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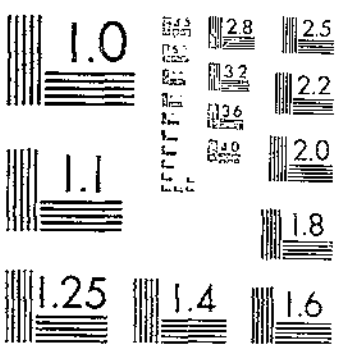

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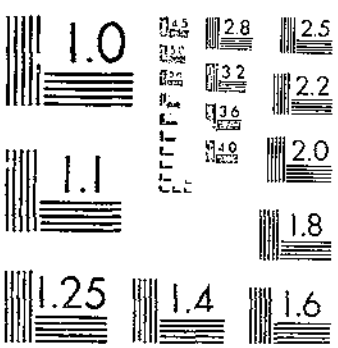

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SELECTIVE LOGGING IN THE SHORTLEAF AND LOBLOLLY PINE FORESTS OF THE GULF STATES REGION

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INTRODUCTION[3]

Selective logging is one of the surest methods of keeping most southern yellow pine lands productive and of keeping small, unprofitable trees out of the mills. It is a simple and practical step in the development of permanent or sustained-yield operations, and therefore merits the consideration of all timberland owners of the southern pine region.

Selective logging or selective cutting correlates present-day silvicultural and the economic requirements in a practical way. Such handling of forest lands may involve not only the selection of the trees to be felled but also the determination of the order in which different areas shall be logged and, sometimes, in addition the determination of the species to be cut. For stands of southern yellow

[1] Acknowledgment is made to C. V. Sweet of the Forest Products Laboratory for suggestions in planning the work and preparing the report, to A. C. Wollin, also of the laboratory, for assistance in collecting and computing the data, to E. L. Demmon of the Southern Forest Experiment Station for helpful suggestions in planning the field work and preparing the report, and to R. A. Chapman of the station for assistance in collecting the field data. Thanks are also due to D. C. Gates, Fordyce Lumber Co., Fordyce, Ark., to L. D. Gilbert, Southern Pine Lumber Co., Diboll, Tex., to T. W. Roshorough, Caddo River Lumber Co., Glenwood, Ark., and to Henry E. Hardtner, Urania Lumber Co., Urania, La., for their generous cooperation and assistance in the conduct of the investigation. The Southern Pine Association, through its officers and an advisory committee, rendered assistance in planning and carrying out the work.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[3] By E. L. Demmon, director, Southern Forest Experiment Station.

pine, however, the method will involve mostly the selection of the trees to be felled. In general it provides for the removal of the larger and older trees and the defective smaller ones, and the reservation of the thrifty small and medium-sized trees for seed production and future growth. In designating the trees to be cut, minimum diameter limits should be used merely as a guide; the primary objective from a silvicultural standpoint, should be to leave only healthy, thrifty trees. Cutting practices on private land, however, must be governed somewhat by immediate economic considerations, and the owner, to operate successfully, may have to strike a balance in his cutting plan between silvicultural desirability and economic feasibility.

Southern yellow pine grows fast on good land, and timber growing on such areas appears to offer every promise of profit. Selective cutting is recommended as a sound method of handling most shortleaf and loblolly pine lands. The information in this bulletin should be helpful to owners of southern pine forest land in setting up management plans that will result in sustained-yield operations, which in turn create stable land ownership and contribute to the industrial and social welfare of the region.

THE FORESTRY SITUATION IN THE SHORTLEAF AND LOBLOLLY PINE STANDS OF THE GULF STATES REGION

The existing forestry situation in the Gulf States is unique in that the region includes some areas presenting some of the best examples of timber growing and other areas that are completely stripped of forest growth. Although there are notable instances of good forestry practice in the region, they are few in number; in fact it is estimated that less than 7 percent of the region as a whole is under the simplest kind of forest management, such as intentionally leaving an occasional seed tree. Furthermore, not more than 1 percent of the existing stands are fully stocked with tree growth (*3*, *4*).[4] Until very recently, competing timber regions and even local industries thought that the South would cut out all its timber during the early part of the twentieth century, but within the last decade it has become increasingly evident that because of the strong, natural regenerative capacity of the southern yellow pines the region is not going to cut out for a long time, if at all, and that with fire protection and good forest management it will produce an enormous amount of wood for all time. The chances that forestry practice will be successful on shortleaf and loblolly pine areas are excellent; second-growth timber, which grew to merchantable size not because of fire protection and management but in many instances without either, now makes up nearly three fourths of the present cut, and the proportion is increasing yearly as the supply of virgin timber becomes exhausted.

The Gulf States region, as considered in this bulletin, is made up of Louisiana, Texas, Oklahoma, Arkansas, Mississippi, and Alabama; it contains about 46,800,000 acres of shortleaf-loblolly pine timberland (fig. 1). Of this area, about 2,700,000 acres are covered with virgin saw timber, 16,400,000 with second-growth saw timber, and 11,500,000 with cordwood, while 14,400,000 acres are restocking and 1,800,000 acres are deforested.

[4] Italic numbers in parentheses refer to Literature Cited, p. 53.

PURPOSE OF THE INVESTIGATION

The primary purpose of this bulletin is to present the results of selective cutting and clear cutting on typical lumber operations in shortleaf-loblolly pine areas of the Gulf States region. To get these results it was necessary to determine: (1) The costs both of logging and of milling trees of different diameters; (2) the quantity, grade, and sales value of the lumber produced from them; and (3) the gross return when different volumes of timber were removed from the stand, under selective cutting, for lumber. It has been recognized for some time that such information is needed by the lumberman who wants to

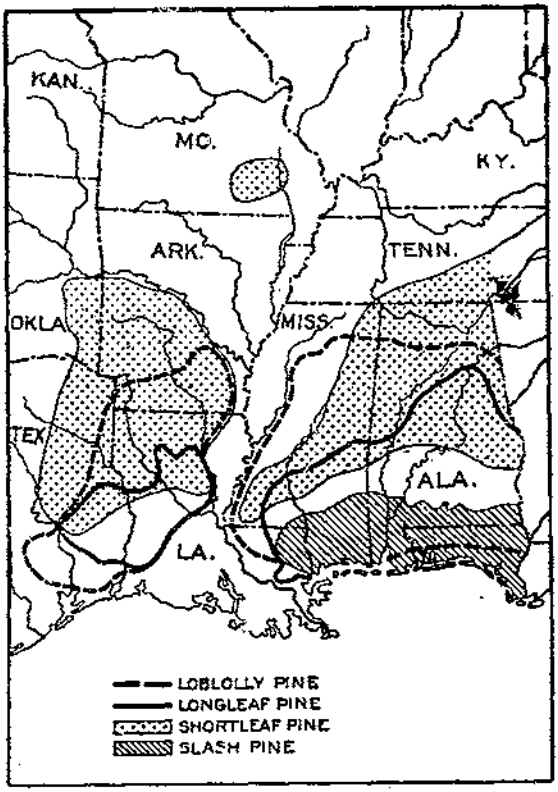

FIGURE 1.—Commercial range of the southern yellow pines in the Gulf States region.

cut out and move on, as well as by the forest-land owner who desires to handle his holdings so as to produce successive crops of timber. The information in this bulletin is intended to serve two main purposes: (1) To present, for actual going operations in southern yellow pine, the financial returns under clear cutting and under selective cutting; and (2) to provide basic data for the use of timberland owners who wish to work out selective cutting limits for their own timber.

SELECTIVE LOGGING

Selective logging, as the term is used in this bulletin, may be defined as a partial-cutting practice that, through judicious selection of the

trees to be removed, meets both silvicultural and economic requirements in such a way as to perpetuate and improve the forest and at the same time to maintain or actually increase the profits to the owner (*9*). In practical application the areas to be logged should be chosen as carefully as the individual trees, so that selective logging on a going operation calls for the proper selection of both the trees to be cut and the areas to be logged. The selection of logging areas is extremely important, particularly when selective cutting is first started on a large tract. The oldest timber, other things being equal, should be cut first.

Selective cutting, as the term is used here, does not mean a "cream-skimming" process that robs the stand of its best trees and leaves nothing but poor species or poor individuals of goods species to form the next cut. The aim should be to leave a good and thrifty stand on the ground, and this necessitates taking out poor trees along with the good ones. Hence, the first cutting under selective logging often fails to yield as high a quality as the owners expect. The practice should not be condemned on this account, however, for the poor trees must eventually be removed from the stand anyway, and with such cutting the rewards of quality and increased increment come as early as the second cut and continue from that time.

LOCATION OF THE INVESTIGATION

The investigation here reported was made at four typical, large, band-mill lumbering operations in the Gulf States region. Study no. 1 was in southern Arkansas; no. 2, in northern Louisiana; no. 3, in eastern Texas; and no. 4, on the Ouachita National Forest in the mountains of west-central Arkansas. The mills and the methods of logging at the various operations were similar and in general were representative of the region, but the timber differed, though all of it was typical of the shortleaf and loblolly pine stands of the Gulf States region.

The field work was carried on, during the latter part of 1929 and the first part of 1930, cooperatively by the Forest Products Laboratory, the Southern Forest Experiment Station, and four lumber companies that are members of the Southern Pine Association; an advisory committee from the same association assisted.

HOW THE WORK WAS DONE

In general, the same technic was used at each of the operations. At each place a representative area of timber, from 13 to 54 acres, was chosen for study. In 2 operations clear cutting was followed and at the other 2, selective cutting. The timber from these areas was studied by a crew as it passed through all the different steps of lumber manufacture. These men went into the woods and the mills and determined the output per unit of time and the cost of lumber per thousand board feet for logs and trees of different sizes; in addition they graded and tallied the lumber from each log separately and determined the loss in volume and the change in quality caused by kiln drying and remanufacture. The same timber was studied both in the woods and in the mill. The trees and the logs were numbered in the woods so that the logs from each tree could be identified at any time during the work. Such a plan permits translating the results into terms of the forest at any stage of lumbering and at any

time, and log by log if desirable. The quantity of lumber by grades and the value for trees of different diameters, for example, were obtained directly by adding the figures on the lumber that came from the logs cut from each tree. Time and output records were also made, and the production costs for trees were obtained in much the same way as were the grades and the value of the timber.

DETAILED DESCRIPTION OF METHODS FOLLOWED

The investigation was confined to shortleaf pine (*Pinus echinata*)[6] and loblolly pine (*P. taeda*), except at the study in western Arkansas where, in addition, white oak (*Quercus alba*), and red oak (including *Q. borealis maxima, Q. shumardii,* and *Q. velutina*) were given consideration.

The areas selected for study represented the following different forest conditions: (1) Second-growth, forest-grown, mixed shortleaf and loblolly pine; (2) second-growth old-field loblolly pine; (3) virgin shortleaf pine on flat land; and (4) virgin shortleaf pine and oak on mountain land.

Areas (2) and (4) were cut selectively whereas (1) and (3) were cut clear, except that in (1) and (3) a few 10-inch trees were left.

Second growth refers to trees that have grown from seeds after the cutting of the virgin timber, to small trees that were on the ground at the time of logging, and to timber that has come in from seed on abandoned farms. Usually such timber in this region is less than 75 years old.

Virgin growth designates timber in which there has been no logging. Ordinarily such timber, at present, averages nearly a century old, although the stand may contain trees ranging in age from 1-year seedlings to veterans more than 250 years old.

Old-field timber covers trees that have come in from seed on abandoned farms. It is considered second-growth timber.

Forest-grown second-growth timber applies to young stands on land that had been cut over but not cultivated.

Diameter, when applied to trees, in this bulletin, means the size outside the bark 4½ feet from the ground, and when applied to logs it means the average size at the small end inside the bark.

Site is an index of growth that is expressed as the average height of the dominant trees in the stand at the age of 50 years.

The Doyle log rule, the one employed by most lumbermen in the South, was used in the first three studies, whereas the Scribner decimal C, which is the official rule of the Forest Service, was required in the fourth study because that study was made on a national forest. The results of the fourth study, however, have been converted to a Doyle basis in order to make all the studies strictly comparable in this respect.

Figures 2 and 3 illustrate the woods work and the transportation.

Members of the study crew determined the time required for felling each tree and for bucking it into logs as it was handled by the two log cutters in the regular logging operation. The volume of each log was obtained by a scale rule. Production costs were computed as follows: Suppose the records showed that the log cutters required 60 minutes to produce 1,000 feet of logs from trees 20 inches in diameter, then if

[6] The names of species of wood appearing in this bulletin are those given in Miscellaneous Circular 92 (6).

the men received 30 cents each per hour, the felling and bucking cost would be 60 cents per 1,000 board feet.

FIGURE 2.—Logging southern yellow pine: A, Felling trees; B, loading logs on wagons for hauling to the landing; C, logs bunched along a track spur ready for car loading.

The logs were skidded to the landing and loaded on wagons by the same men and teams that hauled them to the spur track. The time required to skid each log, the distance it was skidded, and the volume

it contained were recorded. The same procedure was followed in loading. For hauling, the time required for the round trip, the distance traveled, and the volume hauled were recorded. These data when combined with the wages the men received and the cost of the

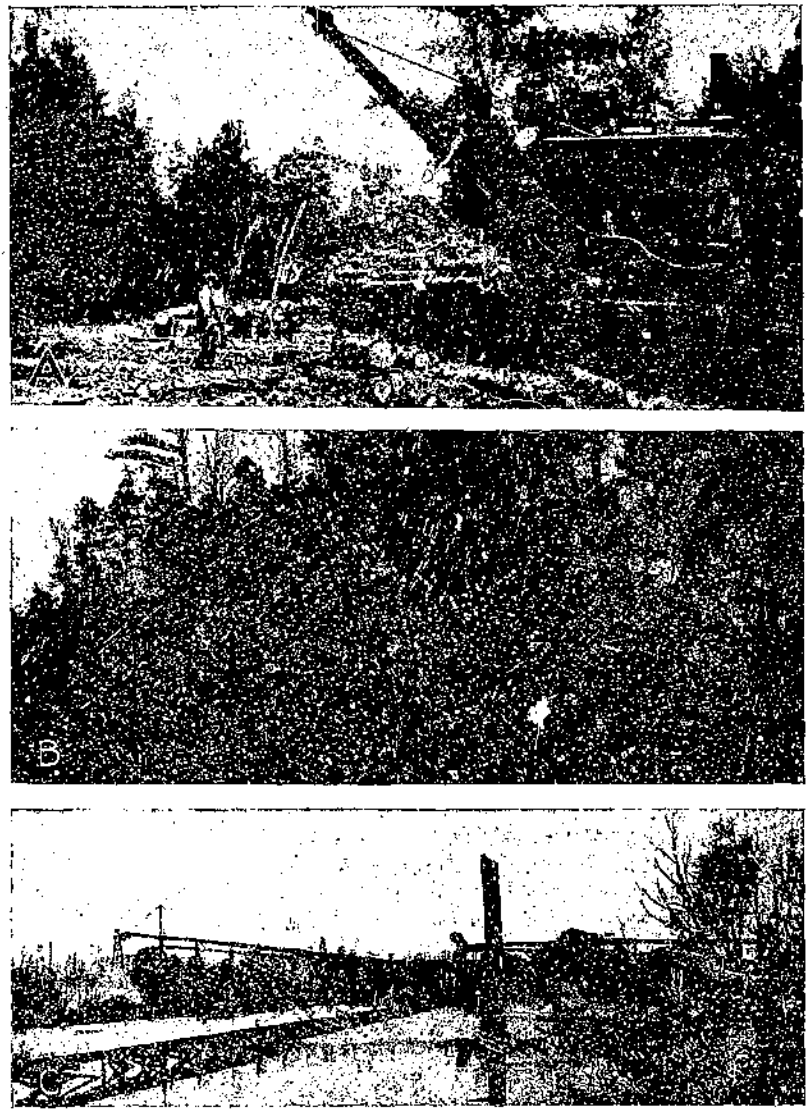

FIGURE 3.—The transportation and milling of southern yellow pine: A, Logs loaded with steamloaders; B, logs hauled by rail to the mill; C, most mills have their logs delivered direct to log pond.

teams made it possible to compute the skidding, loading, and hauling costs for logs of different sizes. The number of each log was also set down so that the cost of handling trees of different sizes could be computed.

The cost of loading the logs on the railroad cars was determined by scaling each log and timing its loading. With this information and a knowledge of the cost of loading the unit cost for logs and trees of different sizes was easily computed.

The cost of hauling the logs to the mill obviously could not be determined from time records, so it was computed for logs of different sizes on the basis of the cost of a car trip and the various board-foot capacities of a standard car when loaded entirely with logs of one size. For example, a car when loaded with 8-inch logs will scale only about one half as much as when loaded with 26-inch logs. In this study the cost of hauling these cars to the mill was considered constant, regardless of the size of logs they contained, so the actual unit hauling cost would be twice as much for 8-inch logs as for 26-inch.

Unloading costs at the mill were determined directly from the wages paid the men who unloaded the cars and the volume handled. The unit cost of unloading for logs and trees of different sizes was computed from the time ratios established by the head saw in the mill, for the different sizes, and the average cost of unloading.

