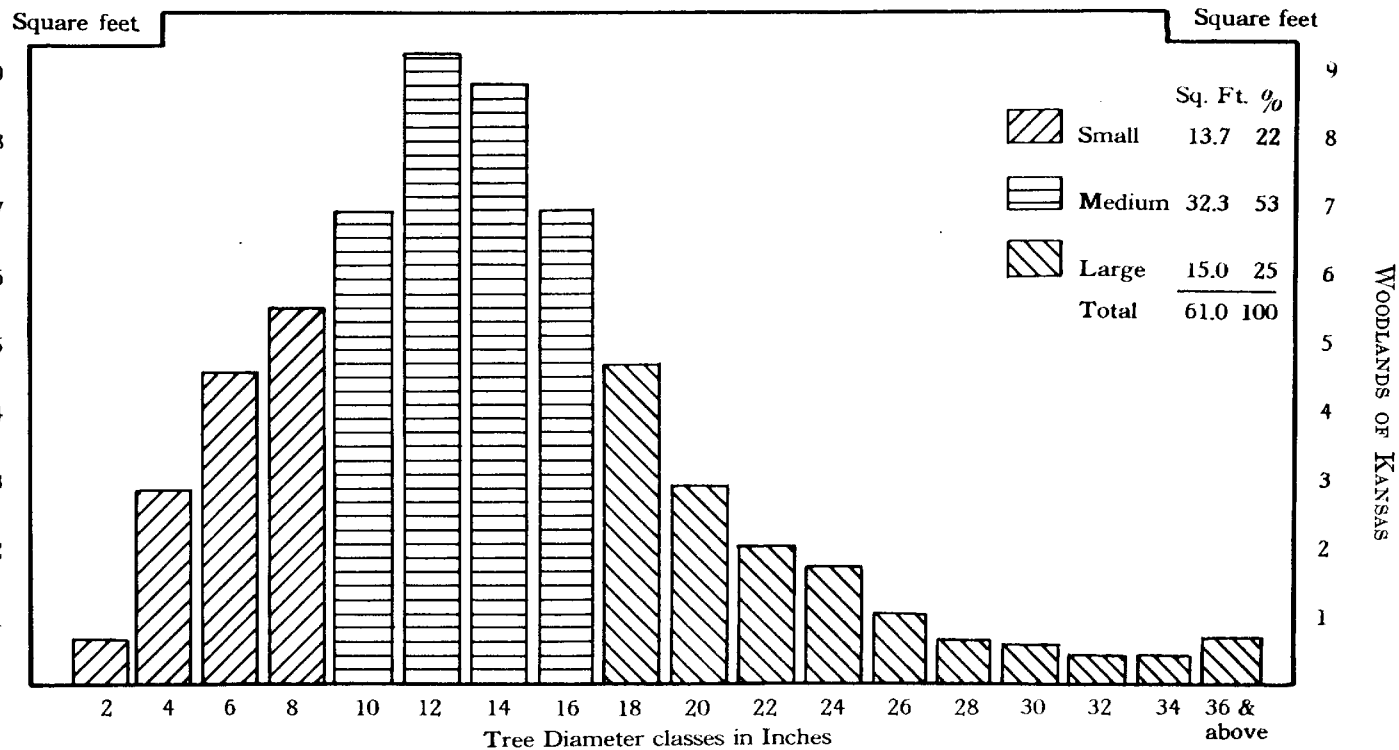


FIG. 2.—Diameter-class distribution of basal area per acre of average natural forest stand in Kansas in 1936.

**Saw Timber.**—The net total volume of saw timber in Kansas is 2,416,800,000 board feet (Table III). Five-sixths of this total is in saw-timber stands. Mixed-hardwood stands contain 2,065,360,000 board feet; cottonwood stands, 339,040,000 board feet; and black-jack post-oak stands, 12,400,000 board feet.

TABLE III.—VOLUME OF SAW TIMBER IN KANSAS IN 1936, BY FOREST COVER TYPE AND SIZE CLASS OF STAND

FOREST COVER TYPE.	Volume <sup>1</sup> in stands of indicated class.				
	Saw timber.	Cordwood.	Restocking.	Total.	
	<i>M bd. ft.</i>	<i>M bd. ft.</i>	<i>M bd. ft.</i>	<i>M bd. ft.</i>	<i>Percent.</i>
Mixed hardwoods:					
Upland .....	231,010	92,420	1,270	324,700	13.4
Terrace .....	1,084,770	178,250	1,930	1,264,950	52.4
Bottom land .....	415,040	60,060	610	475,710	19.7
Totals .....	1,730,820	330,730	3,810	2,065,360	85.5
Cottonwood .....	288,920	50,100	20	339,040	14.0
Blackjack post oak .....		12,180	220	12,400	0.5
Totals .....	2,019,740	393,010	4,050	2,416,800	100.0
Percent .....	83.6	16.2	0.2	100.0	

1. Scribner log rule.

The four leading species groups contain 79 percent of the saw-timber volume (Table IV), distributed as follows: Elms, 66,940,000 board feet, or 28 percent; cottonwoods, 507,380,000 board feet, or 21 percent; oaks, 502,570,000 board feet, or 21 percent; black walnut, 222,470,000 board feet, or 9 percent.

TABLE IV.—VOLUME OF SAW TIMBER IN KANSAS IN 1936, BY SPECIES GROUP AND SIZE CLASS OF STAND

SPECIES.	Volume in stands of indicated class.					
	Saw timber.	Cordwood.	Restocking.	Total.		
	<i>M bd. ft. Scribner.</i>	<i>M bd. ft. Scribner.</i>	<i>M bd. ft. Scribner.</i>	<i>M bd. ft. Scribner.</i>	<i>M bd. ft. Int'l.</i>	<i>Percent.</i>
Elms .....	580,600	85,335	1,005	666,940	766,980	27.6
Cottonwoods .....	447,860	59,325	195	507,380	583,490	21.0
Oaks .....	376,880	123,885	1,805	502,570	577,950	20.8
Black walnut .....	178,250	43,650	570	222,470	255,840	9.2
Hackberries .....	136,870	19,055	45	155,970	179,370	6.4
Ash .....	83,450	17,415	35	100,900	116,030	4.2
Hickories .....	31,640	7,605	125	39,370	45,280	1.6
Miscellaneous hardwoods:						
Medium value .....	139,880	22,005	55	161,940	186,230	6.7
Low value .....	44,310	14,735	215	59,260	68,150	2.5
Totals .....	2,019,740	393,010	4,050	2,416,800	2,779,320	100.0

