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THE PORTABLE BAND SAWMILL AND SELECTIVE LOGGING IN THE LOBLOLLY PINE FORESTS OF NORTH CAROLINA

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CONTENTS

INTRODUCTION

Since the Civil War many thousand acres of farms in North Carolina and other States in the coastal plain have been abandoned for agricultural purposes. Loblolly pine has taken the lead in seeding these areas. It has succeeded admirably because abundant viable seed is produced nearly every year and the species adapts itself readily to a variety of soil and moisture conditions. Such stands are normally even aged, or at least even aged in groups, and form a large part of the remaining pine timber of the region. The commercial range of loblolly pine in North Carolina alone is estimated to cover more than 22,000 square miles, practically all of which is second growth, either of forest or old-field origin. The few remaining virgin stands are being cut out from year to year, making the profitable operation of large lumber mills increasingly difficult.

This situation will inevitably result in the greater use of small mills even where a company has large holdings and desires to grow successive crops of timber on its lands. Profitable operation on a

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

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long-time basis in these stands depends very largely on the adoption of a proper cutting system and the development of manufacturing practices that will produce lumber cheaply and efficiently enough to compete with the water-borne shipments from other regions that regularly come into the Atlantic seaboard markets.

PURPOSE

This bulletin gives information by diameter classes on the relative production cost and lumber grades and yields obtained when an old-field second-growth loblolly pine forest was cut by a new type of portable band sawmill. The information may be used in setting up logging practices that will exclude from the cut the trees that are too small to yield a satisfactory margin for profit and those that will pay larger returns if left for future growth. The new method of lumber

FIGURE 1.—The tract before logging

production described appears worthy of the consideration of all lumbermen interested in operating permanently on the coastal plain.

Selective cutting or logging as here used means a partial-cutting practice in which the large trees and the small defective ones are removed while the small and medium-sized thrifty ones are reserved for future growth and seed production.

AREA STUDIED

The area selected for study was representative of the old-field loblolly type of the Atlantic coastal plain (fig. 1) and was located in northeastern North Carolina. The furrows and ridges still in evidence showed that the land had been in some row crop, such as cotton or corn, before it was taken over by the stand of timber which now occupies it. The stand averaged 55 years in age but varied from 53 years to a very few individual trees that were about 70 years old.

For all practical purposes, however, the stand may be considered even aged.

Loblolly pine made up 94.1 per cent of the volume of the stand considering only trees 8 inches in diameter and larger, even though there were 17 other species, mostly gum, maple, and oaks, associated with it. On a number basis 92 per cent of the dominant trees were loblolly pine. Taking into account all trees 8 inches in diameter and larger, the study area of 8 acres averaged 20,770 board feet, lumber tally, of pine and 1,306 board feet of hardwoods per acre. The largest loblolly pine on the tract was 22 inches in diameter and the largest hardwood 19 inches in diameter.

On an average the area was 80 per cent stocked (trees 4 inches in diameter and larger), as gaged by the ratio of its basal area to yield-table values, and had a site index [3] of about 85 feet.

Table 1, which is based on the data from 8 acres, as are all the other tables, gives the composition of the stand and shows that there were 337 trees per acre, 188 of which were loblolly pine, 5 shortleaf pine, varying from 3 to 22 inches in diameter, and 149 hardwoods, about three-fourths of which were from 3 to 6 inches in diameter. The stand, therefore, was made up of an overstory of pine with an understory of small hardwoods.

TABLE 1.—*Average number of trees per acre by species—old-field loblolly pine, Middle Atlantic coastal plain*

Species	Average number of trees per acre of a diameter breast high of—			
	3 to 6 inches	7 to 12 inches	13 inches and up	Total
Loblolly pine (*Pinus taeda*)	9.2	119.4	59.1	187.7
Red gum (*Liquidambar styraciflua*)	34.0	27.8	2.9	64.7
Black gum (*Nyssa sylvatica*)	42.4	2.7		45.1
Red maple (*Acer rubrum*)	17.7	.9		18.6
White oak (*Quercus alba*)	4.0	.7		4.7
Shortleaf pine (*Pinus echinata*)	2.6	2.0	.1	4.7
Post oak (*Quercus stellata*)	3.9	.5		4.4
Holly (*Ilex opaca*)	1.7			1.7
Sourwood (*Oxydendrum arboreum*)	1.2			1.2
Southern red oak (*Quercus rubra*)	1.1			1.1
Swamp red oak (*Quercus rubra pagodaefolia*)	.8	.2		1.0
Willow oak (*Quercus phellos*)	.4	.1	.4	.9
Hickory (*Hicoria* sp.)	.4			.4
Dogwood (*Cornus florida*)	.4			.4
Haw (*Crataegus* sp.)	.2			.2
Winged elm (*Ulmus alata*)	.1			.1
Yellow poplar (*Liriodendron tulipifera*)	.1			.1
Persimmon (*Diospyros virginiana*)	.1			.1
Total	120.3	154.3	62.5	337.1

For the purpose of studying the effect of different degrees of cutting on the growth of the residual stand, the establishment and growth of reproduction, and to illustrate the practicability of logging successfully in partly cut stands, four sample plots of 2 acres each, all lying close to each other, were established.[4] In selectively cutting these plots the aim was to remove sufficient volume to make logging practicable and at the same time favor loblolly pine and reserve enough

[3] Site index is based on the average height of the dominant trees in the stand at the age of 50 years.
[4] These plots were established by A. L. MacKinney and C. F. Korstion, Appalachian Forest Experiment Station.

thrifty, small, and medium-sized trees to dominate the type, seed the land, and provide a future cut. (Fig. 2.) The amount of timber removed varied from 9,818 to 16,562 board feet per acre. The proportion of the stand removed varied from 53 to 82 per cent and averaged 71 per cent. Under the selective logging plan the mature and poorly formed loblolly pine and all the merchantable hardwoods were removed. This practice resulted in cutting an average of 85.5 loblolly pine trees and 37.8 hardwood trees per acre. There remained

FIGURE 2.—The tract after selective cutting

an average of 102.2 pine trees per acre, varying from 3 to 17 inches in diameter, and 111.6 hardwood trees, varying from 3 to 10 inches in diameter. The volume of the pine left standing, considering only trees 8 inches in diameter and larger, was 6,508 board feet, lumber tally, per acre. The board-foot volume of hardwoods left was negligible.

Table 2 describes the study area further by showing the stand both by the number of trees before and after cutting and the volume distribution by diameter class before cutting.

TABLE 2.—*Composition of old-field loblolly pine trees cut and left per acre in the Middle Atlantic coastal plain*

Diameter breast high in inches	Loblolly pine			Hardwoods			Volume of trees 8 inches and over in board feet lumber tally		
	Cut	Left	Total	Cut	Left	Total	Loblolly pine	Hardwoods	Total
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Per cent*	*Per cent*	*Per cent*
3		0.9	0.9	12.6	34.6	47.2			
4	0.2	.9	1.1	5.8	24.1	29.9			
5	.5	.9	1.4	1.9	18.0	19.9			
6	1.0	4.8	5.8	1.1	13.0	14.1			
7	3.0	11.1	14.1	.3	8.9	9.2			
8	4.0	14.4	18.4	.5	7.5	8.0	3.0	19.6	4.4
9	4.5	19.2	23.7	2.4	4.5	6.9	4.0	13.3	4.7
10	6.0	17.7	23.7	4.1	1.0	5.1	7.1	13.6	7.6
11	8.4	13.6	22.0	3.1		3.1	9.7	12.1	9.9
12	10.0	7.5	17.5	2.6		2.6	10.1	13.7	10.4
13	10.7	5.2	15.9	1.9		1.9	11.9	12.4	12.0
14	9.2	3.5	12.7	.8		.8	11.4	5.9	11.0
15	9.6	1.4	11.0				12.2		11.2
16	6.6	.8	7.4	.4		.4	9.8	3.8	9.3
17	4.9	.3	5.2	.1		.1	8.2	1.8	7.7
18	3.2		3.2	.1		.1	5.7	1.7	5.3
19	2.2		2.2	.1		.1	4.1	2.1	3.9
20	.9		.9				1.6		1.5
21	.5		.5				1.0		.9
22	.1		.1				.2		.2
Total	85.5	102.2	187.7	37.8	111.6	149.4	100.0	100.0	100.0

Table 3 gives the volume distribution of the cut, taking all plots together, and has been used to compute the weighted-average costs and values given later in this bulletin.