The investigation at the mill was carried on by a crew of five men so stationed as to obtain complete records for each log from the time when it came on the log deck to the time when it passed out of the mill on the green chain in the form of lumber. One man rescaled and renumbered the logs as they entered the mill, as a check on the woods work, and recorded their diameters, lengths, and woods number. A second man noted the time required to saw each log and the method of sawing. Another man placed the log number on each board, cant, or timber as it came from the head saw, so that the products from each log could be identified and tallied on the green chain. Finally, a lumber inspector and a tallyman graded and tallied the pine lumber and timber on the green chain for each log in accordance with the grading rules of the Southern Pine Association.

The cost of sawing lumber from logs of different sizes was computed from the actual time required by the mill to produce 1,000 board feet of lumber from logs of different diameters, and the average cost of running the mill for that period. The sawing cost for trees was computed by adding the costs for the logs that made up each tree.

Kiln, yard, and shed costs were obtained directly from each company and were considered to differ among the different sizes of logs in the same ratio as did the numbers of pieces of lumber, cut from the sizes, required to make a thousand board feet.

Planing-mill costs were considered constant per thousand board feet in this study because the planer can be adjusted to output, to a certain extent, and hence planer costs do not necessarily rise as the output of the mill decreases.

Shipping expense was obtained directly from the company's books, and the total cost has been distributed among the different diameter classes in accordance with the number of pieces of lumber for logs of different sizes required to make up a thousand board feet. General costs were also taken directly from company records, and the costs for trees of different sizes were computed from the average cost and the ratios established by the milling time.

Discount, taxes, and insurance were varied in accordance with the average prices of the lumber from each diameter class of logs or trees.

Other costs, such as spur, road, and camp construction, were handled as fixed charges per acre, and under such conditions the cost per thousand board feet of lumber varies inversely with the amount of timber removed per acre. If an acre supports 10,000 board feet of timber and the railroad construction costs are $20 per acre, then the cost per thousand board feet would be $2, but if only 5,000 board feet are cut under selective logging the cost would be $4. It is thought that with improved logging methods the increase in the apportioned cost of permanent improvements that occurs when a part of the stand is left uncut, can be reduced appreciably.

The tables on production costs show the classification of each cost item and explain further the method of handling the items when computing the total costs for trees of different diameters and for different minimum cutting limits. Where the production costs for trees could not be obtained directly, as they were in felling, the costs for the logs that came from each tree were added together. Similarly, the volume and the value of the lumber from each tree were obtained by totaling the lumber that was sawed from the logs making up that tree. This method is feasible only when the same logs and trees are studied in the mill and in the woods, as was done throughout this investigation.

The change in grade and amount of the lumber that takes place between the green chain and the car was obtained by marking the grade on a representative volume of the lumber, and making subsequent tallies of the same lumber as it came from the kiln (7). after rough remanufacture, and also after finish-processing in the planer. The difference between the representative green-chain tally and the finished-lumber tally formed a basis for correcting the green-chain value of all the lumber to what it would be as finished lumber.

Lumber prices were obtained directly from each company. The value of the lumber for each diameter class was computed on the basis of a piece tally, by grades, adjusted for kiln drying and manufacturing changes, and with use of the appropriate lumber prices.

The average lumber value and production cost and the results when a stand was cut to different minimum-diameter limits were computed by using the distribution of the total volume among the different diameter classes as found at each study and shown in tables later on.

The lumber prices and wage scales used in this bulletin are based chiefly on 1929 averages. To adjust the production costs and lumber values given in this bulletin to conditions different from those obtaining during this period a straight-line percentage correction may be applied by diameter classes as explained on page 49.

PRESENTATION AND USE OF RESULTS

The discussion of production costs and lumber values given later is purposely confined to trees alone. Although much of the information was necessarily obtained through the study of logs, this was only a means to an end as far as this investigation was concerned. The real objective is to present figures for trees of different sizes. With figures on production costs, lumber values, and similar subjects available for individual trees, arranged by diameter classes, it is easy to assemble these unit data into values for a forest through the use of additional cruise figures giving the number by sizes of the trees in the stand.

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Figures for four separate operations are given in this bulletin, since the information when thus presented will be valuable to a greater number of operators than averages including all the operations would be. The guidance that the figures offer to a lumberman will depend to some extent on how closely the operations studied compare with his own. If his costs and lumber values are close to the study figures he may use the data without further computation; if they are not, he should take the basic figures shown herein and work out the results for his own conditions. Detailed instructions for doing this appear in later pages.

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE AREA STUDIED IN SOUTHERN ARKANSAS

The 17-acre tract of timberland in southern Arkansas selected for study supported a second-growth, forest-grown stand of shortleaf and loblolly pine averaging about 58 years in age. The area had not been cultivated, but a part of it had the appearance of having been partly cleared at some previous time, perhaps by a windstorm or by deadening. The volume was about equally divided between shortleaf and loblolly pine, and the results of the study are for the two species combined. Scattered among the pine trees were numerous small, unmerchantable hardwoods and a few hardwoods of merchantable size, but they were not included in the cut. On the average the tract supported 183 trees per acre, 100 of which were pine ranging in diameter breast-high from 4 to 26 inches, and 83 were small hardwoods, most of which were less than 10 inches in diameter although they ranged in size from 1 inch up to 20 inches. Considering only the pine the area was classified as an 80-foot site.[6] The average height of the dominant shortleaf pine at the time of the study was 82 feet and the loblolly pine 85 feet. The tract was only 60 percent fully stocked on a volume basis according to the figures given in Miscellaneous Publication 50 (*8*).

The area had been burned over several times, how often is unknown, but the fires had apparently been mild, for the damage was not excessive. Only 1¼ percent of the trees showed fire scars, and the total loss in the stand from defect, which included crook, rot, fire scarring, breakage, and operating damage, amounted to only 3.4 percent; this loss was determined by the difference between gross and net scale. Defect loss rose from 1.1 percent for 8-inch trees to a maximum of 4.8 percent for 12-inch, and then declined to 2.1 percent for the 24-inch class.

Practically all the pine 8 inches in diameter and larger was cut for saw logs, but none of the hardwoods was removed, although a number of the smaller trees were broken down in logging. The area, after the logging, would be classified as clear cut.

A total of 153,323 board feet, gross log scale, of shortleaf and loblolly pine, or 9,000 board feet per acre, was cut from the tract. The logs average 44 board feet each, or about 23 logs to the thousand board feet, and ranged in diameter from 7 to 20 inches and in length from 12 to 20 feet. The average diameter of the logs, as calculated from the volume of the cut, was about 11 inches and that of the trees about 15 inches.

[6] Site is measured by the height of the average dominant tree at the age of 50 years.

The cut was made up of trees ranging in size from 8 to 26 inches in diameter breast high. Since production costs and lumber quality differ among the different diameters it is important in arriving at an average to know the volume in each diameter class. Table 1 gives the volume distribution of the cut among the trees of different size on a gross log scale and also on a lumber-tally basis. The figures in this table show that 65 percent of the cut came from trees 13 to 18 inches in diameter and that the volume harvested diminishes to an extremely small proportion of the whole in the lower and the upper diameters. Further, these figures are used later on in computing weighted-average production costs, lumber values, and the results that would have come if a part of the stand had been left uncut, as is done in selective logging.

TABLE 1.—*Distribution among the different sizes of second-growth, forest-grown mixed shortleaf and loblolly pine trees, by gross log scale and lumber tally, of the volume of timber cut in southern Arkansas*

Diameter breast high	Volume distribution		Diameter breast high	Volume distribution	
	Gross log scale	Lumber tally		Gross log scale	Lumber tally
Inches	*Percent*	*Percent*	*Inches*	*Percent*	*Percent*
8	0.1	0.2	18	8.6	7.8
9	1.1	1.9	19	6.8	6.0
10	2.4	3.6	20	5.1	4.5
11	4.1	5.3	21	3.6	3.1
12	6.6	7.5	22	2.4	2.1
13	10.0	10.6	23	1.5	1.3
14	11.8	12.0	24	.8	.7
15	12.2	12.0	25	.4	.3
16	11.9	11.3	26	.1	.1
17	10.5	9.7			

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE AREA STUDIED IN NORTHERN LOUISIANA

The 13-acre area selected for study in northern Louisiana was a typical old-field stand. It had been farmed in the late eighties by the man who logged it in 1930. On the average the stand was 42 years old, but individual trees as young as 25 years were found, and a few trees around the edge of the cutting area were over 50 years old. There were also on the area a few shortleaf pine trees, the volume of which did not exceed 6 percent of the total cut, and a few longleaf pines that were excluded from the results; for practical purposes the timber may be classed as loblolly pine. In addition, a few small, scattering, unmerchantable hardwoods were growing on the area, but they were of no importance and may be ignored except in connection with cultural thinnings.

The study area, which was classified as an 80-foot site, supported timber equal to about 80 percent of the volume of a fully stocked stand. There were an average of 207 pine trees per acre, ranging in size from 4 to 26 inches in diameter breast high (fig. 4). The trees cut for lumber during the study ranged in size from 8 to 26 inches in diameter and those that were left standing ranged from 4 to 18 inches. The timber 8 inches and larger in diameter aggregated 10,133 board feet, gross log scale, or 17,259 board feet, lumber tally, per acre for the study area. In the selective-cutting plan followed, 77 percent of this

volume was removed from the entire area, or a grand total of 179,209 board feet, lumber tally. The trees that were cut averaged 119 board feet each, log scale, and the logs 44 board feet, log scale, or 23 logs to the thousand board feet. The logs averaged about 11 inches in diameter inside the bark and the trees about 16 inches in diameter outside the bark, according to calculations based on the volume of the cut.

The area had been burned over several times, but the damage was not excessive, even though 6.4 percent of the trees showed indications of butt rot. Forked trees were very noticeable in the stand, amounting to 3.3 percent by volume of the cut. Counting all imperfections for which a reduction in scale was made, such as cat face, crook, and rot, the loss amounted to only 1.3 percent.

Table 2 shows the volume distribution, among the different diameter classes, of the timber cut. As might be expected in a second-growth old-field stand, nearly 50 percent of the volume was concentrated in the 14- to 17-inch diameter classes.

TABLE 2.—*Distribution among the different sizes of second-growth old-field loblolly pine trees, by gross log scale and lumber tally, of the volume of timber cut in northern Louisiana*

Diameter breast high	Volume distribution		Diameter breast high	Volume distribution	
	Gross log scale	Lumber tally		Gross log scale	Lumber tally
Inches	*Percent*	*Percent*	*Inches*	*Percent*	*Percent*
8	0.1	0.2	18	9.2	8.4
9	.2	.4	19	6.9	6.2
10	.7	1.1	20	5.2	4.5
11	2.0	3.6	21	4.0	3.4
12	5.8	7.2	22	3.2	2.7
13	8.9	10.2	23	2.4	2.0
14	11.1	11.0	24	1.8	1.4
15	12.2	12.4	25	1.2	.9
16	12.5	12.2	26	.6	.5
17	11.4	10.8			

VIRGIN SHORTLEAF PINE AREA STUDIED IN THE FLATLANDS OF EASTERN TEXAS

Two areas in eastern Texas about one fourth mile apart, representing different classes of timber, were studied. The stand on one area, which was 6½ acres in extent, consisted chiefly of large, old, shortleaf pines; the small pines were fewer in number than is common, but about the average number of small, scattered, poor-quality hardwoods were growing. None of these hardwoods, which were mainly red gum, hickory, black and willow oak, and red and white oak, were cut in this study. The pine averaged 43.8 trees per acre, ranging in size from 4 to 31 inches in diameter breast high and in age from young growth 10 to 20 years old to veterans of more than 250 years. The pine trees that were cut, which ranged from 40 to 274 years in age, averaged 122 years. Their average height was 107 feet and average diameter 20.2 inches. The area was classified as an 80-foot site; considering the pine only, it was about 40 percent fully stocked. There were 25.4 hardwood trees per acre, ranging in size from 4 to 21 inches, with most of them less than 12 inches in diameter. The second area, about 12 acres in extent, was covered with a virgin stand, but the trees were thicker on the ground and were younger than those on the other area. Like the first area, it contained a few small hard-

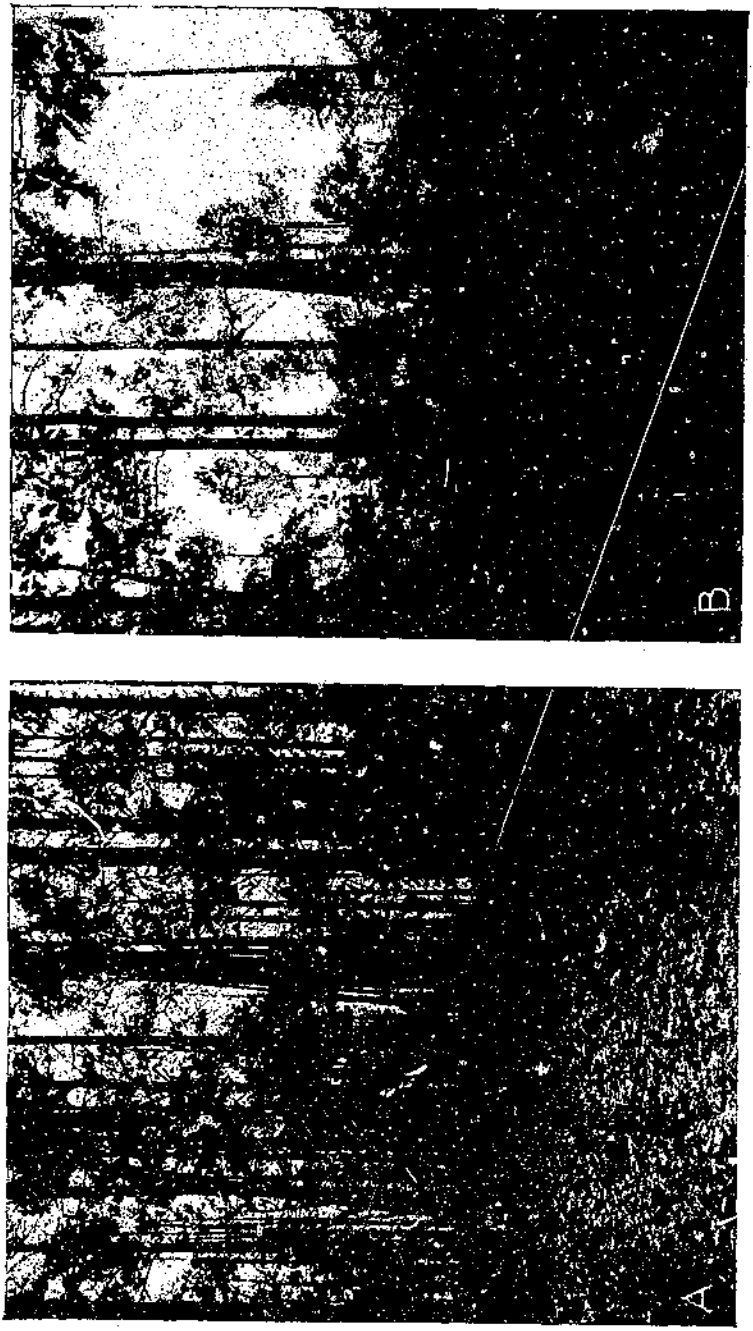

FIGURE 4.—Selective cutting in an old-field loblolly pine stand; (A), Before logging; (B), after logging.

woods of poor quality; the same species appeared, and elm was there in addition. The average number of trees was 128.9 per acre; they ranged from 4 to 28 inches in diameter and from 10 to more than 150 years of age. The pine trees that were cut ranged from 40 to 152 years and averaged 74 years old. The average height of all trees in the stand was 85 feet, and the average diameter breast high was 15.6 inches. The average height of the dominant trees was about 100 feet; the area was classified as between a 70- and an 80-foot site, which made it approximately the same as the first plot. Considering the pine only, the area was about 70 percent fully stocked. There were 9.4 hardwood trees per acre, ranging from 4 to 19 inches in diameter; over two thirds of them were less than 12 inches in diameter.

The combination of these two areas should give a good average for the virgin-growth flatland shortleaf pine areas. The stand on the two areas gave some evidence of fire injury, but judging from the underbrush the area had not been burned over during the 5 years preceding the study. Nine percent of the trees showed fire scars.

The oldest trees on the larger area showed an increase in growth about 70 years ago, indicating that the stand had been thinned out at that time. Since there had been no previous cutting on the area the most logical explanation is that a windstorm had blown down a part of the stand.

All but 2 trees per acre, of those 10 inches or more in diameter breast high, were cut for saw logs on the small plot, while on the larger area 23 such trees were left per acre. This cutting policy corresponded with the general practice of the company to take almost all the trees that measured 12 inches on the stump. None of the hardwoods was removed during the study, although the company's general policy was to cut the hardwoods that could be used, along with the pine. The hardwoods on these areas were of so little importance in the logging that they would have had practically no effect on the financial aspects of the operation.

There was a small amount of loblolly pine (7.5 percent) in mixture, but for all practical purposes the stand could well be considered a pure shortleaf type, and hereafter no mention will be made of the other pine.

A total of 198,938 board feet, gross log scale, of shortleaf pine, or about 10,600 board feet per acre, was cut from the 18.72 acres of the two tracts. The trees that were cut averaged 242 board feet each. The logs, which ranged in length from 10 to 20 feet, ran 12½ to the thousand or 80 board feet each. The average log was about 13 inches in diameter inside the bark and the average tree 17 inches in diameter breast high outside the bark.

Table 3 shows the volume distribution of the timber studied among the different diameter classes on gross-log scale and lumber-tally bases.