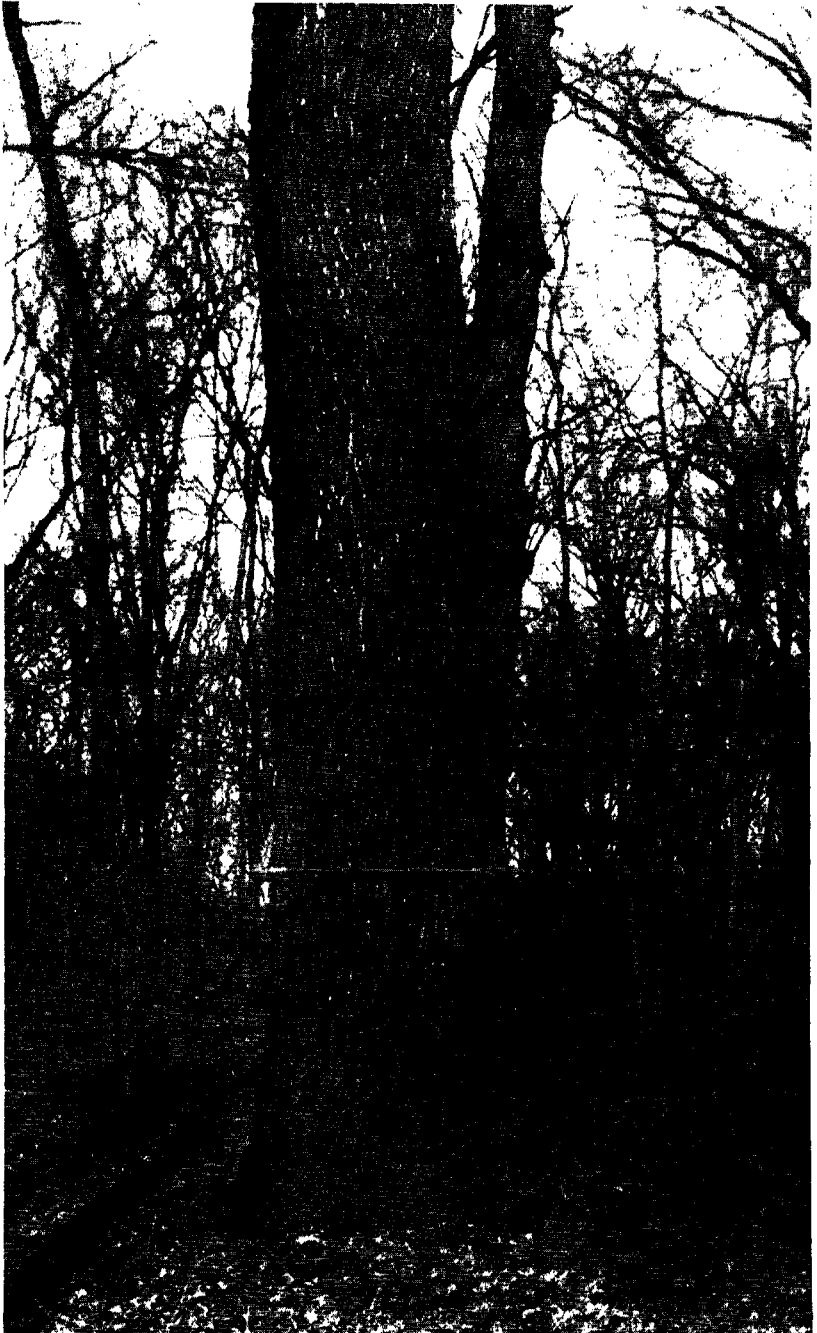


PLATE 3.—A valuable black walnut tree in a Wilson county woodlot. This tree measured 33 inches in diameter at 4.5 feet above the ground.



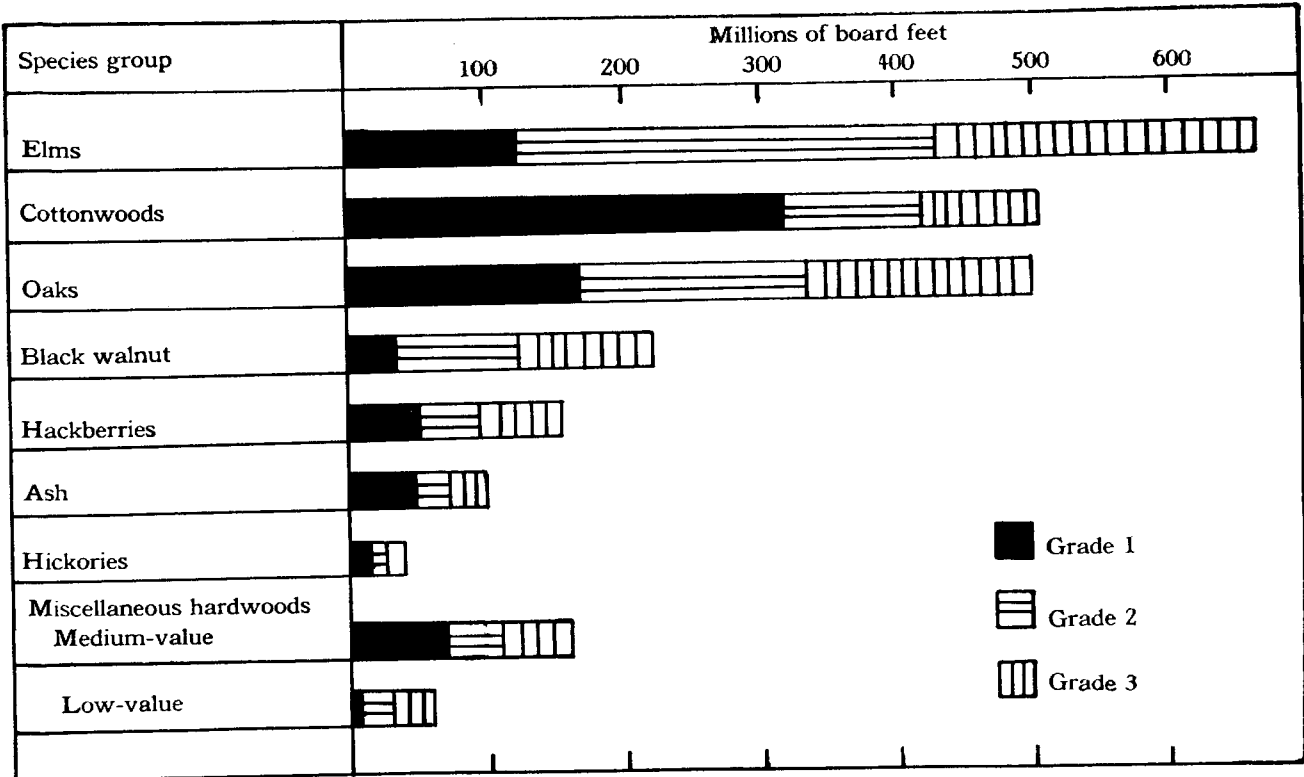


FIG. 3.—Volume of saw timber in Kansas in 1936, by species group and log grade. (The log grade distribution shown is based on values of sawlogs at logging operations in southeastern Kansas.)

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Plate 3 shows a fine specimen of black walnut in southeast Kansas. Large trees with long boles free of side branches yield a high proportion of lumber in wide boards which are the most desirable for furniture manufacture and other uses for which walnut is adapted.

Of the total saw-timber volume of all species, 35 percent is grade 1 material; 33 percent, grade 2; and 32 percent, grade 3 (fig. 3). Elms contain the largest volume of saw timber, and are followed in order by cottonwoods, oaks, and black walnut. Cottonwoods contain about twice as much grade 1 material as their nearest competitor, the oaks.

**Cordwood.**— In addition to the saw-timber volumes just stated, the natural forests of Kansas contain 12,790,000 cords of wood in live trees (Table V). Of this cordwood volume, 17 percent is composed of trees less than nine inches in breast-height diameter; 40 percent is tops and branches of saw-timber trees; and 43 percent is cull trees 9 inches or more in diameter, and cull material in merchantable trees. Saw-timber stands contain 71 percent of the total; cordwood stands, 28 percent; and restocking stands, only 1 percent.

TABLE V.—CORDWOOD VOLUME OF LIVE TREES UNSUITED FOR SAWLOGS IN NATURAL FORESTS IN KANSAS IN 1936, BY SIZE CLASS OF STAND

CLASS OF MATERIAL.	Volume in stands of indicated class.				
	Saw timber.	Cordwood.	Restocking.	Total.	
	<i>M cords.</i>	<i>M cords.</i>	<i>M cords.</i>	<i>M cords.</i>	<i>Percent.</i>
Small trees . . . . .	792	1,219	130	2,141	16.7
Tops and limbs . . . . .	4,241	887	10	5,138	40.2
Cull <sup>1</sup> . . . . .	3,992	1,497	22	5,511	43.1
Totals . . . . .	9,025	3,603	162 <sup>2</sup>	12,790	100.0

1. Includes cull trees and also cull in merchantable trees.
2. In addition, dead cordwood was estimated total 135 M. cords.

**Cubic Contents.**— The total volume of live trees in natural forests in Kansas, including both saw timber and smaller material, amounts to 1,332,080,000 cubic feet (Table VI). Saw-timber stands contain 74 percent of this total; cordwood stands, 25 percent; and restocking stands, 1 percent.

For the entire natural forest area, volume per acre averages 1,241 cubic feet; for saw-timber stands, 1,986 cubic feet; for cordwood stands, 671 cubic feet; and for restocking stands, 158 cubic feet.