TABLE 3.—*Volume distribution of loblolly pine and hardwoods as cut by diameters on a gross-log scale and dry-lumber tally, basis, and percentages of loblolly pine and hardwoods within diameter classes in the Middle Atlantic coastal plain*

Diameter breast high in inches	Loblolly pine		Hardwoods		Total		Within diameter classes			
							Gross log scale		Lumber tally	
	Gross log scale	Lumber tally	Gross log scale	Lumber tally	Gross log scale	Lumber tally	Loblolly pine	Hardwoods	Loblolly pine	Hardwoods
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
8	0.2	0.3	0.6	0.9	0.2	0.3	83.0	17.0	79.5	20.5
9	.4	.4	3.8	5.2	.6	.8	60.6	39.4	47.3	52.7
10	1.8	2.6	12.2	15.4	2.5	3.6	68.3	31.7	66.3	33.7
11	3.2	4.2	16.1	18.2	4.0	5.3	74.4	25.6	72.9	27.1
12	6.5	8.1	19.4	19.8	7.3	9.0	83.0	17.0	82.7	17.3
13	10.0	11.6	19.0	17.6	10.6	12.1	88.5	11.5	88.5	11.5
14	12.6	13.5	9.1	8.0	12.4	13.1	95.2	4.8	95.2	4.8
15	15.7	15.7			14.7	14.4	100.0		100.0	
16	14.8	13.8	6.2	4.9	14.2	13.1	97.2	2.8	97.0	3.0
17	12.3	11.0	4.2	3.2	11.8	10.4	97.7	2.3	97.6	2.4
18	10.2	8.8	4.1	3.0	9.8	8.3	97.3	2.7	97.2	2.8
19	6.7	5.5	5.3	3.8	6.6	5.4	94.9	5.1	94.4	5.6
20	3.2	2.6			3.0	2.4	100.0		100.0	
21	1.8	1.4			1.7	1.3	100.0		100.0	
22	.6	.5			.6	.5	100.0		100.0	

THE PORTABLE BAND SAWMILL

The portable band sawmill used in this study has the power unit, rolls, carriage, deck, sawdust carrier, and log conveyor mounted on a specially constructed flat car. (Figs. 3 and 4.) The mill has 54-inch wheels and uses an 18-gage saw that is swaged to cut about a $\frac{5}{32}$-inch kerf. The carriage is mounted permanently in alignment with the saw, has five knees with patent screw dogs and hand-operated set-works. The power unit consists of a 50-horsepower gasoline engine connected to the saw with a line shaft and a clutch. The logs are hoisted from the ground to the deck on the car by means of a chain conveyor. The sawdust is removed by means of a chain equipped with lugs and running in a trough.

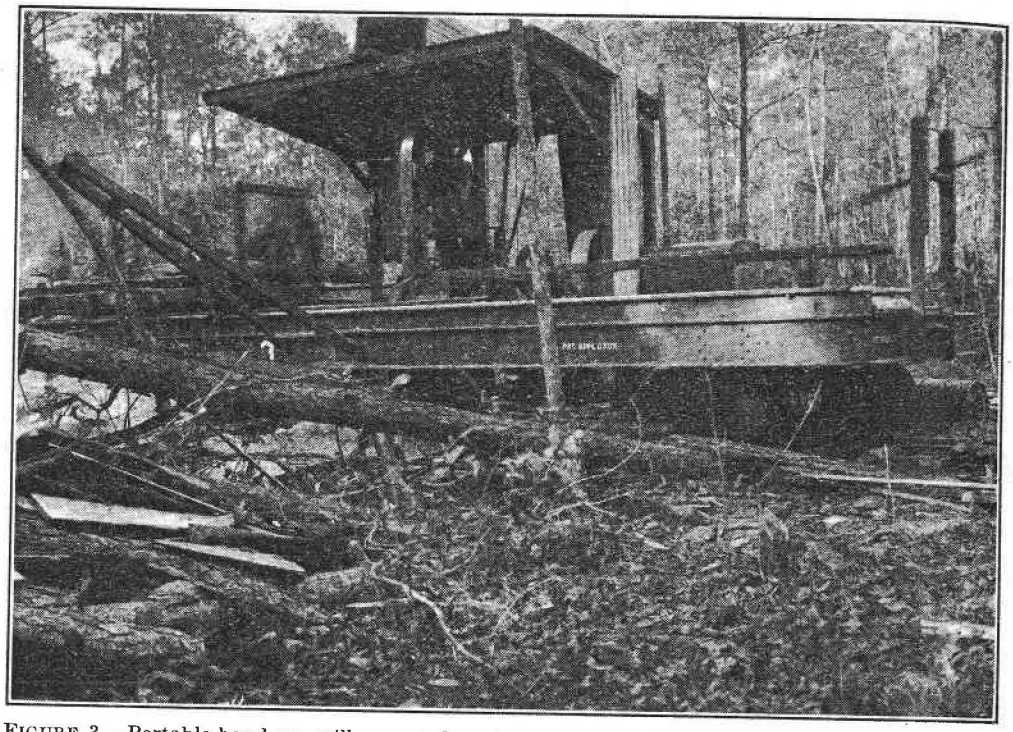

FIGURE 3.—Portable band sawmill mounted on a special steel-frame flat car for easy transportation from setting to setting

Because the mill is mounted on a flat car, it was necessary to build a light standard-gage railway track on which to move the mill about the woods. Gasoline engines were used in place of steam locomotives, and small cars in place of standard freight cars.

Under favorable conditions this mill can be pulled up, moved one-half mile, and made ready for operation in one to two hours. When the mill is moved the log hoist and the sawdust carrier are folded on the deck of the car. Before the mill is placed in operation the car is leveled and blocked on the four corners in order to obtain rigidity and steadiness. The log hoist is then dropped to the ground and the sawdust conveyor put in place. The mill is then ready to run.

Five men are required to operate the mill and one man to pile the lumber on a car ready for transportation to a concentration yard. In addition, a sixth man spent one-third of his time in filing the saws. The output of the mill averaged about 9,000 board feet, lumber tally, per 10-hour day when cutting second-growth loblolly pine.

LOGGING AND MILLING METHODS

Spurs were built into the woods, old grades from the previous logging being used wherever possible. In general, it was planned to keep log cutting and milling balanced and shorten the log haul as much as possible by moving the mill often. The woods crew consisted of 3 log cutters, 1 log buncher, 1 swamper and cart loader, and 2 haulers. On short hauls one wagon was sufficient to keep the mill busy; three wagons kept two mills in logs most of the time. The logs were unloaded at the foot of the log hoist at the mill. The ground man rolled them to the incline chains which raised them to the deck on the flat car. Here they were scaled and placed in position by the man who assisted the sawyer in turning and placing them on the carriage. The sawyer did the sawing and handled the setworks.

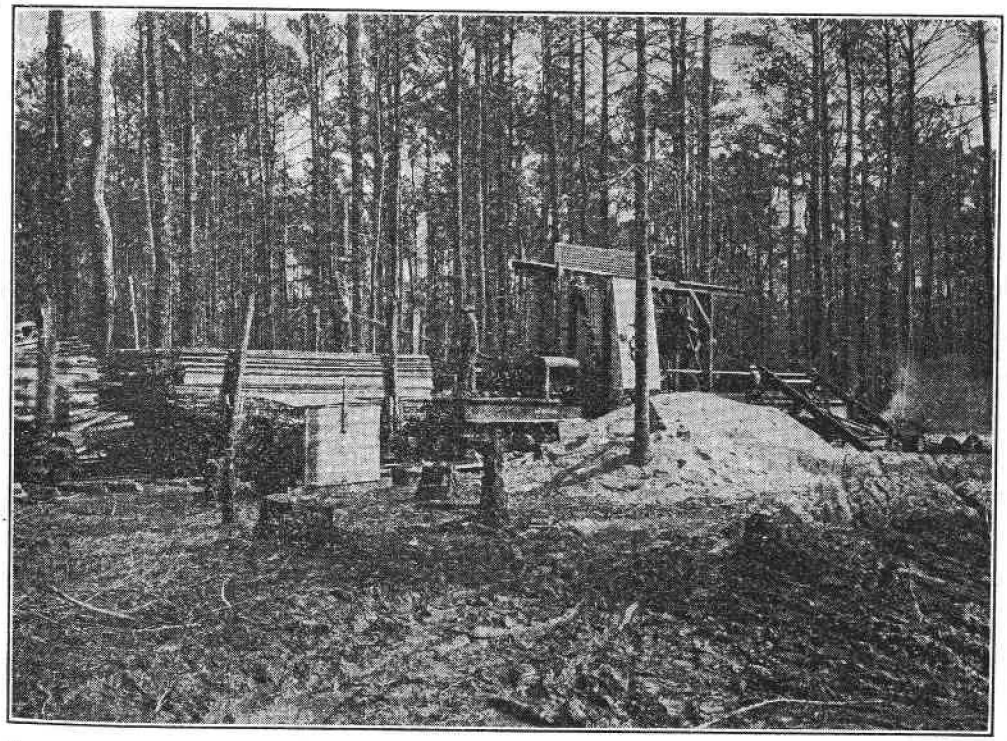

FIGURE 4.—Typical set-up for a portable band mill. The lumber is loaded directly on a flat car for hauling to a concentration yard. Sawdust and unused slabs are left in the woods

Care was used in sawing the logs so as to get the best yield in both quantity and quality. The logs were turned on the carriage whenever it was of advantage to do so. The logs were slabbed thinly. The lumber was of even thickness, and there was no saw snaking, because an automatic speed control on the carriage prevented the log from being fed into the saw too fast.

Since no edging was done in the woods, a part of the lumber was bark edged and a part square edged.

The lumber was passed on by the tail sawyer to the lumber loader, who bulk piled it on a car ready for hauling to the concentration yard. At the yard it was kiln-dried, put through an edger and trimmer, and made ready for shipment or for storage in the dry shed. The slabs were thrown to the ground to be picked up later as needed for fuel for the boiler at the concentration yard.