TABLE 3.—*Distribution among the different sizes of virgin-growth flatland shortleaf pine trees, by gross log scale and lumber tally, of the volume of timber cut in eastern Texas*

Diameter breast high	Volume distribution		Diameter breast high	Volume distribution	
	Gross log scale	Lumber tally		Gross log scale	Lumber tally
Inches	*Percent*	*Percent*	*Inches*	*Percent*	*Percent*
10	0.1	0.2	21	6.0	5.5
11	1.1	1.6	22	5.5	5.0
12	3.1	4.1	23	5.0	4.4
13	5.1	6.3	24	4.5	3.9
14	6.9	8.1	25	4.0	3.4
15	8.6	9.5	26	3.5	2.9
16	8.6	9.2	27	2.9	2.4
17	8.1	8.3	28	2.4	1.9
18	7.5	7.5	29	1.8	1.4
19	7.0	6.8	30	1.2	.9
20	6.5	6.2	31	.6	.5

VIRGIN SHORTLEAF PINE AND MIXED OAK AREA STUDIED IN THE MOUNTAINS OF WEST-CENTRAL ARKANSAS

A rectangular area in the Ouachita National Forest, which extended from bottom land along a stream course up a slope to a ridge top about 500 feet high, was selected for study; it was 53.8 acres in extent. The shortleaf pines on this area averaged 68 trees to the acre; they ranged in diameter breast high from 4 to 29 inches. In age they ran from seedlings to trees more than 250 years old. The hardwoods averaged 2 merchantable trees per acre, 12 inches and more in diameter, and a count of a 12-acre tract within the cutting area showed that there were 34 trees per acre below this size, mostly in the 4- and 6-inch classes. The average age of the trees that were cut was 144 years, and the average total height 76 feet.

For the tract as a whole, the site index was estimated as 60. Considering the shortleaf pine only, the stand was only about one third fully stocked. The area was better stocked on the lower part than on the upper slopes, principally because of better soil and less fire damage. The stand averaged 4,558 board feet, gross log scale, of shortleaf pine and about 240 board feet of hardwoods, 8 inches and larger, per acre. Counting all imperfections for which a reduction in scale was made, such as cat face, crook, and rot, the loss amounted to 8.2 percent.

The aim was to remove all the mature dominant trees, the slow-growing or inferior intermediate ones, and defective trees of all classes, and to leave enough thrifty ones of various sizes, well distributed over the area (fig. 5), to equal 30 percent of the volume of the original stand, in order both to seed the area and to provide another cut in about 35 years; 54 shortleaf pine trees per acre, ranging in size from 4 to 24 inches in diameter, were left standing for these two purposes. The plan called for cutting all merchantable hardwood trees. On 12 acres of this particular area the remaining unmerchantable hardwoods were girdled or poisoned by the Southern Forest Experiment Station as an experiment in an effort to rid the land of them and thus make room for healthy trees of either pine or hardwood.

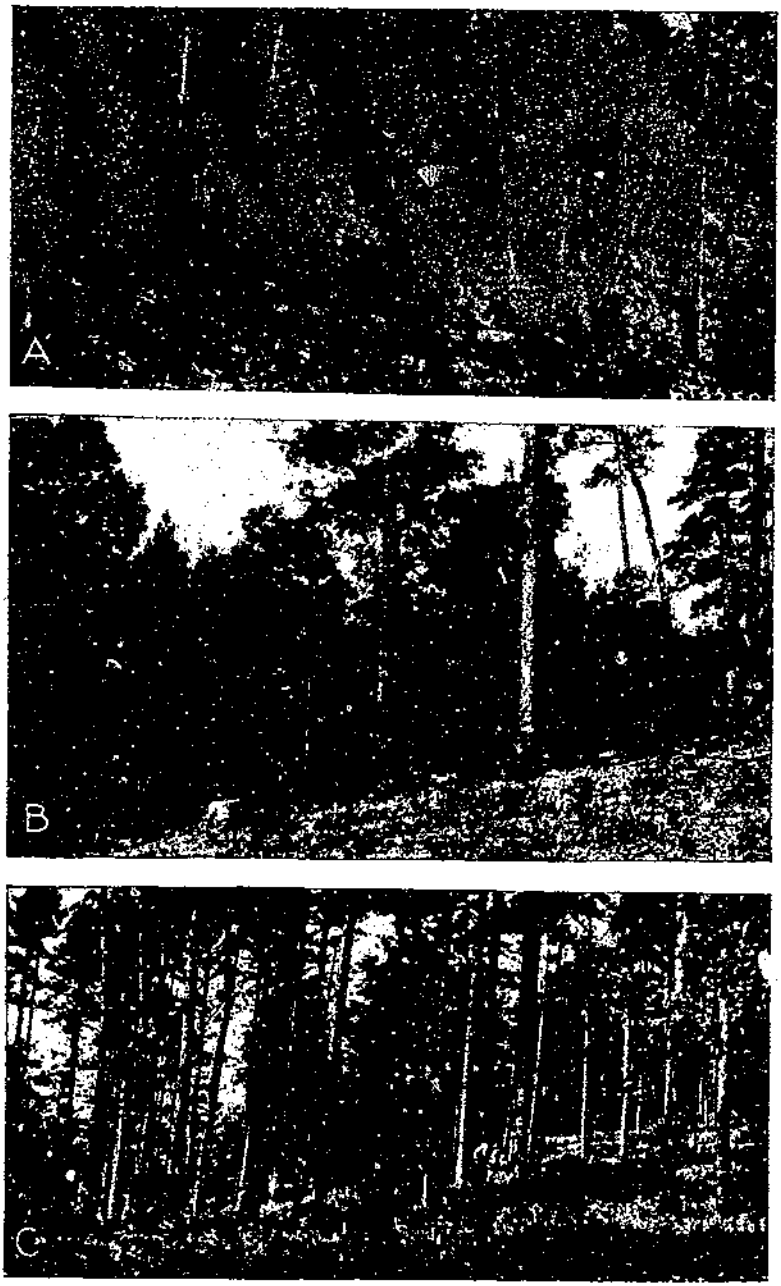

FIGURE 5.—Selective cutting in the Ouachita National Forest. (A) Virgin stands of shortleaf pine (B) cut selectively indicate that (C) young growth will come in under such management.

TABLE 4.—*Distribution among the different sizes of virgin-growth mountain shortleaf pine trees, by gross log scale and lumber tally, of the volume of timber cut in west-central Arkansas, and also the total number of trees cut and left*

Diameter breast high, inches	Trees			Defective trees in the cut	Volume distribution	
	Total	Cut	Left		Gross log scale	Lumber tally
	Number	*Number*	*Number*	*Percent*	*Percent*	*Percent*
4	976	----------	976	----------	----------	----------
5	607	----------	607	----------	----------	----------
6	343	----------	343	----------	----------	----------
7	263	----------	263	----------	----------	----------
8	136	----------	136	----------	----------	----------
9	58	2	54	11.1	----------	0.1
10	77	24	53	10.5	0.3	.5
11	103	45	58	0.9	1.1	1.5
12	126	54	72	9.3	2.0	2.6
13	146	69	77	8.8	3.1	3.9
14	137	70	67	8.6	4.7	5.5
15	128	69	59	8.2	6.4	7.2
16	125	73	52	8.2	8.2	8.9
17	124	84	40	7.8	10.0	10.4
18	94	66	28	7.4	11.6	11.7
19	65	47	18	7.1	12.5	12.2
20	54	44	10	7.6	11.8	11.2
21	46	39	7	7.8	9.4	8.6
22	29	24	5	8.3	6.7	5.9
23	13	8	5	8.9	4.5	3.8
24	7	6	1	9.6	2.9	2.4
25	6	6	----------	10.7	1.8	1.4
26	1	1	----------	11.4	1.2	.9
27	1	1	----------	12.2	.9	.7
28	1	1	----------	13.0	.6	.4
29	1	1	----------	14.3	.3	.2
Total	3,665	734	2,931	----------	----------	----------
Trees per acre	68	14	54	----------	----------	----------
Average	----------	----------	----------	8.2	----------	----------

Table 4 shows the total number of shortleaf pines on the tract, the proportions that were cut and that were left, and the volume distribution among the different diameter classes of the trees cut, both on a gross-log-scale and a lumber-tally basis. There were only 68 pine trees per acre; this is a light stand even with the addition of the few hardwoods that were in mixture. On the average, the 14 shortleaf pine trees cut per acre yielded 4,161 board feet, lumber tally, and in addition the 2 oak trees yielded 286 board feet, a total of 72 percent of the volume of the total stand 8 inches and larger. About 81 percent of the cut came from trees 14 to 22 inches in diameter; the largest volume was from the 19-inch diameter class, which supplied 12.5 percent of the total volume cut.

LOGGING AND MILLING CONDITIONS

All the study areas, with the exception of that in west-central Arkansas, were fairly level, and were well drained; the soil was sandy clay, its surface free from rocks. The surface of the study area in west-central Arkansas varied from smooth, flat land in the lower part to steep, rocky stretches on the sides and the tops of the ridges. The soil was a fine white clay in the bottoms and almost a pure gravel on the slopes and ridges. The rainfall and logging conditions for the period were normal on all areas.

The trees were felled, limbed, and bucked into log lengths by crews of two men each. The logs were skidded to the wagons by the hauling crews, loaded by "cross haul", and transported to the spur track

with wide-tired wagons. The hauling distance in the southern Arkansas, Louisiana, Texas, and west-central Arkansas operations averaged 740; 1,925; 1,150; and 1,593 feet, respectively. All logs were loaded singly on standard-gage cars with a steam loader. The railroad haul from the stands to the mills, in the foregoing order, was 11, 20, 56, and 75 miles, respectively.

All mills had band head saws and complementary equipment, such as edgers and trimmers, but had no resaws. Under ordinary practice at the southern Arkansas and Louisiana mills the no. 2 common and better lumber was kiln-dried and the no. 3 common was air-seasoned. At the Texas mill the higher quality no. 2 common and better lumber was kiln-dried and the low-quality no. 2 common and the no. 3 common was air-seasoned. Occasionally, on rush orders, small and medium-sized timbers were put through the kilns. All the lumber at the west-central Arkansas mill was kiln-dried and was then put through the rip mill for such additional manufacture as was necessary before storage in the dry shed. Practically all the lumber at all the mills was either surfaced or run to pattern before being shipped.

LOGGING COSTS PER THOUSAND BOARD FEET, GROSS LOG SCALE

The increased unit cost and the decreased output when handling small trees instead of large ones are not so apparent to the casual observer when he is in the woods as when he is in the mill, but they exist, nevertheless. Table 5 shows the weighted-average unit cost by items for logging all trees together and the corresponding costs for each diameter class. With the exception of the items for spur tracks and the various camps the unit production costs are greater, in all items for small trees than for large ones. Sawing down the trees and cutting them into logs costs more than three times as much per thousand board feet, gross log scale, for trees 10 inches in diameter as for trees 24 inches in diameter. Loading, freight, and skidding costs show similar relations. Summing up all items, it costs nearly three times as much to cut the logs from 10-inch trees and bring them to the mill as to handle the logs from 24-inch trees. Because of the larger overrun for small trees, however, this ratio and others like it are reduced somewhat when the cost figures are converted to a lumber-tally basis by means of overrun percentages, but the general fact remains unchanged; unit production costs are higher for small trees than for large ones. The grouping of the items in table 5 is somewhat different for each operation because of the different methods of cost keeping employed by the cooperating lumber companies.

TABLE 5.—*Logging costs per thousand board feet, gross log scale and lumber tally, by diameter classes for the 4 operations studied*

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE TREES, SOUTHERN ARKANSAS

Cost item	Classification of cost [1]	Weighted average cost per thousand board feet, gross log scale	Itemized costs per thousand board feet, gross log scale, for the indicated diameter breast high, in inches—																						
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sawing	VT	1.20	4.50	2.91	2.23	1.82	1.53	1.37	1.25	1.15	1.07	1.02	0.98	0.93	0.92	0.90	0.90	0.89	0.88	0.87					
Skidding and wagon haul	VT	1.40																							
Swamping	VT	.31	10.09	6.02	4.56	3.45	2.74	2.26	1.92	1.68	1.49	1.33	1.21	1.09	1.01	.95	.89	.84	.80	.76	.74					
Scaling	VT	.08																							
Loading on cars	VT	.81	4.21	3.24	2.44	1.82	1.38	1.07	.87	.73	.62	.54	.47	.42	.38	.34	.31	.28	.26	.25	.24					
Freight on cars	V Cap	1.53	4.46	3.73	3.08	2.50	2.08	1.82	1.63	1.48	1.37	1.27	1.19	1.12	1.06	1.01	.97	.94	.91	.89	.88					
Supplies and repairs	V Tot	.16																							
Depreciation, insurance, and taxes on woods equipment	V Tot	.64	2.79	1.91	1.48	1.15	.93	.78	.68	.61	.55	.50	.46	.43	.41	.39	.37	.36	.34	.33	.33					
		.18																							
General expense	V Tot	.30																							
Spur tracks	CA	1.80	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93					
Camps	CA	.13																							
Total logging cost per thousand board feet, gross log scale		7.90	27.98	19.74	15.72	12.67	10.59	9.23	8.28	7.58	7.03	6.59	6.24	5.94	5.72	5.54	5.37	5.25	5.13	5.04	4.99					
Total logging cost per thousand board feet, lumber tally		5.62	10.95	8.73	7.89	7.29	6.78	6.25	5.81	5.48	5.19	4.95	4.76	4.59	4.45	4.34	4.24	4.16	4.08	4.03	4.01					

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE TREES, NORTHERN LOUISIANA

Sawing; labor, scaling, and expenses	VT	1.10	8.16	4.78	3.10	2.28	1.84	1.53	1.29	1.11	0.97	0.87	0.82	0.77	0.74	0.71	0.70	0.69	0.68	0.68	0.68					
Hauling; labor, scaling, and expenses	VT	3.47	14.48	11.76	9.55	7.64	6.07	4.95	4.14	3.55	3.11	2.77	2.54	2.35	2.23	2.12	2.04	1.97	1.91	1.87	1.83					
Loading on cars:																									
Labor	VT	0.64																							
Expense	VT	.14	.78	7.39	5.00	3.49	2.41	1.72	1.25	.96	.76	.63	.53	.47	.41	.36	.33	.30	.26	.24	.22	.20					

[1] Code for classification of costs: CA=constant per acre; V Cap=varies with the capacity of the cars when they are loaded with logs of 1 size only; VMT=varies with the time in the mill; VT=varies with the time per thousand board feet required for logs from trees of different sizes; V Tot=varies with the sum of the other logging costs, excluding CA costs.

TABLE 5.—*Logging costs per thousand board feet, gross log scale and lumber tally, by diameter classes for the 4 operations studied*—Contd.

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE TREES, NORTHERN LOUISIANA—Continued

Cost item	Classification of cost	Weighted average cost per thousand board feet, gross log scale	Itemized cost per thousand board feed, gross log scale, for the indicated diameter breast high, in inches—																							
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Spur tracks; labor and expense	CA	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98						
Railroad transportation:																										
Railroad labor	V Cap	.69	6.43	5.49	4.61	3.87	3.25	2.79	2.47	2.24	2.05	1.94	1.82	1.73	1.66	1.59	1.52	1.45	1.38	1.31	1.25					
Railroad expense	V Cap	1.49	2.18																							
Railroad maintenance	VMT	.35	1.66	1.24	.92	.70	.57	.46	.39	.36	.31	.30	.28	.27	.25	.25	.24	.24	.23	.22	.21					
Woods supervision	V Tot	.34	1.64	1.22	.94	.73	.58	.47	.40	.35	.31	.28	.26	.24	.23	.22	.21	.20	.19	19	.18					
Total logging cost per thousand board feet, gross log scale		10.20	41.74	31.47	24.50	19.61	16.01	13.43	11.63	10.35	9.36	8.67	8.17	7.75	7.45	7.20	6.99	6.79	6.61	6.47	6.33					
Total logging cost per thousand board feet, lumber tally		6.65	12.33	11.25	10.41	9.55	8.64	7.80	7.17	6.67	6.24	5.92	5.70	5.50	5.39	5.29	5.20	5.14	5.07	5.03	4.99					

VIRGIN-GROWTH FLATLAND SHORTLEAF PINE TREES, EASTERN TEXAS

Sawing:																										
Labor	VT	1.16	1.18			2.12	1.92	1.74	1.59	1.46	1.36	1.28	1.21	1.16	1.11	1.08	1.04	1.02	1.00	0.98	0.96	0.94	0.92	0.91	0.89	0.87	0.86
Material and supplies	VT	.02																								
Skidway and teamsters:																										
Labor	VT	.93																								
Material and supplies	VT	.24	2.00			6.42	5.32	4.37	3.63	3.10	2.67	2.33	2.07	1.85	1.67	1.54	1.42	1.32	1.24	1.19	1.13	1.09	1.05	1.01	.98	.96	.94
Animal feed	VT	.83																								
Loading:																										
Labor	VT	.46	.59			2.33	1.90	1.49	1.19	.97	.81	.70	.60	.53	.47	.42	.38	.35	.32	.30	.28	.26	.25	.24	.22	.21	.20
Material and supplies	VT	.13																								
Railroad transportation:																										
Woods engine:																										
Labor	V Cap	.59																								
Material and supplies	V Cap	.48	3.50			8.13	7.04	6.16	5.39	4.79	4.29	3.87	3.59	3.31	3.13	2.96	2.85	2.75	2.68	2.60	2.53	2.46	2.39	2.32	2.25	2.18	2.11
Main logging road	V Cap	2.43																								