Of the total volume of live trees, less than one-third, 31 percent, is saw-timber material in sound trees; 33 percent is nonsaw-timber material in sound trees; and 36 percent is cull and small trees. The proportions of saw-timber material, nonsaw-timber material, and cull and small trees are shown for individual species groups in figure 4.

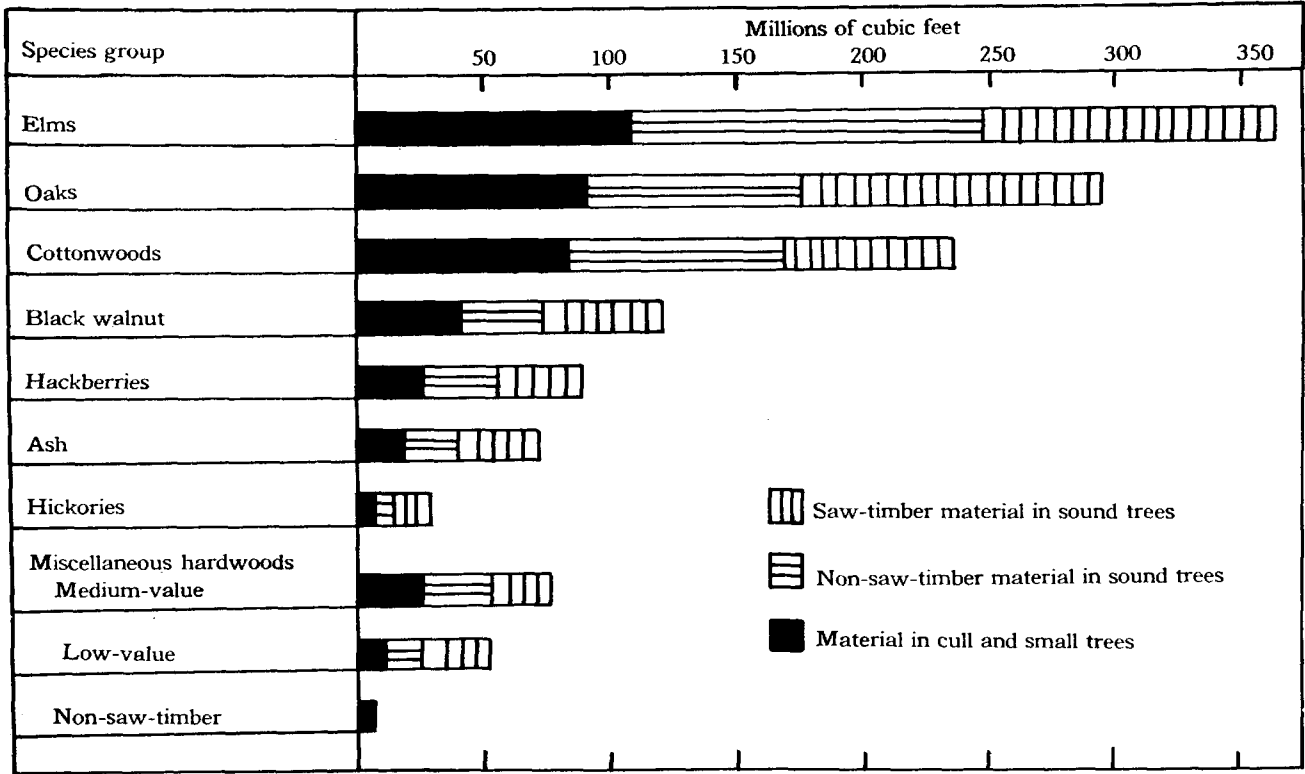


FIG. 4.—Cubic contents of live trees in natural forests in Kansas in 1936, exclusive of bark.

## WOODLANDS OF KANSAS

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TABLE VI.—TOTAL CUBIC VOLUME OF LIVE TREES IN NATURAL FORESTS IN KANSAS IN 1936, BY COVER TYPE AND SIZE CLASS OF STAND

FOREST COVER TYPE	Volume in stands of indicated class.				
	Saw timber.	Cordwood.	Restocking.	Total.	
	<i>M cu. ft.</i>	<i>M cu. ft.</i>	<i>M cu. ft.</i>	<i>M cu. ft.</i>	<i>Percent.</i>
Mixed hardwood:					
Upland.....	116,440	78,200	3,080	197,670	14.8
Terrace.....	526,700	144,620	4,630	675,950	50.8
Bottom land.....	201,520	48,450	1,420	251,390	18.9
Cottonwood.....	140,870	38,510	620	180,000	13.5
Blackjack post oak.....		24,260	2,810	27,070	2.0
Totals.....	985,530	334,040	12,510	1,332,080	100.0
Percent.....	74.0	25.1	0.9	100.0	.....

## PLANTED FORESTS

Like the natural woods, the planted timber varies greatly in different parts of Kansas. For analysis of the differences, the state has been divided into three approximately equal parts on the basis of average annual rainfall. The eastern third of the state receives an annual rainfall of between 30 and 40 inches, and has other conditions favorable to the establishment and maintenance of tree plantations. The central zone receives between 22 and 30 inches of rainfall and is reasonably favorable for tree growth. The western zone receives less than 22 inches of rainfall and, consequently, has comparatively fewer successful plantations.

Of the total 86,000 tree plantings indicated by the survey, 59 percent are field plantings and 34 percent are farmstead windbreaks; less than 6 percent were intended for timber production; and less than 1 percent protect rural school grounds (Table VII).

TABLE VII.—NUMBER AND AREA OF TREE PLANTATIONS IN KANSAS IN 1936, BY PURPOSE

PURPOSE.	Plantings.		Area.	
	Number.	Percent.	Acres.	Percent.
Field planting.....	51,020 <sup>1</sup>	59.3	123,600 <sup>2</sup>	74.9
Farmstead windbreak.....	29,500	34.3	24,600	14.9
Farm woodlot.....	4,800	5.6	16,600	10.1
Rural school-ground planting.....	680	0.8	200	0.1
Totals.....	86,000	100.0	165,000	100.0

1. Includes 620 strip plantings of the prairie states forestry project.
2. Includes 5,000 acres of prairie states forestry project plantings.

Plantings of five acres or more are exceptional, and only one planting in five contains as much as three acres (Table VIII). Since 1910, new plantations made by farmers have averaged less than one acre each. The plantations observed in the survey ranged in area from 0.04 acre to 500 acres. The weighted arithmetic mean of the areas of all plantations was 1.88 acres, and the most common size was 0.5 acre. The distribution of the plantations by width and length is shown by zones in Table IX.

TABLE VIII.—PERCENTAGE DISTRIBUTION OF TREE PLANTATIONS IN KANSAS IN 1936, BY SIZE

SIZE.	Field planting.	Farmstead windbreak.	Farm wood lot.	Rural school-ground planting.	Total.
<i>Acres.</i>	<i>Percent.</i>	<i>Percent.</i>	<i>Percent.</i>	<i>Percent.</i>	<i>Percent.</i>
Less than 1.....	29.0	76.0	33.0	94.0	46.0
1 to 2.....	25.0	17.5	19.0	3.0	22.0
2 to 3.....	17.0	3.0	12.0	3.0	12.0
3 to 5.....	17.0	2.0	14.0	.....	11.0
5 to 10.....	10.5	1.0	16.0	.....	8.0
More than 10.....	1.5	0.5	6.0	.....	1.0
Totals.....	100.0	100.0	100.0	100.0	100.0

Kansas has an average of one tree plantation for every two farms. There is one acre of planted trees for every 170 acres of cropland, or one for every 290 acres of farm land.

Of all the trees now existing in forest plantations in Kansas, 93 percent were grown from planting stock or seed that originated within the state; 64 percent of these were grown from nursery seedlings, 22 percent from wild seedlings, and 14 percent by direct seeding.