HOW THE STUDY WAS MADE

In obtaining the information presented here, a crew of men studied the timber cut from each plot as it passed through the different logging and milling operations and recorded, by individual logs, the volume, the time required for each step of lumber production, and the grades and amounts of lumber produced from each log and tree. Each log was numbered in the woods so that it could be identified with the tree from which it came at any time during the different steps of lumber production. Because the same logs were studied in the woods and at the mill, it was possible to obtain production costs and lumber values for the trees by adding up the corresponding figures for the logs that made up each tree. The cost figures and wage scales prevailing at the operation where the study was made were combined with the time studies to give a basis for computing the costs by tree and log diameter classes. For logs 8 inches in diameter and larger the Doyle log scale was used for determining the volume in board feet. For logs under 8 inches in diameter the Doyle rule was adjusted to give a scale more nearly in accord with actual volume of the log. Instead of subtracting 4 inches for slabs, as is done with the standard Doyle rule, only 3⅔ inches were subtracted for 7-inch logs, 3⅓ inches for 6-inch logs, and 2⅔ inches for 5-inch logs. This modified rule gives 5 board feet for 5-inch logs, 7 board feet for 6-inch logs, and 11 board feet for 7-inch logs, all 16 feet long—as compared to values of 1, 4, and 9 board feet, respectively, by the standard Doyle rule. It is well known that for small logs the Doyle rule gives a ridiculously low scale, and there are a number of ways in which lumbermen correct this; the most common is to give the logs below 8 inches in diameter a scale equal to their length in feet. This practice causes a large underrun in logs of approximately 5 inches in diameter that is inconsistent with the rest of the rule. The adjusted log-scale figures used in this bulletin for small logs give an overrun that corresponds generally with the trend in logs of more than 7 inches diameter.

The log-run costs which follow are based on the volume distribution of the cut among the different sized trees as found in this study.

COST OF PRODUCING LUMBER FROM LOGS AND TREES OF DIFFERENT SIZES

Trees that are too small to pay their way are often taken to the mill. The loss they cause is not apparent, because lumbermen compute their costs and lumber values on the basis of log run. For efficient and most profitable operation, information should be available on costs and lumber values by tree-diameter classes. The next several tables present this information and bring out the economic aspects of selective logging and some of the advantages of sustained-yield operations. In cost accounting it is necessary to remember that certain items, such as felling and hauling, vary with the size of the timber cut, while others, such as taxes on the lumber, vary with the price it brings. Another class of costs, such as permanent improvements, is considered constant per acre and varies only with the relative amount of timber removed from each acre in comparison with the total stand.

Barge expense is the only cost item in the costs that is unusual. In this operation the barge was substituted for the railroad to good

advantage in hauling lumber from the woods to a central shipping point where it could be distributed either by rail or by boat.

The cost classification is explained by footnotes to each table. Interest on invested capital, Federal income tax, and stumpage have not been included in these costs.

LOGGING COSTS FOR LOBLOLLY PINE TREES

The logging costs at this operation are different from those at most places because they end when the logs are dropped at the spur where the mill is located and do not include log transportation, unloading, or pond charges. Table 4 gives the average woods-production costs and the logging cost for each size of tree on a gross log-scale basis. It is five times more costly per thousand board feet gross log scale to log 9-inch trees than 21-inch trees. This ratio was obtained from the actual time consumed in doing the work. Time records obtained with stop watches were combined with the company's wage scales and costs in order to compute the production cost for trees of different diameters. The ratio of costs among diameter classes is somewhat higher than would prevail if another scale rule, such as the Scribner, were used (p. 8).

TABLE 4.—*Total logging costs per thousand board feet gross log scale (Doyle) by diameter classes for loblolly pine trees*

Logging cost items	Classification of costs [1]	Weighted average production cost per thousand board feet gross log scale	Total logging costs, by d. b. h. classes							
			8 inches	9 inches	10 inches	11 inches	12 inches	13 inches	14 inches	15 inches
		Dollars	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	1.38	6.40	5.12	3.63	2.65	2.15	1.77	1.48	1.26
Bunching and wagon haul (animal feed included)	VMT	2.41	7.91	6.49	5.33	4.37	3.59	3.02	2.60	2.31
Supplies (camp and logging)	VMT	.11	.35	.31	.25	.21	.16	.15	.12	.11
Depreciation of equipment (logging)	VMT	.20	.68	.55	.45	.38	.31	.25	.22	.19
General expense (logging)	V Tot.	1.17	4.34	3.53	2.74	2.15	1.76	1.47	1.26	1.10
Total		5.27	19.68	16.00	12.40	9.76	7.97	6.66	5.68	4.97
Overrun per cent		57.2	151	137	123	109	95	82	68	57
Total logging costs converted to a lumber-tally basis dollars		3.35	7.84	6.75	5.56	4.67	4.09	3.66	3.38	3.17

Logging cost items	Classification of costs [1]	Weighted average production cost per thousand board feet gross log scale	Total logging costs, by d. b. h. classes						
			16 inches	17 inches	18 inches	19 inches	20 inches	21 inches	22 inches
		Dollars	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	1.38	1.12	1.04	0.96	0.91	0.88	0.86	0.84
Bunching and wagon haul (animal feed included)	VMT	2.41	2.06	1.89	1.73	1.62	1.52	1.45	1.35
Supplies (camp and logging)	VMT	.11	.09	.08	.08	.08	.06	.06	.06
Depreciation of equipment (logging)	VMT	.20	.18	.15	.15	.14	.13	.12	.11
General expense (logging)	V Tot.	1.17	.97	.90	.83	.78	.74	.71	.67
Total		5.27	4.42	4.06	3.75	3.53	3.33	3.20	3.03
Overrun per cent		57.2	47	40	34	30	27	25	22
Total logging costs converted to a lumber-tally basis dollars		3.35	3.01	2.90	2.80	2.72	2.62	2.56	2.48

[1] Classification of costs: VT, varies with time per thousand board feet; VMT, varies with milling time per thousand board feet; V Tot., varies with total of logging costs.

Similar trends in cost apply to logs as well as to trees. Logging costs for logs on a gross log-scale basis are therefore not shown but may be readily computed from the overrun table and lumber tally costs if desired.

Separate costs for hardwoods are not shown, since an examination of the field data shows that for hardwood trees of the same diameter the costs would be practically the same as those for pine.

OVERRUN FOR LOBLOLLY PINE AND HARDWOOD LOGS AND TREES

Since log scale is used as a basis for payment for woods work and for the purchase of logs, it is important to know something about the overrun for logs and trees of different sizes. Gross overrun is the amount by which the lumber tally exceeds the gross log scale. Net overrun is the amount by which the lumber tally exceeds the net log scale (gross scale less deductions for defects). Table 5 gives figures for overrun and percentage of defect for loblolly pine and hardwood logs and trees. The average overrun for the pine was 57.2 per cent, which means that for each 1,000 feet, gross scale, of logs, 1,572 feet of lumber were obtained. This is a high yield as compared with that from a large band sawmill cutting similar timber where about 10 per cent less lumber was obtained. The high yield results principally from the thin saw used in cutting the logs into lumber and the practice of edging the lumber after it has been dried. Overrun percentages are applied in converting log-scale costs to a lumber-tally basis as follows: Table 4 gives average logging costs as $5.27 per thousand board feet log scale, which reduced to a lumber-tally basis $\left(\frac{\$5.27}{157.2}\times 100\right)$ becomes $3.35 per thousand board feet, lumber tally. Similar computations have been made for all items of logging, and the results hereafter are shown on a lumber-tally basis. Overrun in the hardwood was particularly high because the lumber was not edged closely and on an average the trees were small.

TABLE 5.—*Gross and net overrun* [1] *and percentage defect for loblolly pine and hardwood logs and trees*

LOBLOLLY PINE

Logs				Trees			
Top diameter inside bark in inches	Overrun		Defect	Diameter breast high	Overrun		Defect
	Gross	Net			Gross	Net	
	Per cent	*Per cent*	*Per cent*	*Inches*	*Per cent*	*Per cent*	*Per cent*
5	211	228	5.2	8	151	183	11.3
6	182	200	6.0	9	137	165	10.6
7	153	170	6.3	10	123	146	9.4
8	125	141	6.6	11	109	129	8.7
9	96	112	7.5	12	95	112	8.0
10	67	82	8.2	13	82	95	6.7
11	47	59	7.5	14	68	81	7.2
12	35	43	5.5	15	57	67	6.0
13	27	32	3.8	16	47	55	5.2
14	20	25	4.0	17	40	46	4.1
15	14	18	3.4	18	34	40	4.3
16	8	12	3.6	19	30	35	3.7
17	3	7	3.7	20	27	32	3.8
				21	25	29	3.1
				22	22	26	3.2
Weighted average	57.2	67.2	6.0		57.2	67.2	6.0

[1] Based on modified Doyle rule and dry lumber tally (p. 8).