Spur track:																										
Labor	CA	1.39	1.54			1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.94	1.54	1.54	1.54	1.54
Material and supplies	CA	.15																								
Miscellaneous logging expenses	V Tot	.55				1.44	1.22	1.04	.89	.78	.69	.62	.57	.52	.48	.45	.43	.41	.40	.38	.37	.36	.35	.34	.33	.32	.31
Total logging cost per thousand board feet, gross log scale		9.36				21.98	18.94	16.34	14.23	12.64	11.36	10.34	9.58	8.91	8.40	7.99	7.66	7.39	7.18	6.99	6.81	6.65	6.50	6.36	6.21	6.08	5.96
Total logging cost per thousand board feet, lumber tally		6.98				11.05	10.21	9.44	8.77	8.22	7.74	7.30	7.00	6.67	6.43	6.23	6.08	5.96	5.89	5.83	5.77	5.71	5.66	5.61	5.56	5.52	5.48

VIRGIN-GROWTH MOUNTAIN SHORTLEAF PINE TREES, WEST-CENTRAL ARKANSAS

Sawing:																										
Labor	VT	1.07																								
Tools and supplies	VT	.02	1.27		5.39	4.39	3.55	2.87	2.34	1.95	1.65	1.46	1.28	1.16	1.07	1.00	0.94	0.90	0.87	0.86	0.83	0.83	0.82	0.81	0.79		
Scaling and supervision	VT	.18																								
Brush disposal	VT		.48		2.72	2.09	1.57	1.21	.94	.77	.65	.56	.49	.43	.40	.35	.33	.32	.29	.28	.27	.26	.25	.24	.23		
Skidding, wagon haul, and swamping	VT	3.57																								
Scaling	VT	.08	3.65		18.01	14.22	11.33	9.11	7.37	6.04	5.06	4.35	3.79	3.35	3.02	2.73	2.50	2.31	2.18	2.07	1.99	1.94	1.91	1.90	1.89		
Loading on cars	VT		1.41		8.46	6.70	5.25	4.11	3.25	2.61	2.15	1.81	1.54	1.30	1.10	.94	.79	.70	.60	.54	.48	.44	.42	.40	.39		
Spur track and camps	CA		1.92		1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92	1.92		
Main-line maintenance, train labor, and supplies	VMT		1.19		2.98	2.61	2.31	2.06	1.85	1.66	1.54	1.41	1.30	1.20	1.10	1.01	.93	.87	.80	.75	.71	.68	.66	.65	.63		
Freight	V Cap		1.60		4.48	3.79	3.22	2.75	2.41	2.13	1.96	1.81	1.67	1.56	1.47	1.40	1.33	1.28	1.23	1.19	1.16	1.13	1.12	1.10	1.08		
Salaries	V Tot	.09																								
Office expense	V Tot	.01																								
Liability insurance	V Tot	.16																								
Group life insurance	V Tot	.01																								
Motor-car repairs and supplies	V Tot	.19																								
Miscellaneous expense	V Tot	.22	1.55		6.79	5.46	4.40	3.57	2.93	2.45	2.10	1.84	1.63	1.45	1.32	1.20	1.10	1.03	.96	.92	.88	.85	.84	.83	.81		
Fire and locomotive insurance	V Tot	.01																								
Taxes on logging equipment and railroad	V Tot	.08																								
Depreciation	V Tot	.78																								
Total logging cost per thousand board feet, gross log scale		13.07			50.75	41.18	33.55	27.60	23.01	19.53	17.03	15.16	13.62	12.37	11.40	10.55	9.84	9.33	8.85	8.53	8.24	8.05	7.94	7.84	7.74		
Total logging cost per thousand board feet, lumber tally		10.13			23.94	21.17	18.77	16.60	14.71	13.15	11.91	10.95	10.16	9.53	9.01	8.56	8.20	7.99	7.79	7.73	7.69	7.71	7.83	7.96	8.10		

EFFECT OF OVERRUN ON PRODUCTION COSTS

Logging costs are generally kept on a log-scale basis and milling costs on a lumber-tally basis. Since total costs are ordinarily computed in accordance with the lumber tally, it is necessary to convert logging costs into lumber-tally values, and this is done by means of overrun figures. Gross overrun is the amount by which the lumber tally exceeds the gross log scale. Correction is needed because the Doyle log-scale rule does not give the true lumber content of logs. This is partly the fault of the rule and partly because the efficiency of the mill and the percentages of the different thicknesses of lumber sawed, both of which affect the volume obtained from logs, cannot be predetermined by any rule.

Table 6 shows the gross overrun, arranged by tree diameter, for the four operations studied. The overrun is extremely high in the smaller trees because the Doyle log rule gives values disproportionately lower for small logs than for large ones. Small trees yield more lumber per thousand board feet, log scale, than do large ones; in this way they compensate in part for the higher unit cost of handling them. For example, the felling and bucking cost for the logs from 9-inch trees in southern Arkansas (table 5) was 3.1 times that for 20-inch trees on a log-scale basis, but when the costs are changed to a lumber-tally basis by dividing them by 100 percent plus the appropriate overrun percentage, expressed as a decimal fraction (for 9-inch trees, $\frac{\$2.91}{2.42}=\$1.20$; for 20-inch, $\frac{\$0.93}{1.23}=\$0.76$), the ratio is reduced to 1.6. The overrun figures are based on the lumber tally at the green chain. The total amount of green lumber is reduced by the losses in quantity that occur in seasoning, remanufacture, and planing, but the effect of these losses has been taken care of by using, as the value of a thousand board feet of green lumber, the price actually received for the smaller amount of dry, manufactured lumber obtained from it.

TABLE 6.—*The overrun for the four operations studied*

Diameter breast high, inches	GROSS OVERRUN			
	Southern Arkansas [1]	Northern Louisiana [2]	Eastern Texas [3]	West-central Arkansas [4]
	Percent	*Percent*	*Percent*	*Percent* [5]
8	172.0	260.0		
9	142.0	196.0		117.5
10	111.5	148.0	106.5	99.5
11	81.5	113.5	92.0	83.0
12	66.0	91.0	78.5	70.0
13	49.5	76.0	68.5	59.5
14	43.0	64.0	57.0	51.0
15	37.5	55.5	49.0	45.0
16	33.5	49.0	43.0	40.0
17	30.0	44.5	37.5	35.0
18	27.0	40.5	33.5	30.0
19	24.5	37.0	30.0	26.0
20	23.0	33.5	27.0	22.0
21	21.5	30.5	24.0	18.0
22	20.0	28.0	21.5	14.0
23	19.0	25.0	19.0	10.0
24	18.0	22.5	16.5	6.0
25	17.0	20.0	14.0	2.0
26	16.0	17.5	12.0	−1.5
27			10.0	−5.0
28			8.0	−8.5
29			6.0	−12.0
30			4.0	
31			2.0	
Weighted average	40.4	53.2	34.1	29.0

[1] Second-growth, forest-grown mixed shortleaf and loblolly pine.
[2] Second-growth old-field loblolly pine.
[3] Virgin-growth flatland shortleaf pine.
[4] Virgin-growth mountain shortleaf pine.
[5] Minus sign indicates a loss.

Total unit logging costs, both the average value and the values for individual tree diameters, have been obtained by merely adding up the unit costs of the different logging items. The unit costs of the spur tracks and of the camps vary with the total amount of timber removed from each acre. For the purpose of computing the production costs by diameter classes, however, these two charges have been considered as being the same per thousand board feet for each diameter class of the trees as for all sizes together; therefore, in converting these charges to a lumber-tally basis, the average overrun is used and not the overrun for individual tree sizes, as was done with the other cost items.

All the logging costs shown in the following tables have been converted to a lumber-tally basis by means of the overrun figures in table 6. From here on production costs for this operation will be discussed in terms of lumber tally only.

TOTAL UNIT LUMBER-PRODUCTION COST

To a large extent the unit cost in the mill is governed by the output of the head saw, because the mills are equipped and manned to produce a certain amount of lumber and the cost per day is more or less fixed. Therefore, the unit costs are low when the output is high and high when the output is low. For this reason careful time studies were made at the head saw to determine the comparative time required to produce 1,000 board feet of lumber from logs of different sizes. It was found that more time was required to saw 1,000 feet of lumber from small logs than to saw the same amount from large logs, and hence the costs were higher. The time ratios among the different diameter classes have been used in the computation of sawing costs and several other unit costs connected with milling.

With logging costs converted to a lumber-tally basis, the total unit production costs may be obtained by adding the unit-logging and the unit milling costs, which were recorded on this basis. Such addition has been made, and the total average unit production cost and the equivalent costs for shortleaf and loblolly pine trees of different diameters are shown in table 7.

TABLE 7.—*Production costs* [1] *per thousand board feet, lumber tally, by diameter classes for the four operations studied*

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE TREES, SOUTHERN ARKANSAS

Cost item	Classification of cost [2]	Weighted average cost per thousand board feet, lumber tally	Itemized costs for the indicated diameter breast high in inches																							
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sawing	VT	0.85	1.65	1.20	1.05	1.00	0.96	0.92	0.87	0.84	0.80	0.78	0.77	0.76	0.76	0.76	0.75	0.76	0.75	0.75	0.75					
Skidding and wagon haul	VT	0.99																								
Swamping	VT	.22	3.71	2.49	2.16	1.90	1.71	1.51	1.34	1.22	1.12	1.02	.95	.88	.82	.78	.74	.71	.68	.65	.64					
Scaling	VT	.06																								
Loading on cars	VT	.58	1.55	1.34	1.15	1.00	.86	.72	.61	.53	.46	.42	.37	.34	.31	.28	.26	.24	.22	.21	.21					
Freight on cars	V Cap	1.09	1.64	1.54	1.46	1.38	1.30	1.22	1.14	1.08	1.03	.98	.94	.90	.86	.83	.81	.79	.77	.76	.76					
Supplies and repairs	V Tot	.11																								
Depreciation, insurance, and taxes on woods equipment	V Tot	.13	1.03	.79	.70	.63	.58	.52	.48	.44	.41	.38	.36	.35	.33	.32	.31	.30	.29	.28	.28					
General expense	V Tot	.22																								
Spur tracks	CA		1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37	1.37					
Camps	CA																									
Pond	VMT	.21																								
Sawmill	VMT	2.61	5.23	4.55	4.12	3.81	3.59	3.41	3.26	3.13	3.02	2.90	2.82	2.73	2.64	2.57	2.51	2.44	2.37	2.31	2.24					
Green chain	VMT	.34																								
Yards and kilns	V no. pcs.	2.25	5.91	5.59	4.80	4.47	4.22	4.03	3.88	3.73	3.59	3.46	3.35	3.26	3.19	3.13	3.08	3.04	3.02	2.99	2.99					
Shipping	V no. pcs.	1.51																								
Planing mills	C	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60					
Selling	C	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41					
Depreciation on sawmill and planing mil	VMT	1.22																								
Insurance on plant	VMT	.37																								
Taxes on plant and timber	VMT	.85	7.15	6.21	5.64	5.21	4.91	4.67	4.46	4.27	4.12	3.97	3.85	3.73	3.61	3.52	3.43	3.33	3.24	3.15	3.06					
General expense	VMT	1.88																								
Insurance on lumber	VP	.20																								
Taxes on lumber	VP	.09	.63	.64	.65	.66	.68	.68	.70	.71	.73	.74	.75	76	.78	.79	.80	.82	.83	.84	.85					
Discount on sales	VP	.43																								
Allowance and adjustments	C	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13	.13					
Total		20.72	33.01	28.80	26.24	24.57	23.32	22.19	21.25	20.46	19.79	19.16	18.67	18.22	17.81	17.49	17.20	16.94	16.68	16.45	16.29					

[1] Excluding stumpage, Federal taxes, and interest.

[2] Code for classification of costs: C=constant per thousand board feet; CA=constant per acre; V Cap=varies with the capacity of the cars when they are loaded with logs of 1 size only; VMT=varies with the time in the mill; V no. pcs.=varies with the number of pieces needed to make up 1,000 board feet; VP=varies with the price; VT=varies with the time per 1,000 board feet required for lumber of different sizes; V Tot= varies with the sum of the other logging costs, excluding CA costs.

Sawing; labor, scaling, and expense	VT		0.72	2.27	1.61	1.25	1.07	0.90	0.87	0.79	0.71	0.65	0.60	0.58	0.56	0.55	0.54	0.55	0.55	0.56	0.57	0.58						
Hauling; labor, scaling, and expense	VT		2.27	4.02	3.97	3.85	3.58	3.18	2.81	2.52	2.28	2.09	1.92	1.81	1.72	1.67	1.62	1.59	1.58	1.56	1.56	1.56						
Loading:																												
Labor	VT	0.42																										
Expense	VT	.09	.51	2.05	1.69	1.41	1.13	.90	.71	.59	.49	.42	.37	.33	.30	.27	.25	.23	.21	.20	.18	.17						
Spur tracks; labor and expense	CA		1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29						
Railroad transportation:																												
Railroad labor	V Cap	.35																										
Railroad expense	V Cap	.97	1.42	1.79	1.85	1.86	1.81	1.70	1.59	1.51	1.44	1.38	1.34	1.30	1.26	1.24	1.22	1.19	1.16	1.13	1.09	1.06						
Railroad maintenance	VMT		.23	.46	.42	.37	.33	.30	.26	.24	.23	.21	.21	.20	.20	.19	.19	.19	.19	.19	.18	.18						
Woods supervision	V Tot		.22	.46	.41	.38	.34	.30	.27	.24	.23	.21	.19	.19	.18	.17	.17	.16	.16	.16	.16	.15						
Sawmill and pond:																												
Labor	VMT	2.52																										
Expense	VMT	1.33	3.85	7.75	6.95	6.23	5.55	4.95	4.41	4.00	3.77	3.59	3.45	3.36	3.30	3.25	3.20	3.16	3.14	3.11	3.09	3.07						
Kilns and yard:																												
Yard and sorter labor	V no. pcs.	.92																										
Yard expense	V no. pcs.	.30																										
Dry-kiln and shed labor	V no. pcs.	.69	1.96	2.93	2.79	2.63	2.50	2.33	2.18	2.06	1.96	1.90	1.82	1.79	1.74	1.71	1.69	1.67	1.65	1.63	1.62	1.61						
Dry-kiln expense	V no. pcs.	.05																										
Planer labor and expense	C	.94																										
Selling expense	C	.72	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66						
Shipping labor and expense	V no. pcs.		1.78	2.66	2.53	2.39	2.27	2.12	1.98	1.87	1.78	1.73	1.66	1.62	1.58	1.56	1.53	1.51	1.50	1.48	1.47	1.46						
Miscellaneous allowance; claims and corrections	C		.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82	.82						
Administration expense:																												
General expense	VMT	.98																										
Office expense	VMT	.44																										
Legal expense	VMT	.05																										
Accident insurance	VMT	.33																										
Insurance on plant and equipment	VMT	.46																										
Taxes on land and plant	VMT	.85	6.03	12.14	10.89	9.75	8.69	7.76	6.91	6.27	5.91	5.62	5.41	5.27	5.16	5.09	5.02	4.95	4.91	4.88	4.84	4.81						
Land and timber expense	VMT	.20																										
Loyalty and service	VMT	.34																										
Depreciation	VMT	2.03																										
Machine-shop labor and expense	VMT	.35																										
Insurance on lumber	VP	.15																										
Taxes on lumber	VP	.18	.73	.71	.71	.71	.71	.70	.71	.71	.72	.73	.73	.74	.75	.76	.77	.78	.78	.79	.79	.80						
Discount on lumber	VP	.40																										
Total			23.49	41.01	37.59	34.60	31.75	28.97	26.47	24.57	23.29	22.30	21.47	20.96	20.52	20.23	19.97	19.75	19.60	19.46	19.32	19.22						

TABLE 7.—*Production costs per thousand board feet, lumber tally, by diameter classes for the four operations studied*—Continued

VIRGIN-GROWTH FLATLAND SHORTLEAF PINE TREES, EASTERN TEXAS

Cost item	Classification of cost	Weighted average cost per thousand board feet, lumber tally	Itemized costs for the indicated diameter breast high in inches																								
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sawing:																											
Labor	VT	0.87																									
Material and supplies	VT	.01	0.88	----	----	1.03	1.00	0.97	0.95	0.93	0.91	0.90	0.88	0.87	0.85	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Skidway and teamsters:																											
Labor	VT	.69																									
Material and supplies	VT	.18	1.49	----	----	3.11	2.77	2.45	2.18	1.97	1.79	1.63	1.51	1.39	1.28	1.21	1.15	1.09	1.04	1.02	.99	.97	.95	.94	.92	.92	.92
Feed	VT	.62																									
Loading:																											
Labor	VT	.34																									
Material and supplies	VT	.10	.44	----	----	1.13	.99	.83	.71	.62	.54	.49	.44	.40	.36	.33	.31	.29	.27	.26	.25	.23	.23	.22	.21	.20	.20
Railroad transportation:																											
Woods engine:																											
Labor	V Cap	.44																									
Material and supplies	V Cap	.36	2.61	----	----	3.94	3.67	3.45	3.24	3.05	2.88	2.71	2.61	2.48	2.41	2.33	2.30	2.26	2.25	2.23	2.22	2.20	2.17	2.15	2.12	2.10	2.07
Main logging road	V Cap	1.81																									
Spur track:																											
Labor	CA	1.04																									
Material and supplies	CA	.11	1.15	----	----	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Miscellaneous logging expenses	V Tot	.41	----	----	.70	.64	.58	.53	.50	.46	.43	.41	.39	.37	.35	.35	.34	.34	.33	.32	.32	.32	.31	.31	.31	.30	
Pond:																											
Labor	VT	.21																									
Material and supplies	VT	.03																									
Sawmill:																											
Labor	VT	1.68																									
Material and supplies	VT	.27	2.44	----	----	2.81	2.77	2.73	2.68	2.64	2.60	2.55	2.51	2.47	2.42	2.38	2.34	2.29	2.25	2.21	2.17	2.12	2.08	2.04	1.99	1.95	1.91
Oil	VT	.04																									
Green chain:																											
Labor	VT	.19																									
Material and supplies	VT	.02																									