TABLE IX.—AVERAGE WIDTH, LENGTH, AND AREA OF TREE PLANTATIONS IN KANSAS IN 1936

ITEM.	Field plantings, <sup>1</sup> by zone.				Farmstead windbreaks, by zone.				Farm wood lots, by zone.			
	Eastern.	Central.	Western.	State average.	Eastern.	Central.	Western.	State average.	Eastern.	Central.	Western.	State average.
Width..... rods	1.30	1.60	2.00	1.40	3.50	3.50	3.70	3.50	9.10	13.10	10.00	11.30
Length..... rods	228.00	233.00	86.00	228.00	26.00	25.00	21.00	25.00	31.70	31.70	39.90	33.60
Area..... acres	2.41	2.35	0.84	2.38	0.74	0.88	0.95	0.84	2.38	4.50	3.41	3.66

1. Shelterbelt plantings of the prairie states forestry project average 8 acres in area.

FIELD PLANTINGS

Approximately 51,000 field plantings (including hedgerows) have been planted on 50,500 Kansas farms. Field plantings are in existence on 29 percent of all the farms in the state. They are unequally distributed; 40 percent of the farms in the eastern zone have field plantings, 24 percent of those in the central zone, but only 2 percent of those in the western zone (Table X). The average field planting has an area of 2.38 acres and contains 11.9 cords, or 857 cubic feet, of wood.

TABLE X.—NUMBER OF TREE PLANTATIONS<sup>1</sup> ON FARMS IN KANSAS IN 1936

PURPOSE.	Eastern zone.		Central zone.		Western zone.		Total.	
	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.
Field shelterbelt . . . . .	35,800	70.2	14,800	29.0	420	0.8	51,020	100.0
Farmstead windbreak . . . . .	11,000	37.3	15,400	52.2	3,100	10.5	29,500	100.0
Farm woodlots . . . . .	1,300	27.1	2,500	52.1	1,000	20.8	4,800	100.0
Totals . . . . .	48,100	56.4	32,700	38.3	4,520	5.3	85,320	100.0

1. Field plantings include 620 plantations of the prairie states forestry project. The 680 tree plantations on rural school grounds are not included in this table.

Altogether, the shelterbelts have a length of 41,600 miles (Table XI). Of this total, Osage orange hedgerows compose 39,400 miles, or about 95 percent. The latter figure includes 1,200 miles of clipped

TABLE XI.—LENGTH OF PLANTED FIELD PLANTINGS IN KANSAS IN 1936, BY SPECIES

SPECIES. <sup>1</sup>	Length of shelterbelts.	
	Miles.	Percent.
Osage orange . . . . .	39,400	94.7
Cottonwood . . . . .	700	1.7
Mulberry . . . . .	490	1.2
Catalpa . . . . .	400	1.0
Black walnut . . . . .	200	0.5
Black locust . . . . .	80	0.2
Honey locust . . . . .	50	0.1
Green ash . . . . .	50	0.1
Other <sup>2</sup> . . . . .	230	0.5
Totals . . . . .	41,600	100.0

1. Plantings of mixed species were listed as of the predominating species.

2. Silver maple, red cedar, American elm, sugar maple, boxelder, hackberry, Russian olive, sweetgum, red elm, ponderosa pine, Chinese elm, bur oak (listed in order of numerical importance).

hedges. The most common length is one-half mile; lengths of one-quarter mile, one mile, three-quarters of a mile, and one and one-half miles are the next most frequent, in the order named. These common lengths are the result, of the early-day practice of planting hedgerows along section and quarter lines as a substitute for fences.

**FARMSTEAD WINDBREAKS**

Farmstead windbreaks in Kansas exist on approximately 18 percent of the farms, and number 29,500. Only one-third of the farm dwellings are protected by either natural timber or plantations. Not only are two-thirds of the farm homes unprotected by trees, but 47 percent of those with existing plantations need additional planting for adequate protection. In the eastern third of the state, 13 percent of the farms have farmstead windbreaks; in the central zone, 27 percent; and in the western zone, 13 percent. The windbreaks average 0.84 acre in area and 8.5 cords, or 612 cubic feet, in volume of wood.

The prevailing direction of severe winds differs in different parts of Kansas. Classification of farmstead windbreaks in regard to direction from farm buildings resulted as follows:

Direction	Percentage.
East .....	17
West .....	28
North .....	34
South .....	21

**FARM WOODLOTS**

Farm woodlots have been established by planting on 2.7 percent of the farms, and number 4,800. Only 1.5 percent of the farms in the eastern zone have planted woodlots, as compared with 4 percent in both the central and the western zones. The woodlots average 3.86 acres in area and 34.9 cords, or 2,513 cubic feet, in volume.

**RURAL SCHOOL PLANTINGS**

Of the 7,933 rural schools in Kansas, approximately 680 are protected by planted groves. (In addition, 350 schools are protected by natural stands of trees.) School plantings average 0.3 acres in area and 2.8 cords, or 202 cubic feet, in volume.

**VOLUME OF WOOD IN PLANTATIONS**

Table XII shows volume of planted forest trees in Kansas by species and by class of product. The total volume of live trees amounts to 74,016,000 cubic feet, or 5.5 percent of the corresponding total for natural forests. Volume per plantation averages about 917 cubic feet.



TABLE XII.—ESTIMATED VOLUME OF PLANTED FOREST TREES IN KANSAS IN 1936

SPECIES.	Saw timber, in board feet.		
	Live trees.	Dead trees.	Total.
Black walnut <sup>1</sup> .....	9,430,000	.....	9,430,000
Posts <sup>2</sup> —in pieces			
Osage orange.....	25,260,000	982,000	26,242,000
Catalpa.....	3,688,000	195,000	3,883,000
Mulberry.....	1,152,000	255,000	1,407,000
Black locust.....	674,000	60,000	734,000
Red cedar.....	673,000	2,000	675,000
Honey locust.....	172,000	74,000	246,000
Totals.....	31,619,000	1,568,000	33,187,000
Cordwood—in cords			
Cottonwood.....	220,900	14,100	235,000
Silver maple.....	34,600	8,400	43,000
Catalpa.....	19,800	900	20,700
Mulberry.....	16,800	3,600	20,400
Boxelder.....	16,600	1,100	17,700
American elm.....	16,050	650	16,700
Green ash.....	10,500	3,200	13,700
Honey locust.....	8,500	3,300	11,800
Black locust.....	10,200	800	11,000
Bur oak.....	9,680	20	9,700
Miscellaneous <sup>3</sup> .....	13,400	400	13,800
Totals.....	377,030	36,470	413,500
Tops, Limbs, and Cull—in cords			
Saw timber cull <sup>4</sup> .....	43,500	4,500	48,000
Other cull <sup>5</sup> .....	252,100	9,700	261,800
Totals.....	295,600	14,200	309,800
Total Volume—in cubic feet			
All products.....	74,016,000	4,824,000	78,840,000

1. To arrive at net board-foot volume, deductions of 8 percent for cull trees, 7 percent for scrub trees, and 45 percent for no-product trees of the 10-inch diameter class were made. In addition the board-foot volume was reduced 9.5 percent for long-butt and cull-log volume unused for saw logs and for loss in milling due to sweep, rot, shake, etc.

2. The minimum d. b. h. for posts was 4 inches. All Osage orange and red cedar trees, 75 percent of catalpa trees, 50 percent of mulberry trees, 50 percent of black locust trees, and 27 percent of honey locust trees were figured as posts.

3. Slippery elm, ailanthus, hackberry, Austrian pine, sugar maple, willow, Scotch pine, Chinese elm, Kentucky coffee tree, soapberry, Russian olive, sycamore, ponderosa pine, arborvitae, black cherry, hickory, basswood, red oak, redbud, choke cherry, and wild plum.

4. Includes volume of cull, scrub, no-product, dead, and small trees and mill loss of black walnut.

5. Includes volume of cull trees of Osage orange and red cedar not used for posts and red cedar trees of 2-inch diameter class.

SUITABILITY OF SPECIES

About 40 different species of trees were found growing in forest plantations on farms in Kansas. Of this number, six were evergreens. Many other species are used as ornamental or shade trees with more or less success when given special care or grown under favorable conditions, but have little importance for general farm planting. The records of the Kansas State Department of Agriculture and of the Kansas State Horticultural Society show that practically all eastern trees and many exotic species have been planted in the state at one time or another.<sup>10</sup>

Table XIII shows the 1936 condition of trees in forest plantings on Kansas farms and school grounds as determined in this study, for each of the 16 species most commonly used. The percentages and condition classifications are based on trees standing in 1936, not on the total number planted.