TABLE 5.—*Gross and net overrun and percentage defect for loblolly pine and hardwood logs and trees*—Continued

HARDWOODS

Logs				Trees			
Top diameter inside bark in inches	Overrun		Defect	Diameter breast high	Overrun		Defect
	Gross	Net			Gross	Net	
	Per cent	*Per cent*	*Per cent*	*Inches*	*Per cent*	*Per cent*	*Per cent*
5	245	288	11.1	8	200	237	11.0
6	212	244	9.3	9	173	206	10.8
7	175	197	7.4	10	150	174	8.8
8	137	154	6.7	11	125	142	7.0
9	103	118	6.9	12	103	117	6.5
10	74	80	3.3	13	85	95	5.1
11	50	54	2.6	14	73	80	3.9
12	38	40	1.4	15	63	70	4.1
13	32	33	.8	16	55	62	4.3
14	26	28	1.6	17	50	56	3.8
				18	45	51	4.0
				19	41	46	3.4
Weighted average	98.5	112.1	6.4		98.5	112.1	6.4

The amount of defect in the pine and hardwoods was practically the same, being 6 and 6.4 per cent, respectively. Defect as used here includes the deductions made from the gross volume of the log to cover crook, rot, surface defect, fire injury, and operating damage.

TOTAL PRODUCTION COST FOR LOBLOLLY PINE LOGS AND TREES OF DIFFERENT DIAMETERS

Logging costs converted to a lumber-tally basis by means of overrun figures can be added directly to the milling costs. This has been done, and the lumber-production costs for trees and logs of different diameters are shown in Table 6. Taking all items together, it costs twice as much per thousand board feet to produce lumber from 9-inch trees as from 22-inch trees, which corresponds exactly with the ratio obtained for similar diameters in a large band sawmill. With the portable band sawmill the milling cost alone was 2.46 times as much per thousand board feet for 9-inch trees as for 22-inch trees, as compared with a ratio of 2 in the large band sawmill for trees of similar diameters. This results because the speed of the carriage in the small sawmill is necessarily held to a low maximum, while in the large sawmills such a provision is not necessary.

TABLE 6.—*Total production cost per thousand board feet, lumber tally, of dry lumber for loblolly pine trees and logs of different diameters*

TREES

Cost items	Classification of costs[1]	Weighted average production cost per thousand board feet lumber tally	Diameter breast high							
			8 inches	9 inches	10 inches	11 inches	12 inches	13 inches	14 inches	15 inches
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	0.88	2.55	2.16	1.63	1.27	1.10	0.97	0.88	0.80
Bunching and wagon haul (animal feed included)	VMT	1.53	3.15	2.74	2.39	2.09	1.84	1.66	1.55	1.47
Supplies (camp and logging)	VMT	.07	.14	.13	.11	.10	.08	.08	.07	.07
Depreciation of equipment (logging)	VMT	.13	.27	.23	.20	.18	.16	.14	.13	.12
General expense: Foreman, crosscut filer, repairman and emergency sawyer, stableman, and miscellaneous	V Tot.	.74	1.73	1.49	1.23	1.03	.90	.81	.75	.70
Railroad construction	CA	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Sawmill labor, including band-saw filer	VT	1.94	4.00	3.48	3.03	2.65	2.33	2.10	1.96	1.86
Sawmill supplies, repairs, miscellaneous	VMT	.71	1.46	1.27	1.11	.97	.85	.77	.72	.68
Railroad operation, labor, gasoline, oil	VMT	.74	1.53	1.33	1.16	1.01	.89	.80	.75	.71
Kiln, labor and supplies	V No.	[2] .94	1.49	1.39	1.30	1.20	1.12	1.04	.98	.92
Rip mill, labor and supplies	V No.	[3] 1.07	1.70	1.61	1.49	1.39	1.29	1.20	1.12	1.05
Storage shed, labor	V No.	.46	.72	.68	.64	.59	.55	.51	.48	.45
Barge expense, labor and towage	V No.[4]	[5] 1.50	2.13	2.04	1.93	1.83	1.73	1.64	1.56	1.49
General expense: Foreman, watchman, miscellaneous	VMT	.72	1.48	1.29	1.12	.98	.86	.78	.73	.69
Insurance, workmen's compensation	VMT	.13	.27	.23	.20	.18	.16	.14	.13	.12
Taxes on finishing plant	VMT	.07	.14	.13	.11	.10	.08	.08	.07	.07
Taxes on lumber	VP	.10	.08	.09	.09	.09	.09	.10	.10	.10
Discount and allowance	VP	.25	.21	.22	.22	.23	.23	.24	.25	.25
Standing-timber expense	VMT	1.25	2.58	2.24	1.95	1.71	1.50	1.35	1.26	1.20
Depreciation, plant and equipment	VMT	.96	1.98	1.72	1.50	1.31	1.15	1.04	.97	.92
Selling expense	VP	1.25	1.06	1.08	1.10	1.13	1.16	1.20	1.23	1.26
Total		16.94	30.17	27.05	24.01	21.54	19.57	18.15	17.19	16.43

Cost items	Classification of costs[1]	Weighted average production cost per thousand board feet lumber tally	Diameter breast high						
			16 inches	17 inches	18 inches	19 inches	20 inches	21 inches	22 inches
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	0.88	0.76	0.74	0.72	0.70	0.69	0.69	0.69
Bunching and wagon haul (animal feed included)	VMT	1.53	1.40	1.35	1.29	1.25	1.20	1.16	1.11
Supplies (camp and logging)	VMT	.07	.06	.06	.06	.06	.05	.05	.05
Depreciation of equipment (logging)	VMT	.13	.12	.11	.11	.11	.10	.10	.09
General expense: Foreman, crosscut filer, repairman and emergency sawyer, stableman, and miscellaneous	V Tot.	.74	.66	.64	.62	.60	.58	.57	.55
Railroad construction	CA	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Sawmill labor, including band-saw filer	VT	1.94	1.78	1.71	1.64	1.58	1.52	1.47	1.41
Sawmill supplies, repairs, miscellaneous	VMT	.71	.65	.63	.60	.58	.56	.54	.52
Railroad operation, labor, gasoline, oil	VMT	.74	.68	.65	.63	.60	.58	.56	.54
Kiln, labor and supplies	V No.	[2] .94	.87	.82	.78	.75	.73	.72	.70
Rip mill, labor and supplies	V No.	[3] 1.07	.99	.94	.90	.87	.85	.83	.81
Storage shed, labor	V No.	.46	.42	.40	.38	.36	.35	.34	.34
Barge expense, labor and towage	V No.[4]	[5] 1.50	1.43	1.38	1.34	1.31	1.29	1.27	1.25
General expense: Foreman, watchman, miscellaneous	VMT	.72	.66	.63	.61	.59	.56	.55	.52
Insurance, workmen's compensation	VMT	.13	.12	.11	.11	.11	.10	.10	.09
Taxes on finishing plant	VMT	.07	.06	.06	.06	.06	.05	.05	.05
Taxes on lumber	VP	.10	.10	.10	.10	.10	.10	.10	.10
Discount and allowance	VP	.25	.26	.26	.26	.26	.26	.26	.25
Standing-timber expense	VMT	1.25	1.15	1.10	1.06	1.02	.98	.95	.91
Depreciation, plant and equipment	VMT	.96	.88	.85	.81	.78	.75	.73	.70
Selling expense	VP	1.25	1.29	1.30	1.32	1.32	1.31	1.28	1.27
Total		16.94	15.84	15.34	14.90	14.51	14.11	13.82	13.45

[1] Classification of costs: VT, varies with time per thousand board feet; VMT, varies with milling time per thousand board feet; V Tot., varies with total of logging costs; CA, constant with area; V No., varies with the number of pieces per thousand board feet lumber tally; VP, varies with price of lumber.

[2] Labor $0.90. [3] Labor $1.02. [4] Towage was constant per thousand board feet lumber tally. [5] Labor $1.

TABLE 6.—*Total production cost per thousand board feet, lumber tally, of dry lumber for loblolly pine trees and logs of different diameters*—Continued

LOGS

Cost items	Classification of costs [1]	Weighted average production cost per thousand board feet lumber tally	Top diameter inside bark						
			5 inches	6 inches	7 inches	8 inches	9 inches	10 inches	11 inches
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	0.88	1.59	1.38	1.20	1.05	0.96	0.94	0.92
Bunching and wagon haul (animal feed included)	VMT	1.53	2.94	2.44	2.07	1.82	1.66	1.54	1.45
Supplies (camp and logging)	VMT	.07	.13	.11	.09	.08	.08	.07	.07
Depreciation of equipment (logging)	VMT	.13	.25	.21	.18	.15	.14	.13	.12
General expense: Foreman, crosscut-saw filer, repairman and emergency sawyer, stableman, and miscellaneous	V Tot.	.74	1.39	1.17	1.00	.88	.81	.76	.73
Railroad construction	CA	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Sawmill labor, including band-saw filer	VT	1.94	3.73	3.10	2.62	2.31	2.10	1.95	1.84
Sawmill supplies, repairs, miscellaneous	VMT	.71	1.37	1.13	.96	.85	.77	.71	.67
Railroad operation, labor, gasoline, oil	VMT	.74	1.42	1.18	1.00	.88	.80	.74	.70
Kiln, labor and supplies	V No.	[2] .94	1.74	1.60	1.44	1.26	1.11	.99	.91
Rip mill, labor and supplies	V No.	[3] 1.07	1.98	1.82	1.64	1.43	1.26	1.12	1.04
Storage shed, labor	V No.	.46	.80	.73	.66	.58	.51	.45	.42
Barge expense, labor and towage	V No.[4]	[5] 1.50	2.31	2.20	2.04	1.85	1.69	1.55	1.48
General expense: Foreman, watchman, miscellaneous	VMT	.72	1.38	1.15	.97	.86	.78	.72	.68
Insurance, workmen's compensation	VMT	.13	.25	.21	.18	.15	.14	.13	.12
Taxes on finishing plant	VMT	.07	.13	.11	.09	.08	.08	.07	.07
Taxes on lumber	VP	.10	.10	.08	.09	.09	.09	.10	.10
Discount and allowance	VP	.25	.21	.21	.22	.22	.23	.24	.25
Standing timber expense	VMT	1.25	2.40	2.00	1.69	1.49	1.35	1.26	1.19
Depreciation, plant and equipment	VMT	.96	1.85	1.53	1.30	1.14	1.04	.96	.91
Selling expense	VP	1.25	1.06	1.07	1.09	1.12	1.15	1.19	1.24
Total		16.94	28.73	24.93	22.03	19.79	18.25	17.12	16.41