Stacking and loading kilns	V	no. pcs.	.42																						
Dry kiln:																									
Labor	V	no. pcs.	.25																						
Material and supplies	V	no. pcs.	.12																						
Rough shed																									
Labor	V	no. pcs.	.47																						
Material and supplies	V	no. pcs.	.05	1.72			2.05	1.98	1.91	1.85	1.80	1.76	1.74	1.72	1.70	1.69	1.68	1.67	1.66	1.65	1.64	1.63	1.63	1.62	1.61	1.60	1.60	1.59
Yard:																									
Labor	V	no. pcs.	.26																						
Material and supplies	V	no. pcs.	.14																						
Timber-dock labor and material and supplies	V	no. pcs.	.01																						
Planer and shipping:																									
Hauling		C	.34																						
Planing:																									
Labor		C	.70																						
Material and supplies and oil		C	.17	3.41			3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Shipping labor and material and supplies		C	.69																						
Finish-shed labor and material and supplies		C	.01																						
Selling		C	1.50																						
General expenses:																									
Office and office salary		VMT	.50																						
Office expense		VMT	.06																						
Taxes on plant and timber		VMT	1.15																						
Insurance on plant and timber		VMT	.22	4.27			4.93	4.85	4.77	4.70	4.62	4.55	4.47	4.39	4.32	4.24	4.17	4.09	4.02	3.94	3.86	3.79	3.71	3.64	3.56	3.49	3.41	3.33
Accident insurance		VMT	.26																						
Depreciation		VMT	1.80																						
General and dwelling-house, labor material, and supplies		VMT	.28																						
Insurance on lumber		VP	.11																						
Taxes on lumber		VP	.06	.34			.29	.30	.30	.31	.31	.32	.32	.33	.33	.34	.35	.35	.36	.37	.37	.38	.39	.39	.40	.40	.41	.41
Discounts		VP	.17																						
Total				19.16			24.55	23.53	22.55	21.71	21.00	20.37	19.80	19.36	18.91	18.52	18.21	17.96	17.71	17.51	17.32	17.15	16.97	16.80	16.63	16.44	16.30	16.13

TABLE 7.—*Production costs per thousand board feet, lumber tally, by diameter classes for the four operations studied*—Continued

VIRGIN-GROWTH MOUNTAIN SHORTLEAF PINE TREES, WEST-CENTRAL ARKANSAS

Cost item	Classification of cost	Weighted average cost per thousand board feet, lumber tally	Itemized costs for the indicated diameter breast high in inches																							
			8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Sawing:																										
Labor	VT	0.83																								
Tools and supplies	VT	.01	0.98		2.48	2.20	1.94	1.69	1.47	1.29	1.14	1.04	0.95	0.89	0.85	0.82	0.80	0.79	0.79	0.81	0.81	0.84	0.86	0.89	0.90		
Scaling and supervision	VT	.14																								
Brush disposal	VT	.37			1.25	1.05	.86	.71	.59	.51	.45	.40	.36	.33	.32	.29	.28	.28	.26	.26	.26	.26	.26	.26		
Skidding, wagon haul, and swamping	VT	2.78																								
Scaling	VT	.06	2.84		8.28	7.13	6.19	5.36	4.62	4.00	3.49	3.11	2.81	2.58	2.40	2.24	2.12	2.03	1.98	1.95	1.95	1.97	2.01	2.08	2.15		
Loading on cars	VT	1.09			3.89	3.36	2.87	2.42	2.04	1.73	1.48	1.29	1.14	1.00	.87	.77	.67	.61	.55	.51	.47	.45	.44	.44	.44		
Spur tracks	CA	1.49			1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49		
Main-line maintenance, train labor, and supplies	VMT	.92			1.37	1.31	1.26	1.21	1.16	1.10	1.06	1.01	.96	.92	.87	.83	.79	.76	.73	.71	.70	.69	.69	.71	.72		
Freight	V Cap	1.24			2.06	1.90	1.76	1.62	1.51	1.41	1.35	1.29	1.24	1.20	1.17	1.15	1.13	1.12	1.12	1.12	1.14	1.15	1.18	1.20	1.23		
Salaries	V Tot	.07																								
Office expense	V Tot	.01																								
Liability	V Tot	.12																								
Group insurance	V Tot	.01																								
Motor-car repairs and supplies	V Tot	.15	1.20		3.12	2.74	2.40	2.10	1.84	1.62	1.45	1.31	1.21	1.12	1.05	.98	.93	.90	.87	.87	.86	.86	.88	.90	.92		
Miscellaneous expense	V Tot	.17																								
Fire and locomotive insurinsurance	V Tot	.01																								
Taxes	V Tot	.06																								
Depreciation	V Tot	.60																								
Sawmill and pond:																										
Pond expense	VMT	.13																								
Sawmill labor	VMT	1.42																								
Sawmill repair and supplies	VMT	.38	2.28		3.39	3.25	3.11	2.99	2.87	2.73	2.62	2.50	2.38	2.27	2.17	2.06	1.96	1.89	1.82	1.77	1.73	1.71	1.73	1.75	1.78		
Power	VMT	.35																								

Kilns, rip mill, and chains:																											
Green chain	VMT	.34																									
Green lumber transportation	VMT	.11																									
Power	VMT	.18																									
Tram and shed repairs	VMT	.05	1.08	-----	1.61	1.54	1.47	1.42	1.30	1.29	1.24	1.18	1.13	1.08	1.03	.98	.93	.89	.86	.84	.82	.81	.82	.83	.84	-----	-----
Rip-mill labor	VMT	.35																									
Rip-mill repairs and supplies	VMT	.07																									
Dry-kiln labor	V no. pcs.	.85																									
Dry-kiln repairs and supplies	V no. pcs.	.06																									
Dry-lumber transportation	V no. pcs.	.15	1.45	-----	2.28	2.13	1.99	1.87	1.76	1.68	1.61	1.54	1.48	1.43	1.37	1.33	1.28	1.26	1.25	1.24	1.25	1.26	1.27	1.29	1.31	-----	-----
Shed stacking and cleaning	V no. pcs.	.39																									
Planing mill:																											
Handling and trucking to planer	C	.42																									
Planer labor	C	.91	1.64	-----	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	-----	-----
Planer repairs and supplies	C	.14																									
Planer power	C	.17																									
Shipping expenses:																											
Labor	V no. pcs.	.62																									
Supplies and repairs	V no. pcs.	.12	.78	-----	1.22	1.15	1.07	1.00	.95	.90	.86	.83	.80	.77	.74	.71	.69	.68	.67	.67	.67	.68	.68	.69	.70	-----	-----
Wrapped-trim labor and supplies	V no. pcs.	.04																									
General expense:																											
Salaries	VMT	.56																									
Office expense	VMT	.05																									
Liability insurance	VMT	.18																									
Group life insurance	VMT	.09																									
Fire insurance on plant	VMT	.51																									
Fire protection and watchman	VMT	.07	3.61	-----	5.37	5.15	4.93	4.73	4.54	4.32	4.15	3.96	3.77	3.60	3.43	3.27	3.10	2.99	2.88	2.80	2.74	2.71	2.74	2.77	2.82	-----	-----
Waterworks	VMT	.02																									
Taxes on plant	VMT	.10																									
Depreciation	VMT	1.07																									
Miscellaneous expense	VMT	.42																									
Administration	VMT	.54																									
Selling expense	C		1.67	-----	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	-----	-----
Taxes on lumber	VP	.13																									
Insurance on lumber	VP	.14	.86	-----	.71	.70	.71	.72	.74	.76	.79	.81	.84	.86	.89	.91	.93	.94	.95	.96	.96	.97	.96	.96	.95	-----	-----
Discount	VP	.59																									
Total			23.50	-----	41.83	38.41	35.36	32.64	30.25	28.14	26.49	25.07	23.87	22.85	21.96	21.14	20.41	19.94	19.53	19.31	19.16	19.16	19.32	19.57	19.82	-----	-----

For all the steps in lumber manufacture that vary with time, the unit production costs are much greater for small trees than for large ones. This holds true throughout; the different degrees of efficiency in the same steps or in different steps of logging and milling do not change the essential fact that it costs considerably more to handle small trees than to handle large ones.

LUMBER PRICES

For the purpose of computing the sales value of lumber produced from trees of different sizes, prices have been determined from the company's records for each grade of lumber and for different widths in each grade. These figures, which represent the average sales value of the lumber f.o.b. shipping point during 1929, are shown in table 8. In the same table are also the prices that represent the value of 1,000 feet of green lumber, board measure, when dry and dressed. The figures can be applied to the green-chain grade and piece tally to obtain the sales value of the lumber when dry and finished.

TABLE 8.—*Average prices per thousand feet, board measure, for dressed [1] lumber f.o.b. mill for the 4 operations studied, 1929*

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE, SOUTHERN ARKANSAS

Item	Grade																												
	B and Better					No. 1 Common and C					No. 1 Common					No. 2 Common					No. 3 Common					Timber			
	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	10 to 16 feet long	18 to 20 feet long	22 to 24 feet long	All lengths
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Boards, 4/4-inch, dry and dressed:																													
Including edge grain	44.25	49.00	60.75	68.00	68.50	35.00	35.25	35.75	42.50	55.25						19.50	21.75	22.75	22.75	24.75	14.25	16.50	18.50	19.00	19.75				
Excluding edge grain	40.65					34.25										18.15													
Green stock after drying, remanufacture, and dressing:																													
Including edge grain	41.37	46.84	54.86	63.31	64.18	31.82	34.47	33.60	38.08	44.86						18.90	20.42	22.02	22.23	24.40	14.08	16.30	18.28	18.77	19.51				
Excluding edge grain	38.54					31.17																							
Dimension, 8/4-inch											26.25	24.25	27.25	28.00	30.00	23.75	21.75	22.75	21.50	20.75	16.75	17.00							

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE, NORTHERN LOUISIANA

Boards, 4/4-inch:																													
Dry and dressed	37.63	40.47	43.35	52.14	54.18	30.79	34.95	33.25	38.58	49.84						19.52	20.11	22.85	23.36	26.88	15.82	15.82	16.49	18.62	18.80				
Green stock after drying, remanufacture, and dressing	36.80	39.58	42.40	50.99	52.99	30.11	34.18	32.52	37.73	48.74						19.25	19.77	22.42	22.92	26.18	15.82	15.82	16.49	18.62	18.80				
Dimension, 8/4-inch:																													
Dry and dressed											30.16	29.30	29.84	32.24	39.62	24.39	21.26	25.07	24.52	28.71	17.00	17.00	17.00	17.00	17.00				
Green stock after drying, remanufacture, and dressing											30.04	29.18	29.72	32.11	39.46	24.29	21.17	24.97	24.42	28.60	17.00	17.00	17.00	17.00	17.00				

TABLE 8.—*Average prices per thousand feet, board measure, for dressed lumber f.o.b. mill for the 4 operations studied, 1929*—Continued

VIRGIN-GROWTH FLATLAND SHORTLEAF PINE, EASTERN TEXAS

Item	Grade																									
	B and Better					No. 1 Common and C					No. 1 Common					No. 2 Common					No. 3 Common					Timber			
	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	4 inches wide	6 inches wide	8 inches wide	10 inches wide	12 inches wide	10 to 16 feet long	18 to 20 feet long	22 to 24 feet long	All lengths
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
All lumber, dry and dressed	49.25	50.80	51.40	51.60	67.75	34.60	38.02	35.17	42.00	52.12						20.75	21.71	24.36	25.18	27.60	16.75	18.00	19.00	20.00	20.12				
Green stock after drying, remanufacture, and dressing:																													
Boards, 4/4-inch	45.06	46.68	46.95	52.60	62.32	32.18	35.08	32.83	38.66	47.27						20.72	21.68	24.14	24.70	27.34	16.67	17.92	18.91	19.90	20.02				
Dimension, 8/4 inch																26.10	26.10	26.10	26.10	26.10	14.95	14.95	14.95	14.95	14.95				
Length, 10 feet											30.75	25.00	30.75	31.75	37.00														
Length, 12 feet											28.50	25.00	28.50	30.75	37.75														
Length, 14 feet											28.50	25.00	28.25	30.25	35.50														
Length, 16 feet											29.00	25.38	28.50	31.50	33.25														
Length, 18 feet											32.00	27.00	31.75	32.25	37.25														
Length, 20 feet											32.00	27.50	31.75	32.25	37.75														
Length, 22 and 24 feet											35.50	35.50	35.50	37.50	44.50														
Size (inches):																													
3 by 4, 3 by 6, 3 by 8, 4 by 4																										28.25	30.25	33.25	
4 by 6, 4 by 8, 6 by 6, 8 by 8																										26.75	28.75	31.75	
3 by 10, 4 by 10																										31.75	33.75	36.75	
3 by 12, 4 by 12																										37.75	39.75	42.75	
12 by 12																										34.75	36.75	39.75	

VIRGIN-GROWTH MOUNTAIN SHORTLEAF PINE, WEST-CENTRAL ARKANSAS

Boards 4/4 inch:																														
Dry and dressed	45.85	49.70	60.75	67.50	68.50	35.75	39.15	35.00	41.80	53.65						20.10	20.40	23.40	23.80	29.85	16.60	17.60	18.80	18.90	20.40					
Green stock after drying, remanufacture, and dressing	44.78	48.15	58.01	63.11	58.73	35.56	37.40	34.02	40.19	47.08						20.67	22.20	23.43	24.02	29.50	15.77	16.70	17.47	18.10	19.10					
Dimension, 8/4-inch																														
Dry and dressed											29.80	25.60	28.20	31.50	36.00	25.50	20.00	23.50	23.70	25.25										
Green stock after drying, remanufacture, and dressing											20.44	24.80	28.02	31.21	35.65	24.75	19.40	23.50	23.70	25.25										
All sizes																														28.25

[1] The sales value of 1,000 board feet of green lumber when dry and dressed was obtained from the price of dry and dressed lumber by deducting enough to cover the kiln and planer degrade.

LUMBER GRADES

As long as clear lumber commands a premium, the timberland manager should concern himself with the quality increment as well as the quantity increment of the stand. The average sawmill operator, when he includes stumpage in the costs, makes money from the no. 1 common and better lumber he cuts out of the log and just about comes out even or perhaps loses money on the rest. The comparative amount of high-grade lumber in a tree is therefore extremely important to lumbermen, and information on grades and sales value is necessary in working out management plans and computing economic cutting limits. Table 9 gives information on the grades of lumber obtained from trees of different sizes that were cut for this study. As previously explained these figures are the direct result of adding up the lumber tally for the logs that came from the trees.