Trees found to be suitable for state-wide planting include eastern and Rocky Mountain red cedar, Austrian and ponderosa pine, bur oak, American and Chinese elm, and Russian olive. Green ash and hackberries have demonstrated their capacity to grow under the most adverse conditions; however, insect attacks have seriously affected their condition. Cottonwoods are satisfactory throughout the state on bottom-land sites and on areas having sandy soil and high water-table levels.

Osage orange, black walnut, catalpa boxelder, black locust, mulberry, silver maple, and honey locust' are satisfactory for bottom land and terraces throughout the state; in the western two-thirds of the state, their suitability for upland sites is only fair or poor.

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10. A study made by the Fort Hays Agricultural Experiment Station of the results of early plantings in western Kansas, and results of experiments made by that station to find which trees can be grown successfully in Kansas, are reported in the following bulletin: Johnson, E. W. *Hardy Trees and Shrubs for Western Kansas*. Kansas Agr. Expt. Sta. Bull. 270.

TABLE XIII.—CONDITION OF PLANTED TREES OF THE 16 MOST COMMON SPECIES ON FARMS AND RURAL SCHOOL GROUNDS IN KANSAS IN 1936

SPECIES.	Trees in plantations examined.	Live trees in plantations examined.	Average condition, by zone. <sup>1</sup>		
			Eastern.	Central.	Western.
Red cedar .....	<i>Number.</i> 4,018	<i>Percent.</i> 99	Good	Good	Good
Bur oak .....	210	99	"	Good	Good
Osage orange .....	390,167	92	Good	Fair	Poor
Russian olive .....	827	92	"	Good	Fair
American elm .....	4,984	90	Good	Good	Good
Chinese elm .....	3,088	90	Good	Good	Good
Black walnut .....	9,423	82	Good	Poor	Poor
Cottonwood .....	20,244	79	Good	Good	Good
Catalpa .....	29,573	75	Good	Fair	Fair
Hackberry .....	1,888	65	"	Fair	Fair
Boxelder .....	6,064	64	Fair	Fair	Fair
Black locust .....	36,206	64	Good	Fair	Fair
Mulberry .....	22,817	62	Fair	Fair	Poor
Silver maple .....	2,541	54	Good	Fair	Poor
Green ash .....	37,159	47	Good	Fair	Poor
Honey locust .....	28,223	46	Good	Poor	Poor

1. Boundaries of zones are shown in figure 6. Classification used is as follows: Good, at least 75 percent of trees living; fair, less than 75 percent but at least 50 percent of trees living; poor, less than 50 percent of trees living.  
2. Insufficient data.

## GROWTH, UTILIZATION, AND DEPLETION

### GROWTH<sup>11</sup>

**Growth in Natural Stands.**— Table XIV gives annual growth in board feet of the present natural forest stands in Kansas. It includes the increase in volume of trees of saw-timber size and also the growth of trees that are now below saw-timber size, but at the end of the decade 1937-1946 will be 9 inches or larger in breast-height diameter.

For the present stands, which have a saw-timber volume of 2,416, 800,000 board feet, the estimated annual growth is 94,757,000 board feet per year. Of this total growth, 67 percent is put on by saw-timber stands, 32 percent by cordwood stands, and only 1 percent by restocking stands. The average growth per acre for the entire forest area is 88 board feet; for saw-timber stands, 128 board feet; and for cordwood stands, 61 board feet.

11. The board-foot growth figures given in this report are net, necessary deductions having been made for woods cull, mill cull, and ordinary mortality.

WOODLANDS OF KANSAS

TABLE XIV.—BOARD-FOOT<sup>1</sup> VOLUME AND GROWTH OF NATURAL STANDS OF VARIOUS TYPES IN KANSAS IN 1936

Stand class and forest cover type.	Total area.	Total present volume.	Expected annual growth. <sup>2</sup>		Average per acre.	
					Present volume.	Annual growth.
Saw timber:						
Mixed hardwoods:	<i>Acres.</i>	<i>M bd. ft.</i>	<i>Percent.</i>	<i>M bd. ft.</i>	<i>Bd. ft.</i>	<i>Bd. ft.</i>
Upland . . . . .	73,100	231,010	2.72	6,272	3,160	86
Terrace . . . . .	264,500	1,084,770	2.76	29,941	4,101	113
Bottom land . . . . .	101,200	415,040	3.19	13,237	4,101	131
Cottonwood . . . . .	57,400	288,920	4.86	14,040	5,033	245
Cordwood:						
Mixed hardwoods:						
Upland . . . . .	126,600	92,420	6.12	5,659	730	45
Terrace . . . . .	208,700	178,250	7.80	13,899	854	67
Bottom land . . . . .	69,400	60,060	7.68	4,657	865	67
Cottonwood . . . . .	43,600	50,100	10.81	5,415	1,149	124
Blackjack post oak . . . . .	49,500	12,180	6.38	777	246	16
Restocking stands . . . . .	79,000	4,050	21.23	860	51	11
All stands . . . . .	1,073,000	2,416,800	3.92	94,757	2,252	88

1. Scribner log rule. 2. For the decade 1937-'46.

Approximately 10 percent of the board-foot growth shown in Table XIV consists of black walnut. Results of a special growth study of black walnut are presented in Table XV.

TABLE XV.—ANNUAL GROWTH<sup>1</sup> OF BLACK WALNUT STANDS IN KANSAS

STAND CLASS.	Expected annual growth.	
	Trees of all sizes.	Trees 15 inches and larger in d. b. h.
Saw timber . . . . .	<i>Board feet.</i> 6,699,000	<i>Board feet.</i> 2,255,000
Cordwood . . . . .	2,658,000	531,000
Restocking . . . . .	95,000	.....
Totals . . . . .	9,452,000	2,786,000

1. For the decade 1937-'46. Scribner log rule.

The total annual cubic-foot growth<sup>12</sup> of natural stands in Kansas is 50,117,000, or an average of 47 cubic feet per acre. This is shown by stand class and forest cover type in Table XVI.

**Growth in Plantations.**--Very little material of saw-timber size and quality exists in Kansas forest plantations. A few logs are obtained from cottonwood groves, but fuel wood and fence posts are

12. In computing cubic-foot growth, increment for top material (above saw logs) was included and no deduction was made for cull trees or for cull sections in merchantable trees, because this class of material is closely utilized for fuel wood.

TABLE XVI.—CUBIC VOLUME AND GROWTH OF NATURAL STANDS OF VARIOUS FOREST COVER TYPES IN KANSAS IN 1936

Stand class and forest cover type.	Total area.	Total present volume.	Total expected annual growth. <sup>1</sup>		Average per acre.	
					Present volume.	Annual growth. <sup>1</sup>
Saw timber:						
Mixed hardwoods:	<i>Acres.</i>	<i>M cu. ft.</i>	<i>Percent.</i>	<i>M cu. ft.</i>	<i>Cu. ft.</i>	<i>Cu. ft.</i>
Upland.....	73,100	116,440	2.72	3,169	1,593	43
Terrace.....	264,500	526,700	2.86	15,063	1,991	57
Bottom land.....	101,200	201,520	3.24	6,523	1,991	64
Cottonwood.....	57,400	140,870	5.02	7,069	2,454	123
Cordwood:						
Mixed hardwoods:						
Upland.....	126,600	78,200	4.57	3,576	618	28
Terrace.....	208,700	144,620	5.40	7,807	693	37
Bottom land.....	69,400	48,450	5.44	2,637	698	38
Cottonwood.....	43,600	38,510	6.97	2,686	883	62
Blackjack post oak.....	49,500	24,260	3.36	815	490	16
Restocking stands.....	79,000	12,510	6.17	772	158	10
All stands.....	1,073,000	1,332,080	3.76	50,117	1,241	47

1. For the decade 1937-'46.

the principal products cut. Growth in plantations, therefore, has been computed only in cubic feet. The forest plantations, which now have a volume of about, 78,840,000 cubic feet, are estimated to be growing at an annual rate of about 2,144,000 cubic feet. This growth rate estimate is based upon the annual growth rate of natural upland mixed-hardwood saw-timber stands, determined as 2.72 percent. It means an annual growth of about 13 cubic feet per acre.