Cost items	Classification of costs [1]	Weighted average production cost per thousand board feet lumber tally	Top diameter inside bark					
			12 inches	13 inches	14 inches	15 inches	16 inches	17 inches
		Dolls.	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
Sawing (felling and bucking)	VT	0.88	0.89	0.86	0.83	0.81	0.79	0.77
Bunching and wagon haul (animal feed included)	VMT	1.53	1.37	1.29	1.23	1.17	1.11	1.06
Supplies (camp and logging)	VMT	.07	.06	.06	.06	.05	.05	.05
Depreciation of equipment (logging)	VMT	.13	.12	.11	.10	.10	.09	.09
General expense: Foreman, crosscut-saw filer, repairman and emergency sawyer, stableman, and miscellaneous	V Tot.	.74	.69	.66	.63	.60	.58	.56
Railroad construction	CA	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Sawmill labor, including band-saw filer	VT	1.94	1.74	1.64	1.56	1.48	1.41	1.35
Sawmill supplies, repairs, miscellaneous	VMT	.71	.64	.60	.57	.54	.52	.49
Railroad operation, labor, gasoline, oil	VMT	.74	.66	.63	.60	.56	.54	.51
Kiln, labor and supplies	V No.	[2] .94	.85	.80	.77	.74	.72	.71
Rip mill, labor and supplies	V No.	[3] 1.07	.96	.91	.88	.85	.82	.81
Storage shed, labor	V No.	.46	.39	.37	.35	.34	.33	.33
Barge expense, labor and towage	V No.[4]	[5] 1.50	1.41	1.36	1.31	1.29	1.27	1.27
General expense: Foreman, watchman, miscellaneous	VMT	.72	.65	.61	.58	.55	.52	.50
Insurance, workmen's compensation	VMT	.13	.12	.11	.10	.10	.09	.09
Taxes on finishing plant	VMT	.07	.06	.06	.06	.05	.05	.05
Taxes on lumber	VP	.10	.10	.11	.12	.12	.12	.13
Discount and allowance	VP	.25	.26	.28	.29	.30	.31	.32
Standing timber expense	VMT	1.25	1.12	1.06	1.01	.95	.91	.87
Depreciation, plant and equipment	VMT	.96	.86	.81	.77	.73	.70	.67
Selling expense	VP	1.25	1.31	1.38	1.44	1.50	1.55	1.58
Total		16.94	15.76	15.21	14.76	14.33	13.98	13.71

[1] Classification of costs: VT, varies with time per thousand board feet; VMT, varies with milling time per thousand board feet; V Tot., varies with total of logging costs; CA, constant with area; V No., varies with the number of pieces per thousand board feet lumber tally; VP, varies with price of lumber.

[2] Labor $0.90.

[3] Labor $1.02.

[4] Towage was constant per thousand board feet lumber tally.

[5] Labor $1.

Similar trends are also disclosed by the production costs for logs. The difference in production cost between small and large trees is emphasized here because it has an important bearing on the profits or losses that occur in handling trees of different sizes.

Because the volume of hardwoods in the stand was small, separate production-cost tables are not shown. For all practical purposes the hardwoods, diameter for diameter, may be considered as having the same production cost as the pine although, because there is a greater proportion of small diameters, the average is higher.

The production costs shown here are complete except for stumpage, Federal taxes, and interest. These are purposely excluded, and the spread between production cost and lumber value shown later is available to cover these items and provide a margin for profit.

LUMBER PRICES

Table 7 gives the prices of rough, dry lumber used in this study for loblolly pine and for the different hardwoods in the stand. These prices were obtained direct from the cooperating company's records and represent an average for 1929.

TABLE 7.—*Average prices of rough, dry, 1-inch loblolly pine and hardwood lumber per thousand board feet f. o. b. shipping point, northeastern North Carolina, 1929*

LOBLOLLY PINE

Widths	B and better	No. 1 and C	No. 1 box	No. 2 box	Bark strips	
					B and better	Box
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
4 inches	41.26	32.90	22.00	18.00	30	13
5 inches	43.00	33.70	22.00	18.00	30	13
6 inches	43.56					
7 and 8 inches	46.24	33.70	22.87	18.86	30	13
9 and 10 inches	50.00	37.00	23.90	19.86	30	13
11 and 12 inches	64.00	43.00	26.00	22.00	30	13

HARDWOOD

Species	F A S	No. 1 common	No. 2 common	No. 3 common
	Dollars	*Dollars*	*Dollars*	*Dollars*
Red gum [1]	45	35	18	15
Black gum or mixed oak		35	25	17

[1] Graded as sap gum.

GRADES AND VALUE OF LUMBER

The percentages of the different grades of lumber and the values as shown in Table 8 for loblolly pine trees and logs are for dry, rough lumber ready for the shipment. Changes due to drying and remanufacture have been taken into account and the green grades corrected accordingly. Table 9 gives the percentages of grades for hardwoods as established from a green-lumber tally. The value of the lumber when dry has been computed by applying a correction factor of 7 per cent, established in the course of earlier studies in the eastern hardwoods.

TABLE 8.—*Percentage of lumber by grades and value per thousand board feet, lumber tally, when dry for loblolly pine logs and trees of different diameters*

LOGS

Size in inches [1]	B and better		No. 1 and C		No. 1 box		No. 2 box		Bark strips				Average value of 1,000 board feet of dry lumber
									B and better		Box		
	Per cent	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Dollars*
5	-----	40.97	-----	32.24	86.5	21.89	10.0	17.93	-----	30	4.4	13	21.10
6	0.2	41.22	1.5	32.34	83.6	21.94	10.2	17.98	0.3	30	4.2	13	21.38
7	.8	41.52	3.2	32.49	81.0	21.99	10.3	18.08	.7	30	4.0	13	21.78
8	1.9	41.81	4.9	32.58	78.0	22.09	10.4	18.18	1.1	30	3.7	13	22.32
9	3.0	42.21	6.7	32.73	75.0	22.24	10.5	18.28	1.4	30	3.4	13	22.92
10	4.9	42.61	8.5	32.88	71.5	22.39	10.4	18.43	1.7	30	3.0	13	23.71
11	7.7	43.25	10.3	33.03	67.4	22.64	10.0	18.63	2.0	30	2.6	13	24.79
12	11.0	44.04	12.3	33.42	63.0	22.93	9.3	18.92	2.2	30	2.2	13	26.11
13	14.1	44.94	13.3	34.40	60.2	23.43	8.2	19.27	2.4	30	1.8	13	27.55
14	15.9	45.88	13.6	35.72	58.8	23.98	7.8	19.82	2.5	30	1.4	13	28.73
15	17.0	47.17	13.8	37.24	57.9	24.58	7.6	20.37	2.5	30	1.2	13	29.84
16	17.8	48.11	14.0	38.22	57.5	25.27	7.4	20.87	2.4	30	.9	13	30.83
17	18.4	48.71	14.2	38.96	57.1	25.57	7.3	21.26	2.2	30	.8	13	31.41
Weighted average	7.9	44.56	9.0	33.90	68.4	22.74	10.1	18.65	1.8	30	2.8	13	24.92

TREES

8	0.2	41.27	3.1	32.24	76.3	21.89	14.4	17.93	-----	30	6.0	13	21.15
9	.8	41.42	4.0	32.44	76.0	21.99	13.5	17.98	0.4	30	5.3	13	21.58
10	1.5	41.61	4.9	32.63	75.6	22.04	12.2	18.08	.9	30	4.9	13	22.00
11	2.6	41.96	6.0	32.78	75.2	22.14	10.6	18.13	1.3	30	4.3	13	22.58
12	4.0	42.36	7.2	32.88	74.6	22.24	8.9	18.18	1.5	30	3.8	13	23.21
13	5.6	42.80	8.4	32.98	72.7	22.34	8.2	18.28	1.7	30	3.4	13	23.86
14	7.4	43.35	9.7	33.12	69.9	22.49	8.2	18.38	1.8	30	3.0	13	24.58
15	8.9	44.00	10.5	33.47	67.3	22.64	8.7	18.53	1.9	30	2.7	13	25.20
16	9.8	44.59	10.4	33.96	66.1	22.84	9.3	18.63	2.0	30	2.4	13	25.64
17	10.5	45.24	9.7	34.59	65.4	23.08	10.2	18.77	2.0	30	2.2	13	26.00
18	10.8	45.98	9.1	35.38	64.4	23.38	11.8	18.97	1.9	30	2.0	13	26.31
19	10.4	46.57	8.3	35.87	63.2	23.68	14.5	19.22	1.8	30	1.8	13	26.35
20	9.1	47.02	7.5	36.26	62.1	23.88	17.9	19.42	1.7	30	1.7	13	26.03
21	7.3	47.37	6.7	36.55	61.4	24.08	21.5	19.57	1.6	30	1.5	13	25.57
22	6.6	47.47	5.7	36.51	60.8	24.28	24.3	19.62	1.4	30	1.2	13	25.32
Weighted average	7.9	44.56	9.0	33.90	68.4	22.74	10.1	18.65	1.8	30	2.8	13	24.92

[1] For logs, top diameter inside of bark; for trees, diameter breast high.