TABLE 9.—*Percentage of the total mill output and sales value per thousand board feet, lumber tally, of the various grades sawed from trees of different diameters in the four operations studied*

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE IN SOUTHERN ARKANSAS

Diameter breast high	Grade in green condition																Average value per thousand board feet of green lumber when dry and dressed
	Boards								Dimension						Timbers		
	B and better		No. 1 common and C		No. 2 common		No. 3 common		No. 1 common		No. 2 common		No. 3 common				
	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	
	Percent	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Dollars*
8 inches	0.9	42.00	3.0	32.60	38.2	19.00	10.3	14.10	30.6	26.00	12.0	23.00	5.0	16.75	.....	.....	21.62
9 inches	1.1	42.20	5.0	32.80	41.4	19.40	8.9	14.40	28.9	26.00	10.5	23.00	4.2	16.75	.....	.....	22.05
10 inches	1.7	42.50	6.8	32.90	44.3	19.80	8.0	14.80	26.7	26.00	9.1	23.00	3.4	16.75	.....	.....	22.52
11 inches	2.5	43.00	8.4	33.10	47.7	20.10	7.4	15.30	23.6	26.00	7.8	23.00	2.6	16.75	.....	.....	22.94
12 inches	3.6	43.60	9.8	33.30	52.3	20.40	6.9	15.90	19.0	26.00	6.5	23.00	1.9	16.75	.....	.....	23.35
13 inches	5.0	44.40	10.8	33.40	61.2	20.80	6.6	16.40	9.8	26.00	5.3	23.00	1.3	16.75	.....	.....	23.62
14 inches	6.5	45.20	11.5	33.50	65.3	21.10	6.5	16.80	5.4	26.00	4.0	23.00	.8	16.75	.....	.....	24.12
15 inches	8.2	46.00	11.8	33.70	67.3	21.30	6.4	17.10	2.9	26.00	3.0	23.00	.4	16.75	.....	.....	24.69
16 inches	9.7	46.90	11.4	34.00	68.8	21.50	6.4	17.30	1.6	26.00	2.0	23.00	.1	16.75	.....	.....	25.22
17 inches	11.0	47.80	10.2	34.30	69.7	21.70	6.6	17.40	1.1	26.00	1.4	23.00	.....	16.75	.....	.....	25.64
18 inches	12.2	48.70	9.0	34.80	70.0	21.90	7.1	17.50	.8	26.00	.9	23.00	.....	16.75	.....	.....	26.06
19 inches	13.2	49.60	8.2	35.50	69.6	22.00	8.0	17.60	.4	26.00	.6	23.00	.....	16.75	.....	.....	26.42
20 inches	14.2	50.50	7.6	36.30	68.6	22.20	9.1	17.70	.2	26.00	.3	23.00	.....	16.75	.....	.....	26.89
21 idches	15.1	51.40	7.1	37.20	67.3	22.40	10.5	17.80	.....	26.00	.....	23.00	.....	16.75	.....	.....	27.35
22 inches	15.9	52.30	6.7	38.20	65.2	22.60	12.2	17.90	.....	26.00	.....	23.00	.....	16.75	.....	.....	27.79
23 inches	16.7	53.20	6.4	39.30	62.7	22.80	14.2	17.90	.....	26.00	.....	23.00	.....	16.75	.....	.....	28.24
24 inches	17.5	54.20	6.2	40.40	59.9	22.90	16.4	18.00	.....	26.00	.....	23.00	.....	16.75	.....	.....	28.66
25 inches	18.3	55.10	6.0	41.50	56.9	23.10	18.8	18.00	.....	26.00	.....	23.00	.....	16.75	.....	.....	29.10
26 inches	19.0	56.00	5.8	42.60	53.8	23.20	21.4	18.00	.....	26.00	.....	23.00	.....	16.75	.....	.....	29.44
Weighted average	8.5	47.91	9.8	34.15	63.5	21.37	7.4	16.90	6.7	26.00	3.3	23.00	.8	16.75	.....	.....	24.88

TABLE 9.—*Percentage of the total mill output and sales value per thousand board feet, lumber tally, of the various grades sawed from trees of different diameters in the four operations studied*—Continued

VIRGIN-GROWN FLATLAND SHORTLEAF PINE IN EASTERN TEXAS

Diameter breast high	Grade in green condition																Average value per thousand board feet of green lumber when dry and dressed
	Boards								Dimension						Timbers		
	B and better		No. 1 common and C		No. 2 common		No. 3 common		No. 1 common		No. 2 common		No. 3 common				
	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	Amount	Value	
	Percent	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Percent*	*Dollars*	*Dollars*
10 inches	2.6	44.35	6.1	33.50	19.0	21.20	7.7	17.65	20.4	28.10	5.2	26.10	1.0	14.95	38.0	28.00	26.46
11 inches	3.4	44.70	6.6	33.55	20.2	21.35	6.4	17.80	26.0	28.30	6.0	26.10	1.0	14.95	30.4	28.05	26.79
12 inches	4.3	45.05	7.1	33.65	21.4	21.55	4.1	17.90	29.1	28.80	6.6	26.10	1.0	14.95	26.4	28.10	27.34
13 inches	5.3	45.45	7.7	33.80	22.6	21.80	2.9	18.05	30.0	29.20	7.0	26.10	1.0	14.95	23.5	28.25	27.84
14 inches	6.5	45.90	8.2	33.90	23.6	22.10	2.4	18.15	29.7	29.65	7.2	26.10	1.0	14.95	21.4	28.45	28.34
15 inches	8.0	46.40	8.7	34.00	24.4	22.35	3.2	18.30	27.7	30.10	7.2	26.10	1.0	14.95	19.8	28.70	28.76
16 inches	9.7	46.80	9.2	34.10	25.6	22.70	5.1	18.45	23.8	30.55	7.0	26.10	1.0	14.95	18.6	29.00	29.07
17 inches	11.5	47.20	9.7	34.25	26.2	23.00	6.2	18.55	21.1	30.95	6.7	26.10	1.1	14.95	17.5	29.35	29.51
18 inches	13.3	47.55	10.2	34.45	25.7	23.30	7.6	18.70	19.2	31.40	6.3	26.10	1.1	14.95	16.6	29.75	30.02
19 inches	15.1	47.90	10.6	34.70	25.6	23.65	8.2	18.80	17.8	31.80	5.8	26.10	1.1	14.95	15.8	30.15	30.61
20 inches	16.9	48.20	11.1	35.00	25.2	23.95	8.7	18.90	16.7	32.15	5.2	26.10	1.2	14.95	15.0	30.60	31.21
21 inches	18.6	48.55	11.5	35.35	24.6	24.25	9.1	19.05	15.8	32.55	4.8	26.10	1.2	14.95	14.4	31.10	31.85
22 inches	20.3	48.85	12.0	35.75	23.6	24.50	9.6	19.20	15.1	32.90	4.4	26.10	1.2	14.95	13.8	31.65	32.50
23 inches	21.8	49.20	12.4	36.15	22.4	24.75	10.2	19.30	14.6	33.30	4.2	26.10	1.2	14.95	13.2	32.20	33.11
24 inches	23.3	49.45	12.9	36.60	21.1	25.00	10.7	19.40	14.2	33.60	4.0	26.10	1.2	14.95	12.6	32.80	33.72
25 inches	24.6	49.70	13.3	37.10	19.8	25.20	11.3	19.50	13.9	33.85	3.8	26.10	1.1	14.95	12.2	33.50	34.30
26 inches	25.8	49.95	13.7	37.55	18.6	25.35	11.8	19.60	13.7	34.10	3.6	26.10	1.0	14.95	11.8	34.05	34.84
27 inches	26.9	50.20	14.1	37.95	17.5	25.45	12.3	19.65	13.6	34.30	3.4	26.10	.9	14.95	11.3	34.70	35.33
28 inches	28.0	50.40	14.4	38.30	16.5	25.60	12.7	19.70	13.5	34.45	3.2	26.10	.8	14.95	10.9	35.30	35.81
29 inches	28.9	50.60	14.6	38.70	15.8	25.70	13.0	19.75	13.4	34.60	3.0	26.10	.7	14.95	10.6	35.95	36.24
30 inches	29.6	50.75	14.7	39.00	15.2	25.80	13.2	19.80	13.4	34.65	2.8	26.10	.7	14.95	10.4	36.50	36.56
31 inches	30.3	50.85	14.8	39.25	14.7	25.90	13.3	19.85	13.4	34.70	2.6	26.10	.7	14.95	10.2	37.00	36.87
Weighted average	14.3	48.39	10.4	35.28	23.4	23.35	7.1	18.07	20.8	31.02	5.7	26.10	1.1	14.95	17.2	29.92	30.65

VIRGIN-GROWTH MOUNTAIN SHORTLEAF PINE IN WEST-CENTRAL ARKANSAS

9 inches	3.0	44.80	11.2	35.55	44.2	21.20	5.5	16.30	26.8	29.40	6.8	24.75	2.5	14.75			25.52
10 inches	4.4	45.40	11.3	36.30	44.9	21.55	5.8	16.45	24.2	26.20	6.7	23.85	2.7	14.95			25.07
11 inches	6.0	46.15	11.5	36.55	45.2	21.85	6.2	16.60	21.6	25.90	6.7	22.00	2.8	15.05			25.37
12 inches	7.8	47.35	11.6	36.35	45.3	22.15	6.5	16.70	19.1	26.05	6.6	20.90	2.8	15.05	0.3	28.25	25.89
13 inches	9.6	48.65	11.8	35.75	44.9	22.40	6.9	16.80	16.8	26.55	6.6	21.35	2.8	14.90	.6	28.25	26.56
14 inches	11.4	49.85	11.9	35.45	44.3	22.65	7.3	16.90	14.9	27.20	6.6	21.85	2.8	14.80	.8	28.25	27.30
15 inches	13.2	51.10	12.0	35.75	43.6	22.80	7.7	17.00	13.3	28.05	6.5	22.20	2.7	15.20	1.0	28.25	28.15
16 inches	14.9	52.15	12.0	36.55	42.9	22.95	8.1	17.10	11.9	28.95	6.4	22.50	2.6	15.55	1.2	28.25	29.02
17 inches	16.5	53.20	12.0	37.40	41.9	23.20	8.6	17.20	10.8	29.80	6.3	22.80	2.6	15.70	1.3	28.25	29.90
18 inches	18.0	54.20	12.0	38.20	40.9	23.60	9.0	17.30	10.0	30.60	6.2	23.10	2.6	15.80	1.3	28.25	30.82
19 inches	19.4	55.05	12.0	38.95	40.1	24.05	9.6	17.40	9.2	31.35	6.0	23.35	2.5	15.90	1.2	28.25	31.69
20 inches	20.6	55.65	12.0	39.65	39.5	24.65	10.2	17.55	8.6	32.00	5.8	23.60	2.4	15.95	.9	28.25	32.51
21 inches	21.5	56.20	12.0	40.30	39.0	25.25	10.8	17.70	8.2	32.65	5.5	23.80	2.4	16.00	.6	28.25	33.22
22 inches	22.2	56.60	12.1	40.85	38.3	25.75	11.6	17.85	7.9	33.15	5.2	24.05	2.3	16.00	.4	28.25	33.79
23 inches	22.7	56.75	12.1	41.30	37.7	26.20	12.5	17.95	7.6	33.60	4.9	24.30	2.3	16.00	.2	28.25	34.17
24 inches	23.1	56.70	12.1	41.70	37.1	26.55	13.6	18.05	7.4	33.85	4.5	24.50	2.2	16.00		28.25	34.41
25 inches	23.4	56.55	12.2	41.85	36.4	26.80	14.6	18.15	7.2	33.95	4.0	24.70	2.2	16.00			34.53
26 inches	23.7	56.40	12.2	41.90	35.8	26.95	15.7	18.20	7.0	34.10	3.5	24.90	2.1	16.00			34.58
27 inches	23.9	56.20	12.2	41.80	35.1	26.95	16.8	18.20	6.9	34.20	3.0	25.10	2.1	16.00			34.50
28 inches	24.1	55.95	12.2	41.50	34.4	26.75	18.0	18.20	6.8	34.25	2.5	25.30	2.0	16.00			34.31
29 inches	24.3	55.70	12.2	41.20	33.7	26.40	19.2	18.20	6.7	34.30	1.9	25.50	2.0	16.00			34.08
Weighted average	17.5	54.38	12.0	38.39	41.0	23.92	9.5	17.44	10.7	29.88	5.9	23.00	2.5	15.65	.9	28.25	30.79

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE IN NORTHERN LOUISIANA

8 inches	0.4	36.80	5.6	30.10	39.6	19.25	6.6	15.60	23.5	30.05	17.8	24.30	6.5	17.00			22.98
9 inches	.6	36.80	6.2	30.10	41.1	19.25	6.5	15.60	23.2	30.05	17.6	24.30	4.8	17.00			23.80
10 inches	.8	36.80	6.5	30.45	43.2	19.30	6.4	15.60	22.4	29.85	17.3	24.05	3.4	17.00			23.03
11 inches	1.0	36.95	6.7	31.05	45.6	19.45	6.3	15.65	21.3	29.60	16.8	23.00	2.3	17.00			22.86
12 inches	1.2	37.20	6.8	31.75	48.5	19.70	6.2	15.70	19.4	29.45	16.3	22.45	1.6	17.00			22.78
13 inches	1.5	37.55	6.8	32.25	51.2	20.00	6.2	15.75	17.5	29.45	15.6	22.60	1.2	17.00			22.86
14 inches	1.7	37.90	6.7	32.65	53.4	20.35	6.3	15.85	16.1	29.55	14.9	22.80	.9	17.00			23.01
15 inches	2.1	38.30	6.5	32.95	54.9	20.70	6.7	16.00	15.0	29.70	14.1	23.15	.7	17.00			23.22
16 inches	2.4	38.70	6.3	33.20	56.2	21.10	7.2	16.15	14.0	30.00	13.3	23.50	.6	17.00			23.47
17 inches	2.7	39.20	6.0	33.40	57.2	21.45	8.0	16.40	13.0	30.40	12.5	23.80	.5	17.00			23.68
18 inches	3.1	39.65	5.7	33.60	57.9	21.80	8.9	16.75	11.9	31.10	12.0	24.20	.5	17.00			23.95
19 inches	3.5	40.20	5.4	33.85	58.5	22.20	10.0	17.00	10.9	32.30	11.3	24.60	.4	17.00			24.29
20 inches	3.9	40.80	5.0	34.05	58.9	22.55	11.2	17.20	9.9	34.20	10.7	25.00	.4	17.00			24.63
21 inches	4.3	41.60	4.7	34.25	59.1	22.90	12.5	17.30	8.9	35.85	10.1	25.45	.4	17.00			24.92
22 inches	4.8	42.50	4.4	34.45	59.2	23.25	14.0	17.35	7.7	37.10	9.5	25.90	.4	17.00			25.13
23 inches	5.2	43.35	4.1	34.65	59.0	23.60	15.5	17.40	6.8	38.05	9.0	26.30	.4	17.00			25.32
24 inches	5.6	44.15	3.8	34.85	58.8	23.95	17.0	17.45	6.0	38.70	8.4	26.80	.4	17.00			25.49
25 inches	6.0	44.90	3.5	35.00	58.4	24.30	18.6	17.50	5.3	39.20	7.8	27.20	.4	17.00			25.63
26 inches	6.4	45.50	3.2	35.15	58.0	24.70	20.1	17.55	4.7	39.45	7.2	27.65	.4	17.00			25.80
Weighted average	2.5	39.81	6.1	32.95	54.8	21.22	8.2	16.48	14.2	30.52	13.4	23.54	.8	17.00			23.69

PRODUCTION COST AND LUMBER VALUE COMPARED

With unit production costs and the sales value of the lumber for trees of different diameters available, it is possible to compare the two and thus determine the gross difference available for stumpage, Federal taxes, interest, and profit, and also to determine the smallest tree that will pay its way. In making these comparisons it has been assumed that the cost of woods improvements, such as camps and spur tracks, is the same per thousand board feet for each diameter class as for the stand as a whole.

Table 10 gives a comparison of the total unit production cost, excluding stumpage, Federal taxes, and interest, and the unit sales value of the lumber for pine trees of different diameters.

TABLE 10.—*Difference between production cost [1] and sales value per thousand feet, board measure, of green lumber from trees of different diameters from the 4 operations studied*

Diameter breast high	Second-growth, forest-grown mixed shortleaf and loblolly pine in southern Arkansas				Second-growth old-field loblolly pine in northern Louisiana				Virgin-growth mountain shortleaf pine in west-central Arkansas				Virgin-growth flatland shortleaf pine in eastern Texas		
	Total production cost [1]	Sales value	Difference between cost [1] and value		Total production cost [1]	Sales value	Difference between cost [1] and value		Total production cost [1]	Sales value	Difference between cost [1] and value		Total production cost [1]	Sales value	Difference between cost [1] and value, gross profit
			Loss	Gross profit			Loss	Gross profit			Loss	Gross profit			
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8 inches	33.01	21.62	11.39		41.01	22.98	18.03								
9 inches	28.86	22.05	6.81		37.59	23.08	14.51		41.83	25.52	16.31				
10 inches	26.24	22.52	3.72		34.60	23.03	11.57		38.41	25.07	13.34		24.55	26.46	1.91
11 inches	24.57	22.94	1.63		31.75	22.86	8.89		35.36	25.37	9.99		23.53	26.79	3.26
12 inches	23.32	23.35		0.03	28.97	22.78	6.19		32.64	25.89	6.75		22.55	27.34	4.79
13 inches	22.19	23.62		1.43	26.47	22.86	3.61		30.25	26.56	3.69		21.71	27.84	6.13
14 inches	21.25	24.12		2.87	24.57	23.01	1.56		28.14	27.30	.84		21.00	28.34	7.34
15 inches	20.46	24.69		4.23	23.29	23.22	.07		26.49	28.15		1.66	20.37	28.76	8.39
16 inches	19.79	25.22		5.43	22.30	23.47		1.17	25.07	29.02		3.95	19.80	29.07	9.27
17 inches	19.16	25.64		6.48	21.47	23.68		2.21	23.87	29.90		6.03	19.36	29.51	10.15
18 inches	18.67	26.06		7.39	20.96	23.95		2.99	22.85	30.82		7.97	18.91	30.02	11.11
19 inches	18.22	26.42		8.20	20.52	24.29		3.77	21.96	31.69		9.73	18.52	30.61	12.09
20 inches	17.81	26.89		9.08	20.23	24.63		4.40	21.14	32.51		11.37	18.21	31.21	13.00
21 inches	17.49	27.35		9.86	19.97	24.92		4.95	20.41	33.22		12.81	17.96	31.85	13.89
22 inches	17.20	27.79		10.59	19.75	25.13		5.38	19.94	33.79		13.85	17.71	32.50	14.79
23 inches	16.94	28.24		11.30	19.60	25.32		5.72	19.53	34.17		14.64	17.51	33.11	15.60
24 inches	16.68	28.66		11.98	19.46	25.49		6.03	19.31	34.41		15.10	17.32	33.72	16.40
25 inches	16.45	29.10		12.65	19.32	25.63		6.31	19.16	34.53		15.37	17.15	34.30	17.15
26 inches	16.29	29.44		13.15	19.22	25.80		6.58	19.16	34.58		15.42	16.97	34.84	17.87
27 inches									19.32	34.50		15.18	16.80	35.33	18.53
28 inches									19.57	34.31		14.74	16.63	35.81	19.18
29 inches									19.82	34.06		14.24	16.44	36.24	19.80
30 inches													16.30	36.56	20.26
31 inches													16.13	36.87	20.74
Weighted average	20.72	24.88		4.16	23.49	23.60		.11	23.49	30.79		7.30	19.16	30.65	11.49

[1] Excluding stumpage, Federal taxes, and interest.