**Potential Growth.**—The possibilities of increasing growth in the Kansas forests are indicated by the current growth rate in the stands that are now fairly well stocked. The saw-timber stands of all types are making practically twice as much board-foot growth as cordwood stands, which are less well stocked, and more than 10 times as much as restocking stands. Even the cubic-foot growth rate is from 50 to 100 percent greater in the saw-timber stands than in the cordwood stands. By improving the condition and density of the stands, annual growth of forest products in natural stands could undoubtedly be increased to 140 million board feet of saw timber, or about 75 million cubic feet of wood of all kinds.

Increased yields of fence posts and fuel wood could be provided also by establishing additional plantations and filling in blank spaces in existing plantings. Well-stocked and well-tended plantations should make five times the present meager growth of 13 cubic feet per acre.

To attain these increased yields in natural and planted stands, however, it would be necessary to allow some of the current growth to accumulate in the forest until a more satisfactory degree of stocking was attained. In other words, less than the full quantity of cur-

rent growth should be removed at the present time. This would entail some reduction in the present rate of cutting.

With their present stocking and condition, the forests of Kansas apparently could yield in the decade 1937-1946, without net depletion, about 22,000,000 board feet of mixed-hardwood lumber, 3,000,000 board feet, of black walnut timber, 7,000,000 fence posts, and 594,000 cords of fuel wood. A conservative estimate<sup>13</sup> of the total value of these products is \$4,600,000, a sum that compares favorably with the annual value of many field crops.

**TIMBER UTILIZATION AND LOSSES**

**Industrial Requirements.** — Kansas has approximately 250 sawmills. With few exceptions, these sawmills are small, portable outfits operated by farm tractors. Only two mills produce more than 1,000,000 board feet annually (Table XVII). In general, the work is seasonal. Operations begin after cool weather starts in October or November, and continue until spring. A few mills continue operations throughout the summer, mainly to supply the demand of box and basket factories. The major part of the output of these mills is lumber for the construction of farm buildings and fences.

Some of the 250 mills in Kansas supply materials to local furniture, box, and basket factories, and to local wood-working plants. Others supply materials for making products such as wagon tongues, hammer and saw handles, singletrees and doubletrees. Still others supply timbers for bridge construction and mine ties.

TABLE XVII.—SAWMILLS IN KANSAS IN 1935, BY PRODUCTION CLASS AND NUMBER OF MEN EMPLOYED

AVERAGE ANNUAL PRODUCTION (Thousands of board feet).	Mill.	Men employed.
	Number.	Number.
1,000 or more.....	2	12
100 to 1,000.....	39	196
50 to 100.....	52	205
10 to 50.....	100	352
Less than 10.....	59	158
Totals.....	252	923

All together, in 1935, these mills produced 18,000,000 board feet of lumber. In addition, 5,300,000 board feet of black-walnut logs were sold, making the 1935 cut of timber total 23,300,000 board feet. Most of the black-walnut logs are shipped either by truck or by rail to Kansas City where they are sawed into dimension stock and veneer. Some of the timber and stump cuts are shipped to wood-

13. Based on the following averages: Black walnut lumber, \$50 per M bd. ft.; other lumber, \$20 per M bd. ft.; posts, 15 cents each; cordwood, \$5 per cord.

utilization plants at St. Louis, Chicago, and other midwestern manufacturing centers. The black walnut is used chiefly for furniture, cabinet work, and interior finish. One of its special uses is for gun stocks, and part of the supply is shipped to European countries.

Table XVIII shows the 1935 lumber production by species.

TABLE XVIII.—LUMBER PRODUCTION IN KANSAS IN 1935, BY SPECIES

SPECIES.	Lumber produced.	
	<i>Board feet.</i>	<i>Percent.</i>
Oak.....	10,300,000	44
Black walnut.....	5,300,000	23
Cottonwood.....	2,600,000	11
Elm.....	2,300,000	10
Ash.....	700,000	3
Hickory.....	700,000	3
Miscellaneous.....	1,400,000	6
Totals.....	23,300,000	100

**Fuel and Fence Posts.**— Kansas produced 995,000 cords of fuel wood in 1935, including 935,000 cords from natural timber and 60,000 cords from tree plantations. A small quantity of cordwood is shipped to Kansas City packing plants for use in curing meat.

The survey has shown that 5,300,000 fence posts were produced in Kansas in 1935, from both natural and planted forests. The 3,640,000 posts cut from natural timber were chiefly of oak. Other species were used where oaks were not available. Of the 1,660,000 posts cut from plantations, approximately three-fourths were Osage orange. Others of the more important species used for posts are catalpa, honey locust, black locust, mulberry, and black walnut.

**Timber Losses.**— The forest-fire hazard in Kansas is not serious at present, although in the days of early settlement prairie fires, which some observers believe kept forests from spreading to the uplands in the eastern half of the state, were

**FIRE** a constant threat. Woods burning is not practiced as a rule, and because of the relatively low inflammability of the woods very little loss occurs from this cause. Usually, fire losses occur only in connection with land-clearing fires, with brush burning, or burning fence rows and field margins.

According to the United States Census of Agriculture of 1935, 68 percent of the woodland area in Kansas is pastured. This is probably responsible more than any other factor for the lack of natural reproduction and for the injury to small trees. In existing mixed-hardwood bottom-land and terrace stands, trees 5 inches or less in

**GRAZING** d. b. h. average only 50 per acre, and in upland stands they average only 35 per acre; in protected stands, they range from 10 to 20 times this number. Livestock grazed on woodland areas prevent normal reproduction by packing the soil,

injuring the seedlings by browsing and breakage, and in some instances consuming the seed. While the immediate effect is not so noticeable as that of fire or heavy cutting, the prevention of natural reproduction by grazing, together with its ill effect on the older trees, in time greatly depletes the stand and sometimes eliminates them.

Plate 4 shows a woodlot which has been protected from grazing. Young trees and shrubs are shown developing under the overstory of the older trees. This growth does not occur where livestock are permitted access to the woodlot.

Damage to natural timber in Kansas by insects and diseases has in general been small, there having been few outbreaks of con-  
**INSECTS** sequence. However, present cutting methods are in-  
**AND** creasing the percentage of defective trees in the stands.  
**DISEASES** Usually logging operations remove only sound trees, or hardly any of the diseased and defective trees.

Of the planted trees, green ash and honey locust have been particularly susceptible to wood borers in the central and western parts of the state. Complete defoliation of Osage orange by grasshoppers is common in heavily-infested areas. Walnut datana has defoliated black walnut and pecan over extensive areas in recent years.

The series of hot, dry seasons since 1930 has taken a heavy toll of both planted and natural timber in Kansas. Planted trees, especially in the western two-thirds of the state, have suffered greatly. **DROUGHT** Table XIX shows the condition of the planted trees in 1936 by zone. The species that appear to be most affected by drought in plantations are Osage orange, black walnut, catalpa, boxelder, black locust, mulberry, silver maple, and honey locust.

TABLE XIX.—CONDITION OF PLANTED FOREST TREES ON FARMS IN KANSAS IN 1936, BY ZONE

ZONE.	Thrifty trees.	Trees having dead top branches.	Dead trees.
	Percent.	Percent.	Percent.
Eastern.....	95	2	3
Central.....	59	23	18
Western.....	45	20	35

Although land clearing is not now being practiced on a major scale as during the period of settlement, it remains one of the chief factors in forest depletion. Most land suitable for farming has been cleared long ago, only small corners and pockets of timberland having agricultural value now being cleared. **LAND CLEARING** Clearing for grazing is done to some extent, but for this purpose the general method is to cut only the large merchantable





PLATE 4.—Protection from grazing in this woodlot has permitted the development of young growth which will replace the mature trees when they are removed.

trees, thereby opening up the stand sufficiently to permit the growth of more forage. Such opening of the stand is usually accompanied by burning of the slash and as much as possible of the shrub growth. The burning of the large brush piles severely injures or kills outright many of the trees left standing.