TABLE 9.—*Percentage of lumber by grades and value per thousand board feet for red gum [1] logs and trees by diameter classes*

LOGS

Top diameter inside bark, in inches	FAS	No. 1 common	No. 2 common	No. 3 common	Average value of 1,000 board feet of green lumber after seasoning [2]
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Dollars*
5	-----	-----	-----	100.0	13.95
6	-----	1.0	31.7	67.3	15.02
7	-----	1.4	41.6	57.0	15.37
8	-----	5.9	42.7	51.4	16.24
9	-----	5.4	44.5	50.1	16.20
10	0.5	6.8	46.0	46.7	16.64
11	-----	4.9	34.7	60.4	15.83
12	6.0	2.7	36.0	55.3	17.13
13	-----	20.9	51.0	28.1	19.26
14	8.2	20.7	48.0	23.1	21.43
Weighted average	.7	5.7	42.6	51.0	16.39

[1] The average value of black gum was $17.42 per thousand board feet of green lumber.
[2] Value when dry obtained by reducing value when green 7 per cent to cover the loss by degrade and shrinkage during seasoning.

TABLE 9.—*Percentage of lumber by grades and value per thousand board feet for red gum logs and trees by diameter classes*—Continued

TREES

Diameter breast high, in inches	FAS	No. 1 common	No. 2 common	No. 3 common	Average value of 1,000 board feet of green lumber after seasoning
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Dollars*
8			53.3	46.7	15.44
9		1.6	39.2	59.2	15.34
10		2.4	39.2	58.4	15.49
11		6.0	46.9	47.1	16.38
12		4.3	42.2	53.5	15.93
13	0.5	8.7	39.6	51.2	16.81
14		3.3	40.4	56.3	15.63
15					
16	6.5	8.1	39.3	46.1	18.37
17		10.3	50.0	39.7	17.26
18		3.0	64.5	32.5	16.31
19	9.4	20.7	35.7	34.2	21.42
Weighted average	.7	5.7	42.6	51.0	16.39

Although this stand was about 80 per cent stocked, that the trees had not cleared themselves of their lower limbs early in life was evident from the low yield of only 7.9 per cent B and better. The trees in the largest diameter classes in this study, which were more or less open grown, showed less high-grade lumber than the trees several inches smaller in diameter that had grown in thicker stands.[5] This brings out the necessity for clearing the trunks of the trees of their lower limbs as early in life as possible. Close stocking, hardwoods in mixture, and limb pruning under favorable conditions are three ways by which this end may be gained. Generally, the larger and older the tree the greater the proportion of high-grade lumber. Small trees not only yield poorer quality lumber than large trees but, grade for grade, it is worth less because the average width is less. For example, in loblolly pine the B and better lumber from 9-inch trees is worth only $41.42 per thousand board feet, whereas that from 20-inch trees is worth $47.02. Taking all grades together, the average value of the lumber from 9-inch trees was $21.58 per thousand board feet, as compared with $26.03 for that from 20-inch trees. The increase in value as the trees become larger and the decrease in production costs when combined form the main economic argument for selective logging. By properly regulating the cutting the production costs can be held constant or reduced and the value of the product increased. Table 8 indicates that management of forest stands must take into account quality as well as quantity growth.

The quality and price trends for loblolly pine trees apply generally for logs. In addition to the effect of size on value, the position the log occupied in the tree also has an influence. Butt logs ordinarily yield higher quality lumber than the other logs in the tree (p. 18).

For the few hardwoods in the stand the same trend obtains as that shown for the pine, although the relationship among the different-sized logs and trees is not constant because of the small quantity of material studied and the poor quality of the trees. Table 9 gives the

[5] PAUL, B. H. THE RELATION OF CERTAIN FOREST CONDITIONS TO THE QUALITY AND VALUE OF SECOND-GROWTH LOBLOLLY PINE LUMBER. Jour. Forestry 30:4-21. 1932.

percentage of the different grades of lumber and the value by diameter classes for hardwood logs and trees.

In handling loblolly pine stands the necessity of growing wood of good quality as well as in satisfactory quantities must be kept in mind. There is a temptation to favor the pine and eliminate the hardwoods, which are not ordinarily of very good quality. It is probably satisfactory in the first cut to eliminate all but a small number of the best hardwoods. In subsequent cuts under management the hardwoods should improve in quality, and it is believed that they should be retained, in small volume at least, for the purpose of hastening the natural pruning of the pine and for improving the soil.

PRODUCTION COSTS AND LUMBER VALUES COMPARED

With production costs (excluding stumpage, Federal taxes, and interest on invested capital) and values available, it is possible to compare them and determine the realization for logs and trees of different diameters and for different cutting limits. It has been assumed that the permanent-improvement costs are the same for logs and trees of different sizes. Table 10 shows the production cost and lumber value for loblolly pine logs and trees. According to these figures a tree must be 11 inches in diameter to pay its way, not including stumpage, Federal taxes, interest, or profit, and a log must be 8 inches, if charged with all production costs. Logs less than 8 inches in diameter, however, may be taken to the mill, because below a certain size they need to bear only direct costs, owing to the custom of lumber companies of computing railroad and camp costs on the basis of the total volume, considering only a given size and larger. Small logs on the ground have no value unless utilized, whereas small logs in thrifty standing trees are valuable as growing stock and yield the best return if left growing.

TABLE 10.—*Difference between production cost and value of lumber per thousand board feet, lumber tally for loblolly pine logs and trees of different diameters*

Logs				Trees			
Top diameter inside bark in inches	Total lumber production cost	Value of lumber	Difference [1]	Diameter breast high	Total lumber production cost	Value of lumber	Difference [1]
	Dollars	*Dollars*	*Dollars*	*Inches*	*Dollars*	*Dollars*	*Dollars*
5	28.51	21.10	−7.41	8	30.17	21.15	−9.02
6	24.93	21.38	−3.55	9	27.05	21.58	−5.47
7	22.03	21.78	−.25	10	24.01	22.00	−2.01
8	19.79	22.32	+2.53	11	21.54	22.58	+1.04
9	18.25	22.92	+4.67	12	19.57	23.21	+3.64
10	17.12	23.71	+6.59	13	18.15	23.86	+5.71
11	16.41	24.79	+8.38	14	17.19	24.58	+7.39
12	15.76	26.11	+10.35	15	16.43	25.20	+8.77
13	15.21	27.55	+12.34	16	15.84	25.64	+9.80
14	14.76	28.73	+13.97	17	15.34	26.00	+10.66
15	14.33	29.84	+15.51	18	14.90	26.31	+11.41
16	13.98	30.83	+16.85	19	14.51	26.35	+11.84
17	13.71	31.41	+17.70	20	14.11	26.03	+11.92
				21	13.82	25.57	+11.75
				22	13.45	25.32	+11.87
Weighted average	16.94	24.92	+7.98		16.94	24.92	+7.98

[1] A minus sign indicates a loss.

For loblolly pine there was an average realization of $7.98 per thousand board feet, but it varied from a loss of $9.02 for 8-inch trees to a profit of $11.92 for 20-inch trees. This wide spread in realization is brought about by the decreased cost of handling large trees and their higher value as compared with small trees. The production cost with the portable band sawmill was from $1 to $2 less than that in the average large band sawmill and resulted in a smaller tree paying its way.

Table 10 also gives a clew to the stumpage price that an operator can afford to pay for trees of different sizes. If, for example, a company must have a 20 per cent margin for profit and risk, then the average stumpage value would be the production cost ($16.94) times 1.20, subtracted from the value of the lumber ($24.92), which leaves $4.59 as the average stumpage value for the stand as cut. Computing similarly, 10-inch trees have a minus stumpage value of $6.81 per thousand board feet as compared to a positive value of $9.10 for 20-inch trees.