The question of what effect a decline in lumber prices has on cutting limits often arises. If declines of 10 percent in production cost and also in lumber value had occurred simultaneously, in this operation, no change in the size of the tree that was barely paying its way would have occurred, because production costs and sales value are nearly equal in the diameter classes among which the change from profit to loss comes. If sales value alone had declined 10 percent and the production costs had remained the same, then the minimum size of the trees that paid their ways in the southern Arkansas stand would have been 14 inches instead of 12. Or, if production costs had been reduced 10 percent and lumber prices had remained the same, a tree 11 inches in diameter would have paid its way, excluding stumpage, Federal taxes, and interest.

FINANCIAL RESULTS FOR DIFFERENT MINIMUM-DIAMETER CUTTING LIMITS

Cutting limits are discussed here primarily for the purpose of bringing out the economic aspects of selective logging applied to an entire stand. The controlling motive in marking a stand for sustained-yield management by selective logging should be to take out enough timber to justify logging and yet leave enough to reseed the land and also provide a return cut within a reasonable time. A minimum-diameter cutting limit may be used, but trees below this limit should be marked for cutting if they are defective, and healthy trees well above the minimum size may be left occasionally if they are needed for seeding purposes or to help out the next cut when the existing stand is heavy and yet is short of small trees. The financial returns under such conditions can be computed, once the volume distribution of the cut among the different diameter classes has been determined, just as easily as when a diameter limit is followed strictly, as is done in table 11.

TABLE 11.—*Gross return [1] per thousand board feet, lumber tally, and per acre in cutting to different minimum-diameter limits in the 4 operations studied*

SECOND-GROWTH, FOREST-GROWN MIXED SHORTLEAF AND LOBLOLLY PINE IN SOUTHERN ARKANSAS

Diameter breast high for cutting, inches	Volume removed per acre	Per thousand board feet, lumber tally			Gross profits [1] per acre
		Total production cost	Sales value	Difference: Gross profit [2]	
	Board feet, lumber tally	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8 and up	12,636	20.72	24.88	4.16	52.57
9 and up	12,611	20.60	24.80	4.20	52.97
10 and up	12,371	20.56	24.94	4.38	54.18
11 and up	11,915	20.40	25.03	4.63	55.17
12 and up	11,247	20.23	25.16	4.93	55.45
13 and up	10,298	20.07	25.33	5.26	54.17
14 and up	8,958	19.96	25.58	5.62	50.34
15 and up	7,443	19.98	25.88	5.90	43.91
16 and up	5,926	20.21	26.18	5.97	35.38
17 and up	4,408	20.78	26.49	5.71	25.88
18 and up	3,274	21.99	26.81	4.91	16.08
19 and up	2,288	23.58	27.13	3.25	7.44
20 and up	1,530	27.35	27.48	.13	.20
21 and up	961				
22 and up	569				
23 and up	303				
24 and up	139				
25 and up	61				
26 and up	13				

[1] Excluding stumpage, Federal taxes, and interest. [2] Minus sign indicates a loss.

TABLE 11.—*Gross return per thousand board feet, lumber tally, and per acre in cutting to different minimum-diameter limits in the 4 operations studied*—Con.

SECOND-GROWTH OLD-FIELD LOBLOLLY PINE IN NORTHERN LOUISIANA

Diameter breast high for cutting, inches	Volume removed per acre	Per thousand board feet, lumber tally			Gross profits per acre
		Total production cost	Sales value	Difference: Gross profit	
	Board feet, lumber tally	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8 and up	17,259	26.97	23.32	−2.05	−45.74
9 and up	16,500	25.39	23.33	−2.06	−34.11
10 and up	15,859	24.91	23.34	−1.57	−24.90
11 and up	14,830	24.33	23.36	−.97	−14.39
12 and up	13,444	23.69	23.42	−.27	−3.63
13 and up	11,566	23.04	23.52	.48	6.55
14 and up	10,048	22.72	23.62	.90	9.04
15 and up	8,106	22.60	23.76	1.16	9.47
16 and up	6,165	22.78	23.94	1.16	7.09
17 and up	4,227	23.60	24.15	.55	2.32
18 and up	2,931	25.68	24.44	−1.24	−3.26
19 and up	1,438	30.06	24.84	−5.82	−8.37
20 and up	923	37.10	25.15	−11.95	−10.99
VIRGIN-GROWTH FLATLAND SHORTLEAF PINE IN EASTERN TEXAS					
10 and up	14,474	19.16	30.65	11.49	166.31
11 and up	14,445	19.15	30.66	11.51	166.26
12 and up	14,213	19.10	30.72	11.62	165.16
13 and up	13,020	18.99	30.87	11.87	161.67
14 and up	12,708	18.80	31.09	12.29	155.04
15 and up	11,538	18.79	31.36	12.57	145.01
16 and up	10,161	18.73	31.72	12.99	131.99
17 and up	8,820	18.75	32.12	13.37	118.04
18 and up	7,028	18.83	32.53	13.70	104.59
19 and up	6,542	18.90	32.94	13.94	91.20
20 and up	5,558	19.29	33.36	14.07	78.20
21 and up	4,891	19.72	33.77	14.05	65.49
VIRGIN-GROWTH MOUNTAIN SHORTLEAF PINE[3] IN WEST-CENTRAL ARKANSAS					
8 and up	6,299				
9 and up	6,121	23.55	29.64	6.09	37.28
10 and up	6,080	23.44	29.66	6.22	37.82
11 and up	6,008	23.27	29.72	6.45	38.75
12 and up	5,878	23.04	29.81	6.77	39.79
13 and up	5,660	22.72	29.96	7.24	40.98
14 and up	6,324	22.34	30.18	7.84	41.74
15 and up	4,912	21.98	30.42	8.44	41.46
16 and up	4,427	21.66	30.67	9.01	39.89
17 and up	3,846	21.36	30.92	9.56	36.77
18 and up	3,155	21.15	31.14	9.99	31.52
19 and up	2,536	21.09	31.22	10.13	25.71
20 and up	2,037	21.24	31.10	9.86	20.09
21 and up	1,551	21.74	30.66	8.92	13.83
22 and up	1,076	22.99	29.53	6.54	7.03

[3] Includes a volume of 286 board feet per acre, lumber tally, of red and white oak.

Of course there is no maximum-diameter cutting limit; all trees from the largest down to the minimum-diameter limit are removed, except only those left for seed and similar purposes. Hence a minimum-diameter cutting limit of 12 inches, for example, means that essentially all trees 12 inches and larger in diameter breast-high are to be cut.

Table 11 gives the weighted production cost, excluding stumpage, taxes, and interest; the value of the lumber; and the gross return per thousand board feet and also per acre under different minimum-

diameter cutting limits. Before considering these results, however, it is desirable to understand clearly how leaving a part of the stand uncut affects the various factors in lumber production. In general, there are three classes of costs: (1) Varying expenditures, like those for felling and bucking, the amounts of which vary directly with the time required to cut 1,000 board feet of logs from trees of different sizes; (2) constant expenditures, such as those in the planing mill, that are constant per thousand board feet of lumber; and (3) completed or fixed expenditures, such as those for spur tracks, the apportionments of which vary with the amount of timber removal per acre. Unit-cost items in the first group decline in selective cutting as the smaller, more time-consuming trees are left to grow, whereas the apportionments of the permanent improvement costs increase as the amount of timber removed from each acre decreases.

APPLICATION OF RESULTS TO THE HANDLING OF TIMBERLANDS

Where the operator depends on natural reproduction to stock the land, as operators in southern yellow pine generally do, the manner of cutting the existing stand largely determines the degree to which the land will be kept productive, assuming of course that there is fire protection. Likewise, the method of cutting has a marked effect on both the immediate and the future profits of the operation, no matter whether the owner wants to make his operation permanent or to cut out and move on. Although selective cutting may not be perfectly satisfactory for all stands of southern yellow pine, it does have an extremely wide application. On very poor sites, however, selective cutting may not obtain the best results because reproduction in openings would have to meet too severe competition from the larger trees unless extremely heavy cutting and wide spacing are practiced. In fairly young and extremely thick stands, in which the tops are small, the trees left under selective cutting would probably not immediately show increased growth comparable with the extra amount of light and moisture that would be available. On the other hand, such a stand could probably be handled satisfactorily by harvesting this crop in two cuts, say 10 to 20 years apart. During the last cut enough thrifty small trees, carefully selected, might be left to develop in time a stand that could be handled by selective cutting.

COMPARISON OF SUSTAINED-YIELD AND PERIOD OPERATION

Any form of partial cutting, such as selective logging, has a bearing on the length of time that a mill can operate on the timber that a given tract will supply. This relation holds no matter whether the operator plans to cut clear and move on or, by some form of partial cutting, to extend the life of the operation or perhaps even make it permanent. In most period operations the depreciation and amortization charges for permanent improvements are high, even though the work is continued until every last stick of timber that will saw out a 2 by 4 has been taken. The production cost is higher because small trees are included in the cut, and the average value of the lumber is reduced for the same reason. On the other hand, construction charges for camps and spur tracks are lower than those on partly cut areas with comparable stands. The increased cost for camps and spurs under selective cutting, however, is offset to a large degree by decreased costs for other items, such as felling and milling, which

become less as the size of the timber increases. In fact, for the four different operations studied, 30 to 50 percent of the total volume of the stand could have been left uncut without having increased the unit production cost, because of the compensating effect of these factors. Meanwhile the average value of the lumber increases steadily as a larger percentage of the smaller trees are left uncut.

There are many things for an operator to consider before deciding to clear cut or to cut partly in an effort to develop a permanent or sustained-yield operation, but one question crowds all others into the background: Under which plan will he get the greater return in money? Almost any operating problem can be overcome when a certain way of doing a thing will yield a higher profit Definite figures for long-time operations to answer the question of how to cut are not abundant, but Hallauer (*5*) compares the results for southern yellow pine for a period and a sustained-yield operation and concludes that the sustained-yield is more profitable for virgin and second-growth shortleaf pine. His figures, especially the investments in plant and equipment, were drawn from actual operations, while some of the other costs were obtained from general figures that were checked by judgment.

In addition to the actual cash advantage of sustained-yield operation there are numerous others, some direct, and some the indirect ones that always result from permanency and stabilization in any community, such as better schools and roads and a satisfied class of labor. Any lumberman, therefore, who can see his way clear from a strictly financial standpoint, based solely on his profits from timber growing and lumber manufacture, to make his operation permanent by cropping his lands systematically is bound to reap additional benefits. He will reap them either directly, as for example through the operation of power plants and stores, or indirectly through the better social conditions that invariably obtain in a permanent community.

MINIMUM-DIAMETER LIMITS FOR SELECTIVE CUTTING

For the operator who is interested in only one cut there is a size of tree below which he should not go if he desires to make the most money per acre. There is also a size below which he should not go if he wants to make the most money for each thousand board feet of timber handled. These 2 minimum cutting limits for the 4 stands studied are given in table 12. Both these economic limits, of course, are affected by the products into which the timber is cut and the comparative production costs of the different companies, particularly the cost of permanent improvements in the woods. The smallest pine tree that paid its way, not including stumpage, Federal taxes, interest, or profit, was 10 inches in diameter; it was found at the operation in Texas. The reason for this low limit was that the company cut its small logs into timbers and dimension, for which there was a very good market close at hand, with the result that the 10-inch trees were worth about $4 more per thousand board feet than those at the study in southern Arkansas, where no timbers were cut. Cutting a high percentage of the small trees into timbers and dimension also reduced mill costs and in addition increased overrun, thereby reducing woods costs. In contrast with this was the operation in the mountains of western Arkansas, where a virgin shortleaf pine tree had to be 15 inches in diameter to pay its way. If stumpage, Federal taxes, and interest

are added to the production cost these cutting limits will have to be raised from 2 to 4 inches.

TABLE 12.—*The smallest tree that paid its way and the minimum-diameter cutting limits that yielded the highest return per acre and per thousand board feet for the operations studied*

Class of timber	Average age of stand	Diameter breast high of the smallest tree that paid its way [1]	Minimum-diameter cutting limit that yielded the highest gross return	
			Per acre	Per thousand board feet, lumber tally
	Years	*Inches*	*Inches*	*Inches*
Second-growth, forest-grown shortleaf and loblolly pine in southern Arkansas	58	12	12	16
Second-growth old-field loblolly pine in northern Louisiana	42	16	15	15
Virgin-growth flatland shortleaf pine in eastern Texas	122	10	10	20
Virgin-growth mountain shortleaf pine and mixed oak in west-central Arkansas	144	15	14	19

[1] Excluding stumpage, Federal taxes, and interest.

The minimum-diameter cutting limit that yields the highest profit per acre is of greatest interest to the operator who does not care to log a second time and wants to cut the timber the first time so that he may make the most money. From this standpoint the minimum-diameter cutting limit ranges from 10 inches in virgin shortleaf pine, where a large percentage of the small trees was cut into timbers and dimension, to 14 inches in the virgin shortleaf-mixed oak type of stand in the mountains of western Arkansas, where practically no timbers were cut, the entire log going into lumber, and then again upward to 15 inches in the old-field stand of northern Louisiana. At the area in southern Arkansas, the owner would have made fully $2 more per acre if all trees below 12 inches in diameter had been left standing, and in addition about 1,400 board feet of young trees, per acre, would have remained on the ground to provide the nucleus for another cut and to supply seed.

If the mill has enough timber to keep it running satisfactorily the minimum-diameter limit that yields the highest profit for each thousand board feet handled should be considered. Of course this cutting limit, as usual, could not be followed strictly because it would not be either good forestry or good business to leave standing trees that were not growing at a fair rate or trees that were defective. The quality of the site would also affect the amount of timber that could be left and yet permit satisfactory reproduction. On poor sites the competition for moisture is more severe than on good, moist sites, and the stand left after cutting would therefore have to be lighter to permit reproduction to survive.

There is still another question, one for which the available data are insufficient, namely, the exact degree to which a stand must be opened up to get the most satisfactory increase in growth for the trees that are left standing. On the Ouachita National Forest, for example, timber-sale officers state that in general if a shortleaf pine tree is to increase its growth rate materially after selective cutting in the stand it must have around it an opening with a 25-foot radius.

Selective cutting when properly executed will consider not only the size and the form and the thrift of the trees to be cut but also the species. On the Ouachita National Forest, in the shortleaf pine-mixed oak type of stand, the marking practice called for the removal of all merchantable hardwoods as a forest-improvement measure both because of their poor quality and because of a desire to favor the pine. Oftentimes shortleaf and loblolly pines are found growing together on old fields in which the fertility of the soil has been reduced by agricultural crops. On such land loblolly may not maintain its growth so well as shortleaf, and for that reason a selective cutting in such a stand might well favor shortleaf. On the other hand, on average sites loblolly grows more rapidly than shortleaf, when in mixture, although it cannot endure the competition that shortleaf can; this accounts for the fact that in mixed stands the loblolly trees are both larger and fewer than the shortleaf. Loblolly is also considered more windfirm than shortleaf, yet it does not cut into quality lumber so well. Considering all these things, probably the best way to mark such a stand for cutting would be to leave the thrifty trees of each species without exercising any conscious effort to favor either one.

PRACTICAL ASPECTS OF SELECTIVE LOGGING

If an operator leaves trees standing, good trees on which he could make some profit, with the idea of coming back later and cutting them after they have increased in volume and quality, he must have faith in the future of the lumber industry, confidence that the State will maintain equitable tax laws, assurance that fire will not ravage his holdings, and conviction that the method of cutting used is satisfactory. In addition, the mill cut and the productive capacity of his lands must be balanced reasonably well and, last but not least, his financial condition must be such as to permit the investment. Selective logging should not be entered into on the spur of the moment; it must have adequate plans carefully thought out. Although every business venture extending into the future for several decades requires long-time plans and contains an element of risk, the growing of timber should not be disparaged on this ground; it is little if any different from other long-term enterprises and, if the fifth largest of our national industries is even to hold its own, timberlands of good quality must be kept productive. Selective cutting offers one good way of doing this.

Fortunately for forestry practice, very little of the timber in the shortleaf-loblolly pine territory is logged with power skidders, so that in embarking on selective cutting no very radical changes in logging methods are ordinarily required. The lowered cut per acre under selective cutting and the absolute necessity of reducing to the very minimum the damage to the stand left on the ground, practically eliminate the power skidder. Animal or tractor logging, however, fits in well with selective cutting.