**Total Annual Depletion.**— Table XX summarizes the depletion of Kansas forests by cutting in the year 1935, which may be taken as typical except for the abnormally large volume of drought-killed timber cut for fuel and fence posts.

The depletion for lumber is not the entire reduction of saw-timber volume. A considerable quantity of saw-log material is taken for fuel and fence posts in some areas, and some is wasted in logging and milling. A limited quantity is killed by fire and insects, and in years such as 1935 large numbers of mature trees have died of drought. It is probable that total depletion in an average year is close to the current annual growth, or about 94,000,000 board feet.

In total cubic volume, depletion by cutting forms the greater part of the annual drain. Most drought-killed and insect-killed trees are utilized for fuel or posts. When Table XX is compared with Table XVI, it appears that annual depletion of cubic volume is half again as great as annual growth. Furthermore, a considerable share of the growth is on low-grade trees, and timber cut for lumber is chiefly of the better species; as a result, the proportion of the better timber species in the stands is diminishing.

TABLE XX.—FOREST DEPLETION BY CUTTING IN KANSAS IN 1935

ITEM.	Annual depletion, by product.			
	Lumber. <sup>1</sup>	Posts.	Fuel wood.	Total.
Natural forests:	<i>M bd. ft.</i>	<i>Number.</i>	<i>Cords.</i>	<i>Cu. ft.</i>
Live trees.....	23,300	2,190,000	700,000	59,459,500
Dead trees.....		1,450,000	235,000	14,551,500
Totals.....	23,300	3,640,000	935,000	74,011,000
Planted forests:				
Live trees.....	40	1,485,000	12,000	1,984,550
Dead trees.....		175,000	48,000	3,587,250
Totals.....	40	1,660,000	60,000	5,571,800
Totals.....	23,340	5,300,000	995,000	79,582,800

1. Values given under this heading are not the whole of the saw-timber depletion by cutting. Some saw timber is used for posts and for fuel wood.

Cutting is confined mainly to accessible and well-stocked stands, while much of the growth is on trees in scattered and inaccessible stands.

The increase of material suitable for posts is adequate to meet state requirements without depletion of the growing stock. Utilization of Osage-orange posts is only about 45 percent of the estimated growth. The existing hedgerows of Osage orange, alone, can supply 38 percent of the number of posts required.

**KANSAS' FOREST REQUIREMENTS**  
**NEED FOR FOREST PRODUCTS**

Kansas uses annually about 381 million board feet of lumber, or approximately 200 board feet per capita. The uses to which it puts this lumber have been estimated by the Forest Service as shown in Table XXI.

TABLE XXI.—ANNUAL WOOD REQUIREMENTS FOR KANSAS<sup>1</sup>

USE OR PRODUCT.	Annual requirements.	
	Board feet.	Percent.
<b>Use:</b>		
Farm construction.....	115,000,000	30.2
Urban and rural nonfarm construction.....	111,820,000	29.3
Factory use.....	50,000,000	13.1
Highways.....	8,720,000	2.3
Other public construction.....	5,700,000	1.5
Railroads <sup>2</sup> .....	32,000,000	8.4
Utilities other than buildings.....	375,000	0.1
Cross ties as lumber.....	57,500,000	15.1
<b>Totals.....</b>	<b>381,115,000</b>	<b>100.0</b>
<b>Product:</b>	<i>Number.</i>	<i>Cords.</i>
Cross ties as ties.....	1,800,000	.....
Telephone, telegraph, and power-line poles.....	63,000	.....
Posts.....	7,000,000	.....
Fuel wood.....		875,000

1. Figure for fuel-wood consumption based on survey data. All other figures estimated by Frank J. Hallauer, forest engineer, U. S. Forest Service.

2. Other than car repairs (which is included with factory) and cross ties.

Farm construction is the largest single item in lumber requirements; about 30 percent of the total goes into this use. Urban and rural nonfarm construction, factory use, and railroad cross ties are leading items. Of materials other than lumber, fuel wood and fence posts are the most important.

More wood is consumed in Kansas for fuel than for any other purpose. Each Kansas farm requires, on the average, the equivalent of approximately 12 cords of wood annually for heating and cooking. At present, the fuel wood consumed on the farms average five cords per farm year, and is supplemented with coal, oil, and gas. At five cords per farm, 875,000 cords of wood are needed annually on the farms alone. If wood fuel was used exclusively, the farms would need about 2,095,000 cords each year. About 199,000 cords of the fuel wood produced in Kansas in 1935 were used in cities of the state.

While it is not desirable to eliminate entirely the use of other kinds of fuel on farms, planting of additional groves of trees where needed and proper management of existing natural stands would make possible a great reduction in the farm fuel bill.

The zinc- and lead-mining industry in southeastern Kansas uses annually about 1,000,000 board feet of rough oak for narrow-gauge ties and rough lumber, about the same quantity of finished pine

lumber, and about 1,000 cords of fuel wood, principally oak. The pine lumber is shipped in from outside the state. About 95 percent of the oak lumber, ties, and fuel wood comes from the Ozarks in Missouri.

The coal-mining industry near Pittsburg, Kan., uses annually about 40,000 railroad ties of all sizes, practically all of which are shipped in from other states.

On the average, 30 new posts annually are used on each Kansas farm. Metal posts form about three-fourths of one percent, and stone posts one-half of one percent of the total number so used.

An undetermined quantity of small, round material is used for fence stays, garden poles, and chicken and turkey roosts.

#### NEED FOR PROTECTIVE FORESTS

Kansas has 165,000 acres of planted trees, or one acre of planted trees for every 170 acres of cropland. On the basis of a detailed study of the needs of each farm examined in the survey, it is estimated that the state should have 691,000 acres of tree plantations of all classes. This represents one acre of trees for every 39 acres of cropland. When the present acreage of planted trees is deducted, 526,000 acres remain yet to be planted by the various agencies.

In the river valleys of southeast Kansas, extensive areas of low land are subject to inundation by floods. These floods reduce the value of such land for crop farming. Removal of forest cover from river banks has tended to increase the damage during the recurrent flood periods. This land should be reforested as a measure for prevention of abnormal erosion and of floods. Some of it would have to be planted, but much would reforest naturally if grazing use were eliminated.

#### PROPOSED FOREST PROGRAM

A review of the forest situation in Kansas reveals that:

Management of either natural or planted woodlands is generally lacking.

Natural saw-timber stands in the more accessible locations are being depleted of the more valuable species, such as walnut, oak, hickory, and ash.

New tree plantations established by private initiative within the past 30 years have barely maintained the total area of established plantations.

Certain lands located in flood zones along rivers and on steep slopes, some of which are now devoted to farming and grazing, should be devoted exclusively to the growing of trees to aid in flood control and to prevent abnormal erosion.

The woodlands are divided into numerous small private tracts.

Research is needed for development of forest-management methods.

To improve the situation, a program of public forestry in Kansas should be concerned with: (1) Cooperation in management of natural woodlands, maintenance and improvement of existing tree

plantations, and development of farmstead windbreaks, field shelterbelts, and farm woodlots; (2) planting of field gullies to control soil erosion; (3) protection and development of foresty growth adjacent to streams, to aid in flood control; (4) development and management of suitable areas as state forests; (5) education of rural people to appreciate the value of forest trees; (6) establishment of a research program to provide technical information for the educational and demonstration programs. A program for rounding out the present forestry activities in the state will be outlined here.

### STATE FORESTS AND PARKS

Kansas has one state forest of 3,000 acres, located in Crawford and Cherokee counties. Most of this forest is land that was reclaimed following strip-pit coal operations. The reclamation work was done by the Civilian Conservation Corps, and consisted in leveling the surface of the ground and planting trees, chiefly walnut. The Forest Service gave technical advice and assistance. This work was suspended in 1937 owing to curtailment of CCC activities.

Adjoining the state forest is an area of approximately 12,000 acres of worked-out coal land. This land should ultimately be acquired by the state, reclaimed, and added to the forest.

Kansas has 25 state parks, totaling 14,749 acres. These parks, developed mainly for fishing, game, and recreation, contain areas that have already been planted to trees and others that should be.