The hardwoods on an average did not pay their way, since the value of the lumber was $16.46 per thousand board feet and the production cost $20.01 per thousand board feet. Because there is likely to be a loss or only a slight profit in handling small or defective hardwoods, there is a tendency to leave them standing, which is amply justified if the operator is interested in one cut only. If, on the other hand, it is desired to grow successive crops of timber on the land, the space occupied by poor hardwoods must be released to pine or good-quality hardwoods if the maximum return from the land is to be realized. While all the hardwoods were cut into lumber during the study, the company ordinarily utilized as much of this material as possible in its own operation for ties and similar products. Some attempts had also been made to sell the hardwoods for pulpwood. In view of the loss incurred in cutting them into lumber, the problem of finding some method of disposing of the poorer hardwoods at least at a price equal to the cost of cutting them needs immediate solution. With fire protection and management, hardwoods in old-field pine stands should develop in time into fairly good quality trees, so that the present problem would not be perpetual in handling such stands. It may oftentimes be practicable to remove many of these poor-quality trees by thinning, girdling, or poisoning operations. Thrifty, sound hardwood trees of valuable species in mixture with loblolly pine are desirable according to the best information available, and in long-time plans may be allowed to make up 10 to 20 per cent of the stands.

A consideration of the comparative returns and grades of lumber obtained from trees of different sizes should be supplemented with similar information on logs of different sizes and position in the tree. Table 11 has been prepared to supply such information. The logs were divided into three quality classes based largely on their original position in the tree. In studying the results shown here the difference between small logs from small thrifty trees and small logs from the tops of large trees should be kept in mind (p. 17). As might be expected, there is some overlapping of quality and value in logs of the same diameters but from different positions in the tree, yet the three quality classes, on an average, are separated by a spread of $3.56 per thousand board feet between butt and middle logs and $2.97 between middle and top logs.

TABLE 11.—*Percentage of lumber by grades, value per thousand board feet of dry lumber, and production cost of loblolly pine logs of different diameter and quality*

BUTT LOGS

Top diameter inside bark in inches	B and better		No. 1 and C		No. 1 box		No. 2 box		Bark strips				Average value	Production cost	Difference [1]
									B and better		Box				
	Per cent	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
6	--------	41.35	4.0	32.90	78.3	22.00	12.2	18.00	--------	30	5.5	13	21.45	25.26	−3.81
7	1.2	41.50	6.4	32.90	74.0	22.08	11.6	18.03	1.5	30	5.3	13	22.17	22.96	−.79
8	3.7	41.75	8.8	32.90	69.8	22.15	10.9	18.09	1.9	30	4.9	13	23.08	20.69	+2.39
9	6.3	42.15	11.5	32.95	65.5	22.27	10.0	18.15	2.3	30	4.4	13	24.11	19.20	+4.91
10	9.7	42.70	13.8	33.00	61.3	22.40	9.0	18.25	2.6	30	3.6	13	25.32	17.95	+7.37
11	13.3	43.45	15.5	33.10	57.4	22.65	8.1	18.40	2.9	30	2.8	13	26.63	17.00	+9.63
12	15.5	44.30	16.7	33.60	55.4	23.00	7.3	18.70	3.1	30	2.0	13	27.77	16.13	+11.64
13	17.5	45.20	17.0	34.60	54.4	23.45	6.6	19.15	3.1	30	1.4	13	28.92	15.35	+13.57
14	18.8	46.15	16.7	35.70	54.7	23.95	6.0	19.70	2.9	30	.9	13	29.91	14.68	+15.23
15	19.7	47.10	13.7	36.90	57.4	24.50	5.3	20.30	2.6	30	1.3	13	30.42	14.19	+16.23
16	20.4	48.15	10.5	38.00	61.9	25.03	4.9	20.95	2.3	30	--------	----------	31.02	13.81	+17.21
17	20.9	49.30	7.0	39.20	65.6	25.60	4.5	21.60	2.0	30	--------	----------	31.41	13.23	+18.18
Weighted average	14.2	44.97	14.3	34.25	58.7	23.09	7.4	18.75	2.8	30	2.6	13	27.40	16.72	+10.68

MIDDLE AND OTHER LOGS WITH FEW SMALL KNOTS

5	--------	40.58	--------	32.52	85.9	22.00	9.9	18.00	--------	30	4.2	13	21.23	25.77	−4.54
6	--------	40.70	2.2	32.60	83.7	22.00	10.0	18.00	0.1	30	4.0	13	21.48	23.30	−1.82
7	0.2	41.09	3.5	32.65	81.8	22.00	10.3	18.06	.4	30	3.8	13	21.70	21.29	+.41
8	.7	41.37	5.0	32.72	79.5	22.20	10.5	18.12	.7	30	3.6	13	22.16	19.35	+2.81
9	1.6	41.90	6.2	32.80	77.0	22.47	10.8	18.23	1.0	30	3.4	13	22.72	17.82	+4.90
10	3.2	42.38	7.4	32.92	73.9	22.80	11.1	18.40	1.3	30	3.1	13	23.48	16.63	+6.85
11	5.4	42.93	8.6	33.08	70.2	23.30	11.5	18.60	1.5	30	2.8	13	24.47	15.77	+8.70
12	7.2	43.60	9.7	33.35	66.7	24.00	12.2	18.85	1.8	30	2.4	13	25.53	15.02	+10.51
13	8.4	44.40	10.6	33.87	63.6	24.90	13.4	19.20	2.0	30	2.0	13	26.59	14.41	+12.18
14	9.2	45.40	11.4	34.70	60.7	26.00	15.0	19.69	2.2	30	1.5	13	27.72	13.86	+13.86
15	9.9	46.50	12.0	35.80	57.9	27.30	16.7	20.38	2.5	30	1.0	13	28.99	13.34	+15.65
Weighted average	3.9	43.56	7.5	33.31	73.4	23.10	11.2	18.55	1.2	30	2.8	13	23.95	16.83	+7.12

[1] A minus sign indicates a loss.

TABLE 11.—*Percentage of lumber by grades, value per thousand board feet of dry lumber, and production cost of loblolly pine logs of different diameter and quality*—Continued

TOP LOGS AND OTHER LOGS WITH COARSE OR MANY SMALL KNOTS

Top diameter inside bark in inches	B and better		No. 1 and C		No. 1 box		No. 2 box		Bark strips				Average value	Production cost	Difference
									B and better		Box				
	Per cent	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
5	--------	40.50	--------	32.90	92.6	22.00	2.5	18.00	--------	30	4.9	13	21.46	24.82	−3.36
6	--------	40.80	0.3	32.90	89.8	22.06	5.3	18.00	--------	30	4.6	13	21.46	23.22	−1.76
7	0.3	41.20	.4	32.95	86.4	22.10	8.5	18.05	--------	30	4.4	13	21.46	21.49	−.03
8	.3	41.70	.4	33.04	83.6	22.19	11.5	18.10	--------	30	4.2	13	21.44	19.75	+1.69
9	.3	42.27	.7	33.15	80.1	22.28	14.5	18.20	0.4	30	4.0	13	21.48	18.29	+3.19
10	.3	42.88	1.4	33.30	76.4	22.38	17.7	18.34	.4	30	3.8	13	21.55	17.04	+4.51
11	.4	43.60	2.4	33.50	72.3	22.50	21.0	18.58	.4	30	3.5	13	21.72	16.24	+5.48
12	.4	44.30	3.5	33.75	68.2	22.65	24.2	18.90	.4	30	3.3	13	21.93	15.55	+6.38
13	.4	45.02	4.6	34.00	64.0	22.82	27.5	19.34	.4	30	3.1	13	22.19	14.94	+7.25
14	.5	45.80	5.8	34.29	60.3	23.06	30.0	19.82	.5	30	2.9	13	22.60	14.35	+8.25
15	.5	46.55	6.9	34.58	56.0	23.35	33.3	20.38	.6	30	2.7	13	23.01	13.98	+9.03
Weighted average	.4	44.25	1.3	33.56	78.1	22.34	16.5	18.61	.4	30	3.3	13	21.68	17.53	+4.15

The information in Table 11 should be useful to the operator in determining his top cutting limits and to the log buyer and seller in obtaining an idea of the comparative value of logs of the same size but from different positions in the tree. A top log, if charged with all production costs, had to be about 7 inches in diameter to pay its way, not including stumpage or Federal taxes. If the railroad-construction charges are carried by the larger logs, as is often the case, 6-inch logs would nearly pay their way. If the small logs had been sawed into scantlings instead of lumber, the returns under ordinary conditions would have been larger.

RETURNS FROM DIFFERENT DIAMETER CUTTING LIMITS

To illustrate the economic side of selective logging, it is desirable to consider the returns when cutting to different diameter limits. In using these data it must be kept in mind that a rigid diameter limit is not advocated and in most cases would not be good practice. Trees below the limit should be cut if of poor form and thrift, and trees above the limit should be left if needed for seed production or to increase the yield of the second cut.

Table 12 shows the results if the loblolly pine in the stand were cut to different diameter limits. If all trees 8 inches in diameter and larger were cut, 20,770 board feet of lumber would be removed and the gross returns per acre would be $129.19. To compute the net returns, stumpage, interest, and Federal taxes would have to be deducted from this figure. These items are so variable that no attempt is made here to give figures for them. If the 8, 9, and 10 inch trees are left uncut the gross returns become $137.02 per acre. That is, by cutting only trees 11 inches in diameter and larger the highest return per acre is obtained. The highest return per thousand board feet, however, is obtained when only trees 15 inches and larger are cut. This indicates that the owner interested in a return cut would do well to adhere to the 15-inch cutting limit, whereas an operator who has purchased timber only with the privilege of taking what he desired might take out trees as small as 11 or 12 inches. From the standpoint of both the landowner and the operator, leaving the small trees uncut is an advantage, for by cutting only trees 11 inches in diameter and larger, as compared with cutting to an 8-inch limit, the operator prevents a loss of $7.83 per acre and the landowner saves 2,929 board feet of small timber to stock the land and grow into a second cut. Under such a plan, however, it would be a long time before another cut would be possible. By leaving all trees 13 inches in diameter and smaller, 9,513 board feet, lumber tally, per acre would remain, and a return cut could be made to advantage in 10 years.