Existing information on logging selectively cut stands is not all satisfactory; it fails to point out the best methods. Intensive studies in this matter are needed. It is of course obvious that as the cut per acre is reduced, the track and camp costs rise, but many practical men think that logging methods can be changed and so improved as to partly offset this increase. The figures heretofore given show that certain costs, such as felling and milling, decrease under selective

cutting, and even under present logging practice production costs do not increase until as much as 30 or 40 percent of the stand is left. But the lumber industry should not be satisfied with this situation, for further study of logging methods should develop practices that will decrease or at least hold constant the logging costs that increase under present practices. Good roads and the use of trucks make it possible to log stands selectively with but little if any additional cost, because expensive track and camp constuction is not required.

Because the trees left standing must be carefully protected from injury, some loggers insist that the costs of selective cutting are higher than those of clear cutting. Experience on national forests indicate that when once the men have become accustomed to working in selectively cut stands this objection to the practice is largely overcome.

Flexibility in the logging operation is also an advantage in handling selectively cut stands. The operator in many instances will wish to select his logging chances as well as the individual trees to be cut, the choice depending on market conditions and the relative maturity of the timber. The possibility of selecting for cutting only the timber that can be handled at a profit during depression periods is an excellent safeguard against financial difficulties at such times; it fits in nicely with a flexible logging set-up; and within limits is not inconsistent with good forestry practice.

One of the outstanding practical requirements of selective cutting is that enough trees of sufficient size and satisfactory thrift be left to seed in the openings made when the larger trees are cut and to yield another cut in a reasonably short time. Successful forestry practice depends in a large measure on keeping the land well stocked. In addition, the trees left standing should be capable of growing at an increased rate after their release, since otherwise one of the advantages of selective cutting is lost. To gain this objective care in selecting the trees to be left is necessary. The most accurate method of determining the rate of growth of a tree is to cut a small core out of it and measure the annual growth rings. An instrument known as an increment borer is best for this purpose. The general appearance of a tree is also a good indication of its thrift, especially to one intimately acquainted with the timber type. Rounded or pointed tops, dense crowns of a dark green color, and grayish bark are usually indications of a thrifty young pine tree and may be used as a guide by an experienced man.

Clear, wide, high-grade boards come only from large clear-boled trees (fig. 6). Hence in cutting selectively with the production of as much of this class of material as possible in mind, it is doubly important to select with extreme care the larger trees that are to be left so that the period when they will produce high-grade material may not be delayed too long.

The general quality of the succeeding cuts from an area can be greatly increased by removing poorly formed and defective trees from the stand. Such a practice also releases valuable space to young growth that should develop under good management into material of much higher quality than the trees it replaces.

ADVANTAGES OF SELECTIVE LOGGING

Selective logging, in addition to being one of the best methods (*1*, *2*, *3*) of keeping southern pine lands fully productive, makes it

FIGURE 6.—The relation of clear boles and clear lumber: (A) Open stands of young, old-field southern yellow pine are often limby and consequently yield little clear lumber, whereas (B) virgin stands as well as (C) second-growth, forest-grown stands, in which the trees have shed their lower limbs early in life, have good, clear boles and produce a fair amount of the higher grades of lumber.

possible to remove a principal part of the value of the stand in the form of large trees and yet remove a small fraction of the total volume;

that is, selective logging removes the greatest value with the least volume, because the large trees that are cut are worth more per thousand board feet than the small ones.

By careful cutting an even-aged stand may be converted into an all-aged stand in which the trees that are removed at each cutting should be of good quality unless wind damage or other accidental injury has occurred. Under such a plan, with a reasonable volume removed there would be little or no delay in getting reproduction started because in shortleaf and loblolly pine (*3*) some seed is borne nearly every year. A stand selectively cut over is much less likely to allow the inroads of undesirable species, such as scrub oak, or even another pine that in time would change the type, than is one cut clear or with only seed trees left. It is also possible to rid the stand of undesirable hardwoods that may already be present. Hardwoods of good quality, however, may be handled along with the pine and are of value in maintaining desirable soil conditions and in hastening the natural process of pruning of the major species in the stand. Soil-moisture conditions are better in selectively cut stands because of the protection from the sun and wind afforded by the trees left standing. This condition is more satisfactory for seed germination and probably reduces the mortality of seedlings as compared with the results on clear-cut lands having no overhead protection.

The fire hazard, as a rule, is less on selectively cut areas than on clear-cut lands because there is less slash, the humidity of the air is higher, and the wind velocity is lower (*9*). Furthermore, general conditions are less favorable for fire in a selectively cut area because in the spring the inflammable material on the ground, shaded by the trees, dries out more slowly and in the fall the ground growth stays green longer than on clear-cut areas. In addition, although selective cutting opens more territory to the fire hazards of lumbering operations than does clear cutting, for the same amount of timber, the presence of men on the ground and the fact that the trees left standing furnish are incentive for fire protection and care would appear to be sufficient to offset this seeming disadvantage.

Selective cutting makes possible an early second cut, a procedure that has many advantages. The sooner a return cut is made the less expense there will be in reclearing and resurfacing old rights of way for logging spurs. Although there are no definite figures available, experienced loggers estimate that regrading an old right of way costs only about half as much as grading a new route for the first time.

An early second cut may also be the means of extending the life of a mill, in a measure filling in the gap between the exhaustion of one crop of timber and the obtaining of another through regrowth. Timber, of course, is the first requirement of a mill, its raw material. The supply of raw material must be continuously adequate if the mill is to make money.

Selective logging as a means of perpetuating the forest and keeping lands productive can exercise a tremendous influence on business and social stabilization and development in many large forest areas of the South, and a controlling influence in not a few of them. Clear cutting without provision for regrowth makes the reverse true. All such accompaniments of clear cutting add to the cost of operation and many times reduce profits measurably. Forestry practice is not a cure for all the ills that beset the lumber industry, yet handling forest lands

so that they will supply continuous crops of timber is one of the most important steps that can be taken in developing and stabilizing the lumber industry of the South.

The growth increment in selectively cut stands is of higher quality than in even-aged stands of the same volume. Figure 7, picturing the quality of the lumber found in typical virgin shortleaf pines of different sizes, shows especially the increase in B and better lumber with increase in diameter breast high. This, in turn, shows why wood laid on by large trees is worth more than an equal volume grown by small ones.

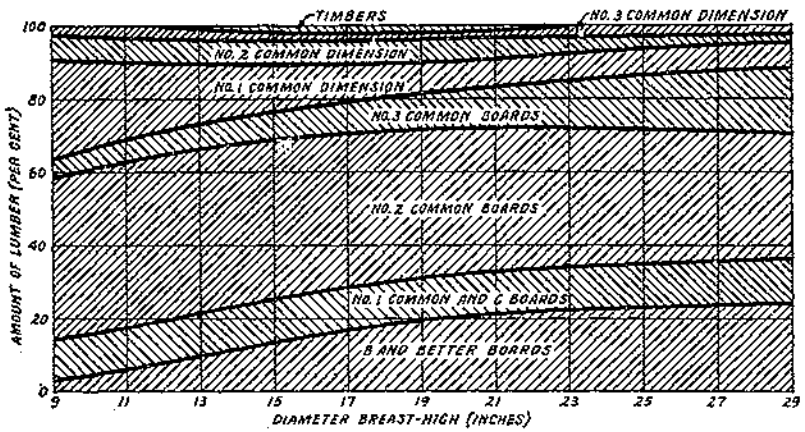

FIGURE 7.—Comparative amounts of the different grades of lumber obtained from virgin shortleaf pine of different diameters, in a typical stand; the percentages are plotted cumulatively.

Under a thorough selective logging plan a given area of land will produce timber more cheaply than under clear cutting and planting. Zeigler, Bond, and Spillers [7] compared two areas in Alabama on which it was planned to grow shortleaf and loblolly pine by selective cutting and by planting. Their computation shows that the actual cost of growing, or in other words the cost of the stumpage under selective cutting, was $1.18 less per thousand board feet international ¼-inch kerf log scale than under clear cutting and planting.

SUGGESTIONS FOR COMPUTING CUTTING LIMITS

Under ordinary conditions plans for handling southern pineland will vary from the simplest minimum-diameter cutting limit for the operator who wants to make the most money per acre and move on, to the extensive ideas of the large owner who has a heavy investment in plant and lands and desires to manage his holdings so that they will supply his sawmill with raw material continuously, and perhaps supply a pulp mill also. In any operation within this wide range the basic data on production costs and quality differences previously presented will be helpful in working out the proper cutting plan.

Since the study covers the four main classes of shortleaf-loblolly pine timber, an operator should be able to select from this bulletin an example that will closely approximate his own holdings. Having

[7] ZEIGLER, E. A., BOND, W. E., and SPILLERS, A. R. A FINANCIAL STUDY OF GROWING LOBLOLLY AND SHORTLEAF PINES IN THE FARM WOODLANDS IN LEE COUNTY, ALABAMA. South. Forest Expt. Sta. [Rpt.] 90 p., illus. 1930. [Unpublished.]

done this he will wish to cruise a fair sample of his own woods, perhaps 40 sample acres or more, well distributed over his holdings, for the purpose of determining the volume distribution of the stand among the different diameter classes; that is, the percentage of the total volume that occurs in each size class of tree. Figures in this bulletin can then be applied to such a table for the purpose of working out minimum cutting limits.

In illustration, assume that the total unit production costs of table 7 for the southern Arkansas stand, when multiplied by the owner's volume distribution figures, give $19.50 per thousand board feet as the weighted-average unit cost for his operation. Then suppose his average actual production cost is $18.52 per thousand board feet. Subtracting $18.52 (actual cost) from $19.50 (calculated cost) gives a difference of 98 cents, which shows that his costs are really 5 percent lower than those determined through the use of the figures in this bulletin. Production costs for individual diameter classes can then be computed for his own operation simply by reducing by 5 percent the costs given in this bulletin; the cost for 9-inch trees would then be $27.42 instead of $28.86 (table 7). Through a similar computation figures for each diameter class can be determined. The average sales value of the lumber for each diameter class of tree may be corrected similarly when an operator's prices are different from those of this bulletin.

With the preceding data available an operator can compute the returns when cutting to different minimum diameter limits, as explained in detail for the southern Arkansas operation in table 13.

TABLE 13.—*Gross return per thousand board feet, lumber tally, and per acre in cutting to different minimum-diameter limits, in a typical stand of second-growth, forest-grown mixed shortleaf and loblolly pine in southern Arkansas*

Diameter breast high	Volume per acre cut from the diameter class	Cost per thousand board feet, lumber tally, excluding spur cost[1]	Cost per acre, excluding spur cost	Sales value per thousand board feet, lumber tally	Sales value of lumber per acre	Diameter breast high for cutting	Total volume per acre removed at the minimum-diameter cutting limit	Cumulative cost per acre, excluding spur cost	Cost per thousand board feet, lumber tally, excluding spur cost	Spur cost per thousand board feet, lumber tally	Total cost per thousand board feet, lumber tally	Cumulative sales value per acre	Sales value per thousand board feet, lumber tally	Gross return per thousand board feet, lumber tally	Gross return per acre
1	2[2]	3[3]	4[4]	5[5]	6[6]	7	8[7]	9[8]	10[9]	11[10]	12[11]	13[12]	14[13]	15[14]	16[15]
	Bd. ft.	*Dollars*	*Dollars*	*Dollars*	*Dollars*		*Bd. ft.*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8 inches	25	31.64	0.79	21.62	0.54	8 inches and up	12,636	244.48	19.35	1.37	20.72	314.39	24.88	4.16	52.57
9 inches	240	27.49	6.60	22.05	5.29	9 inches and up	12,611	243.69	19.32	1.37	20.69	313.85	24.89	4.20	52.97
10 inches	456	24.87	11.34	22.52	10.27	10 inches and up	12,371	237.09	19.16	1.40	20.56	308.56	24.94	4.38	54.18
11 inches	668	23.20	15.50	22.94	15.32	11 inches and up	11,915	225.75	18.95	1.45	20.40	298.29	25.03	4.63	55.17
12 inches	949	21.95	20.83	23.35	22.16	12 inches and up	11,247	210.25	18.69	1.54	20.23	282.97	25.16	4.93	55.45
13 inches	1,340	20.82	27.90	23.62	31.65	13 inches and up	10,298	189.42	18.39	1.68	20.07	260.81	25.33	5.26	54.17
14 inches	1,515	19.88	30.12	24.12	36.54	14 inches and up	8,958	161.52	18.03	1.93	19.96	229.16	25.58	5.62	50.34
15 inches	1,517	19.00	28.96	24.69	37.45	15 inches and up	7,443	131.40	17.65	2.33	19.98	192.62	25.88	5.90	43.91
16 inches	1,428	18.42	26.30	25.22	36.01	16 inches and up	5,926	102.44	17.29	2.02	20.21	155.17	26.18	5.97	35.38
17 inches	1,224	17.79	21.77	25.64	31.38	17 inches and up	4,498	76.14	16.93	3.85	20.78	119.16	26.49	5.71	25.68
18 inches	986	17.30	17.06	26.06	25.70	18 inches and up	3,274	54.37	16.61	5.29	21.90	87.78	26.81	4.91	16.08
19 inches	758	16.85	12.77	26.42	20.03	19 inches and up	2,288	37.31	16.31	7.57	23.88	62.08	27.13	3.25	7.44
20 inches	569	16.44	9.35	26.89	15.30	20 inches and up	1,530	24.54	16.04	11.31	27.35	42.05	27.48	.13	.20
21 inches	392	16.12	6.32	27.35	10.72	21 inches and up	961	15.19				26.75			
22 inches	266	15.83	4.21	27.79	7.39	22 inches and up	569	8.87				16.03			
23 inches	164	15.57	2.55	28.24	4.63	23 inches and up	303	4.66				8.64			
24 inches	88	15.31	1.35	28.66	2.52	24 inches and up	139	2.11				4.01			
25 inches	38	15.08	.57	29.10	1.11	25 inches and up	51	.76				1.49			
26 inches	13	14.92	.19	29.44	.38	26 inches and up	13	.19				.38			
Total	12,636														

[1] Excluding stumpage, Federal taxes, and interest.

[2] The volume of timber, per acre, in the corresponding diameter class of column 1, expressed in board feet, lumber tally.

[3] The respective totals of table 4 minus $1.37, the cost of spur tracks, camps, and roads, which varies with the amount of timber cut per acre.

[4] Column 2 figures multiplied by the corresponding figures of column 3 and divided by 1,000.

[5] Values from table 6.

[6] Column 2 figures multiplied by the corresponding figures of column 5 and divided by 1,000.

[7] The cumulative totals of column 2 figures, starting with the largest diameter class and cutting all trees of the diameter of the corresponding column 1 figure and larger, expressed in board feet, lumber tally.

[8] The cumulative totals of column 4 figures, starting with the largest diameter class and going down to the limit of the corresponding column 1 figure.

[9] Column 9 figures divided by the corresponding figures of column 8, which were first divided by 1,000.

[10] The cost of spur tracks and so forth ($17.31 per acre) divided in turn by column 8 values, which were first divided by 1,000.

[11] Column 10 figures plus the corresponding figures of column 11.

[12] The cumulative totals of column 6 figures, starting with the largest diameter class.

[13] Column 13 figures divided by the corresponding figures of column 8, which were first divided by 1,000.

[14] Column 14 figures minus the corresponding figures of column 12.

[15] Column 15 figures multiplied by the corresponding figures of column 8, which were first divided by 1,000.

SUMMARY

The stabilization and further development of the timber industry in the South depends very largely upon keeping southern forest lands continuously productive. Selective cutting seems to be an excellent method of accomplishing this on most shortleaf and loblolly pine areas. Such a cutting practice also fits in satisfactorily with permanent or sustained-yield operations.

With extension of good roads and improvement in logging methods, selective-cutting plans can be adapted to log a stand to the best advantage, whether economic conditions are good or bad, and yet preserve to a reasonable degree the silvicultural aims of proper management. Under such a plan areas as well as individual trees may be selected for cutting.

The economic justification for selective cutting lies in the basic fact that production costs are lower for large trees than for small trees, and in addition, because of higher grades and greater widths, the lumber from large trees is worth more per thousand feet, board measure, than is that from small trees. On the average it costs twice as much to produce 1,000 board feet of lumber from shortleaf and loblolly pine trees 8 inches in diameter as to produce the same quantity of lumber from similar trees 24 inches in diameter; further, the lumber from the small trees is worth only about three fourths as much as that from the large trees. For every operation there is a diameter limit below which trees do not pay their way in lumber production. This limit differs with types of timber and should be determined in each instance no matter what the ultimate objective of the operation may be, for it has a bearing on both profits and cutting practice.

Under sustained-yield management in which the stand is handled from decade to decade, every effort should be made to grow wood of quality as well as quantity. Proper stocking, hardwoods in mixture with the pine, and even pruning done under favorable conditions are some of the important measures that rid the trees of their lower limbs so that they may lay on clear wood at an early age. Further, age also has an effect; in general, size for size, the older trees contain lumber of higher quality than that in the younger ones. When once selective cutting is in operation, trees need not be cut while still young, as is desirable in clear-cutting operations, but may be cut at almost any age as long as the distribution of size classes is such that enough timber can be obtained at each cutting cycle to make logging practicable.

Since it is fairly certain that increased profits from lumber production, over a long period in the future, will result more from closer utilization and lowered production costs than from extremely high lumber prices, selective cutting is especially important because of its direct bearing on costs, returns, and utilization. Ordinary computation shows that permanent or sustained-yield operation will be more profitable than period operation. In addition, logs from small unprofitable, unthrifty trees are kept from clogging the mills.

The fire hazard is less in selectively cut stands than on clear-cut areas.

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END