### EDUCATION

Since practically all of the forest land of Kansas is in small private holdings, a program of education and field demonstration designed to reach a large number of owners is necessary. The state extension forester should direct this work, with the assistance of the county agents and the Forest Service.

### RESEARCH

In a program of research to provide technical information for the educational and demonstrational work of the Extension Service, the following subjects would take an important place:

**1. Establishment of tree plantations.**— Study of planting methods, spacing, cultivation, and species adapted to various localities and soil types.

**2. Benefits from plantations.**— Study of the protection afforded by planted trees to crops, livestock, soil, and farm homes.

**3. Woodlot management.**— Study of the costs of thinning, harvesting, and replanting, and of the economic return from harvested products, in order to determine the feasibility of devoting land to the sole purpose of wood production.

**4. Protection.**— Study of methods for controlling insects and diseases in both natural and planted stands.

**5. Utilization.**— Development of small modern wood-utilization plants to provide a market for high-quality logs that would otherwise go into low-value products. Development of methods of cutting Osage-orange hedgerows to obtain the maximum number of posts.

**6. Marketing.**— Collection of information on log markets and prices to aid timber owners in disposing of woodlot products. Study of the possibilities of cooperative marketing of woodlot products, particularly black walnut logs.

## GLOSSARY

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### FOREST COVER TYPES

**Mixed Hardwoods.** This is a mixed type in which the principal species are American elm, slippery elm, hackberry, green ash, black walnut, bur oak, red oak, chinquapin oak, hickories, and cottonwoods. Bottom-land hardwoods occur on overflow lands bordering rivers and creeks, terrace hardwoods on first and second benches, and upland hardwoods on hillsides and ridges.

**Cottonwoods.** Cottonwoods are the predominant species, composing 50 percent or more of the total volume.

**Blackjack post Oak.** Blackjack oak and post oak are the predominant species, composing 50 percent or more of the volume.

### TREE SIZES

**D. B. H. (diameter breast high) of Trees.** Diameter, outside bark, four and one-half feet from the ground.

**Two-inch Diameter Classes.** Trees ranging from one to 2.9 inches in D. B. H. are placed in the two-inch class; corresponding limits apply to the other diameter classes.

**Basal Area.** Area of a cross section of a tree stem at breast height.

### TIMBER SIZE CLASSES

**Saw-timber Stands.** Stands containing 2,000 board feet or more volume per acre in trees of saw-timber size, that is, 9 inches or more in breast-height diameter, were classified as saw-timber stands. In computing the acreage and volume of such stands, deductions were made for cull, scrub, and no-product trees and also for loss in milling. To determine the deduction factors, a special log-grade study was made in the eastern third of the state. No dead trees were included in saw-timber volume. If 50 percent or more of the volume occurred in trees 15 inches and larger in breast-height diameter, the stand was classified as old growth; if more than half of the volume occurred in trees less than 15 inches in breast-height diameter, the stand was classified as second growth.

**Cordwood Stands.** Stands containing less than 2,000 board feet of saw timber per acre, but having three cords or more per acre in trees 5 inches or larger in breast-height diameter, were classified as cordwood stands.

**Restocking Stands.** Stands containing less than 2,000 board feet of saw timber, or less than three cords of wood, per acre, were classified as restocking stands.

**Deforested Land.** Land formerly timbered but now used for purposes other than timber production was classified as deforested.

### CUBIC-VOLUME RATIOS WITHIN SPECIES GROUPS

The distribution of cubic volume among individual species in certain species groups was approximately as follows:

Elms—American, 75 percent; slippery, 25 percent.

Oaks—Bur, 45 percent; red, 22 percent; chinquapin, 12 percent; post, 8 percent; black, 6 percent; blackjack, 5 percent; pin, white, shingle, 2 percent.

Black Walnut and Black Cherry—Black walnut, 99 percent; black cherry, 1 percent.

Ash—Green, 95 percent; white, 3 percent; blue, 2 percent.

Hickories—Shellbark, 41 percent; pecan, 29 percent; bitternut, 19 percent; pignut, 9 percent; mockernut, 2 percent.

Miscellaneous Hardwoods—Medium-value saw timber: Sycamore, 37 percent; basswood, 21 percent; coffee-tree, 7 percent. Low-value saw timber: Boxelder, 48 percent; willow, 25 percent; honey locust, 15 percent; mulberry, 10 percent; black locust, 15 percent; catalpa, 0.5 percent.

### TREE CLASSES

**Merchantable Tree.** A merchantable tree is at least 9 inches in breast-height diameter and will produce a sound log at least 8 feet in length. The merchantable height is from stump to the point on the main stem where defect, deformity, or large branches make the wood unsuitable for saw logs, with further limitation to a top diameter of 8 inches inside bark. (For most trees, the top diameter was considerably greater than 8 inches.)

**Cull Tree.** A tree of less than saw-log size that will not become merchantable, owing to form, crook, knots, extreme limbiness, or other defects, was classified as a cull or scrub tree. A tree of less than saw-log size that gives promise, with additional growth, of becoming merchantable was classified as a no-product tree.

### VOLUME

**Board-Foot Volume.** Board-foot volume was computed for all merchantable trees. Allowance was made for cull in merchantable trees, including loss in milling due to sweep, rot, shake, and other factors.

**Cubic-Foot Volume.** Total cubic-foot volume included all wood, exclusive of bark, between the stump and a top diameter of 4 inches inside bark. Limb-wood larger than 4 inches, as well as the main stem, was included.

**Tops and Limbs.** Tops and limbs included the volume of the stem above saw logs in saw-timber trees, and branches 4 inches or larger in diameter inside bark.

**Small Trees.** Small trees have breast-height diameters from 1 inch to 8.9 inches.

**Cull Volume.** Cull volume includes the total cubic volume of cull trees and a fraction of the volume of merchantable trees that is allowed for woods cull and mill losses.

**Log Rule.** In computing present board-foot volume and growth, use was made of the Scribner formula for a 16-foot log with a ¼-inch saw-kerf allowance, i. e.,

$$B. M. = 0.79D^2 - (2D - 4)$$

in which D is the top diameter inside bark in inches.

### GROWTH

**Annual Growth.** Annual growth is average growth during the 10 years, 1937-1946. It represents only the short-term outlook for existing stands, and should not be taken to indicate an average long-term rate of growth. In computing cubic-foot growth, no deduction was made for cull trees or for cull in merchantable trees; in computing board-foot growth, deductions were made for both.

### LOG GRADES

**Grade 1** The log must be at least 12 feet long and 12 inches in diameter at the small end. It must be at least 80 percent sound and yield 60 percent or more of No. 1 lumber or veneer.

**Grade 2.** The log must be at least 10 feet long and 8 inches in diameter at the small end, or at least 8 feet long and 10 inches in diameter at the small end. It must be at least 75 percent sound and yield 30 percent or more No. 1



common or better lumber. A log less than 10 inches in diameter is required to be surface-clear, straight, and sound.

**Grade 3.** The log must be at least 8 feet long and 8 inches in diameter at the small end. It should be suitable for production of tie cuts or low-grade lumber.

### MISCELLANEOUS

**Cropland.** Includes cropland harvested, crop failure, and idle or fallow land.

**Farm Land.** Includes all land in farms.

**Tree Plantations** (farmstead windbreaks, field shelterbelts, planted farm woodlots, and rural school-ground plantings). Tree plantations included all planted groves of 50 trees or more. Farmstead windbreaks serve as protection to farm buildings, and field shelterbelts as protection to crops. Planted farm woodlots are used for the production of fuel wood and other wood products. Rural school-ground plantings furnish protection to buildings and ground.

**Posts.** Posts were at least 7 feet long and showed not more than a 3-inch sweep. Round posts of sufficient size were considered as two or more split posts. Posts averaged 0.75 cubic foot.

**Conversion Factors.** Board-foot volume of saw logs of all species can be converted to cubic feet by use of the ratio 1,000 board feet to 170 cubic feet. For individual species the conversion factor varies. Cord volume can be converted to cubic feet by use of the ratio, 1 cord to 72 cubic feet.