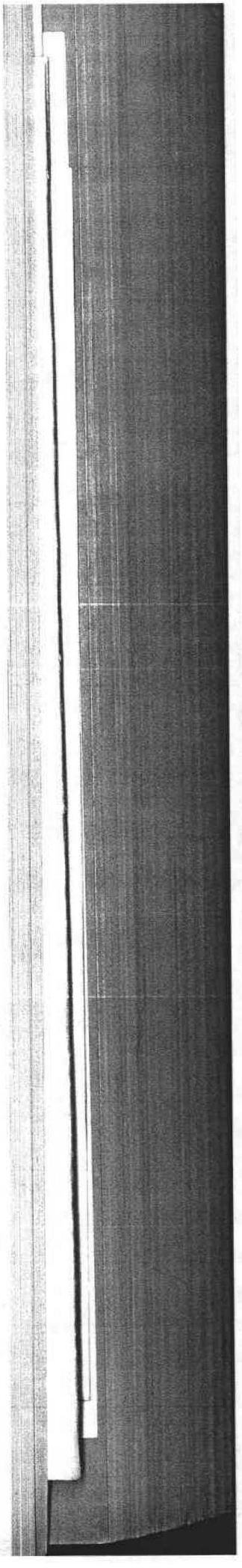

TABLE 12.—*Total production costs,*[1] *lumber value, and gross returns per thousand board feet, lumber tally, and per acre for loblolly pine by cutting to different diameter limits*

Cutting to a diameter limit breast high of—	Value of lumber	Total lumber-production cost	Difference	Cut per acre	Gross returns per acre [2]
	Dollars	*Dollars*	*Dollars*	*Board feet*	*Dollars*
8 inches and up	24.26	18.04	6.22	20,770	129.19
9 inches and up	24.35	17.77	6.58	20,147	132.57
10 inches and up	24.47	17.42	7.05	19,316	136.18
11 inches and up	24.68	17.00	7.68	17,841	137.02
12 inches and up	24.94	16.59	8.35	15,827	132.16
13 inches and up	25.21	16.37	8.84	13,729	121.36
14 inches and up	25.52	16.29	9.23	11,257	103.90
15 inches and up	25.75	16.45	9.30	8,890	82.68
16 inches and up	25.97	17.03	8.94	6,356	56.82
17 inches and up	26.13	18.27	7.86	4,320	33.96
18 inches and up	26.21	21.13	5.08	2,617	13.29

[1] Includes all costs except stumpage, interest, and Federal taxes.
[2] Available to cover profit, stumpage, interest, and Federal taxes.

Table 12 shows that the production cost under selective logging does not increase but actually decreases until the 15-inch diameter cutting limit is reached. This is conservative, since in an established selective logging operation costs for railroads and camps would not increase so rapidly, because old grades and roads could be used over and over, while in the foregoing example no such credit has been taken into account.

So far results for the pine only have been given, but in managing the stand for permanent timber production some consideration must be given to the hardwoods. The most logical thing to do is to cut the poor hardwoods along with the pine. This was done, and the results are shown in Table 13, together with a diameter-cutting limit for the pine. Since, as previously pointed out, the hardwoods did not pay their way, the returns are less than for pine alone. For example, if all trees 8 inches and larger, both hardwoods and pine, are cut, the gross returns per acre would be only $122.52, as compared with $129.19 for the pine alone. If all the hardwoods 8 inches in diameter and larger and only the pine 11 inches and larger are cut, the gross return is $131.35, whereas the pine alone yields $137.02. These examples indicate that the removal of the hardwoods actually caused a loss, but over a long time this would be made up by an increased volume of pine. From this comparison it must not be taken for granted that all the hardwoods should be cut, for good-quality hardwood in small amounts in a pine stand is believed to be beneficial; and if fire is kept out, it should pay its way. For the first cut, however, a slight loss will probably be incurred in clearing the area of undesirable hardwoods.

TABLE 13.—*Total production cost, value of lumber, and gross returns per thousand board feet, lumber tally, and per acre by cutting all hardwoods and the loblolly pine to different diameter limits*

Cutting to a diameter limit breast high of—	Volume removed per acre		Value of lumber	Total [2] production cost	Difference	Gross returns per acre [3]
	Loblolly pine	Hardwoods [1]				
	Board feet	*Board feet*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8 inches and up	20,770	1,306	23.80	18.25	5.55	122.52
9 inches and up	20,147	1,306	23.87	17.95	5.92	127.00
10 inches and up	19,316	1,306	23.97	17.64	6.33	130.54
11 inches and up	17,841	1,306	24.12	17.26	6.86	131.35
12 inches and up	15,827	1,306	24.30	16.93	7.37	126.27
13 inches and up	13,729	1,306	24.45	16.78	7.67	115.32
14 inches and up	11,257	1,306	24.57	16.82	7.75	97.36
15 inches and up	8,890	1,306	24.56	17.08	7.48	76.27
16 inches and up	6,356	1,306	24.35	17.79	6.56	50.26
17 inches and up	4,320	1,306	23.89	19.04	4.85	27.29
18 inches and up	2,617	1,306	22.96	21.28	1.68	6.59

[1] The volume removed is constant because in a selective-logging plan favoring pine the present hardwoods should be removed.
[2] Includes all costs except stumpage, interest, and Federal taxes.
[3] Available for profit, stumpage, interest, and Federal taxes.

Under the selective-logging plan carried out in this study, all the merchantable hardwoods 8 inches in diameter and larger were cut and 69 per cent of the total volume of the pine, which was made up of trees from 8 to 22 inches in diameter. Only 7.5 per cent of the cut, however, came from trees less than 12 inches in diameter.

Under management the next cut of pine will be made up of better-quality trees than the present one. and there should be fewer hardwoods of low value.

APPLICATION OF RESULTS TO UTILIZATION AND FOREST PRACTICE IN NORTH CAROLINA

Competition in the lumber industry has become so keen that the producer, if he is to continue in the business, must take advantage of every opportunity to increase the revenue obtainable. Higher stumpage and lumber prices and an increasing demand for forest products can not be depended upon to carry him along. Closer utilization carried out in a practical way is one of the best ways of getting more revenue from the forest. The use of the portable band saw described in this bulletin is a forward step in utilization. At this operation the waste due to sawdust was reduced about one-third of that common with large band saws. In addition the lumber was kiln-dried before being edged, then edged to random widths, thus increasing the amount of lumber that a given log would yield as compared with the results where the lumber is edged while green and cut to stock widths.

Easy portability of woods and mill equipment adds materially to the success of selective-logging operations, since it is necessary to cover a larger area to obtain a given amount of timber than under clear cutting. Although the operation studied was carried on by the use of railroads, the mill, with some modification, can be mounted on trucks to travel on ordinary roads. For small tracts of timber such a mill would have many advantages.

With a thin saw and a market for bark strips it is possible to reduce the waste in slabs to a minimum. Furthermore, in this operation the edgings were dry and ready to be manufactured into molding, handles, and dimension stock without further drying or handling.

The lumber was well manufactured at this portable band sawmill, and the loss from thick and thin lumber and lumber of nonuniform thickness was reduced to a practicable minimum.

Before attempting to apply the methods set forth in this bulletin, each individual company should determine (1) whether it desires to make its operation permanent and (2) whether it can do so. Such a decision rests primarily on whether the owners expect to stay in the lumber business or other wood-using industry, whether sufficient land is owned and enough timber is available to make possible a permanent operation, and whether the financial condition of the company permits of carrying on such an undertaking. No nation-wide recommendation can be made. It is certain, however, that there are thousands of acres in the coastal plain better suited at present to raising trees than other crops, that higher yields of timber are obtained under management and fire protection than under unregulated cutting with little or no fire protection, and that loblolly pine grows rapidly and has a wide and ready market both here and abroad.

The best information indicates that selective logging is a practicable way of cutting loblolly pine stands. No matter whether the area is large or small this method of cutting can be used. For the farm wood lot or the small area of timberland selective cutting is especially to be considered, because these areas are usually easily accessible and can be logged at any time with moderate or practically no direct cost for roads. Improved highways and the development of motor trucks have made it practicable to market either logs or lumber successfully even though the haul is as great as 20 to 30 miles.

Practically none of the loblolly pineland is producing all the wood it is capable of producing, because there are not enough trees on it. Timberland owners when embarking on selective cutting will have to work with less than fully stocked stands and must, therefore, be content with less than maximum growth until their timber can be improved by management and fire protection to a point where the land is stocked with all the thrifty well-formed trees it will support. The area studied was about four-fifths stocked with timber 4 inches and larger, which may be accepted as representative of old-field timber on the better sites. It is interesting to compute the returns for such a stand for the next two cutting cycles, assuming that selective cutting will be practiced and fire kept out. Table 14 shows the actual amount of timber per acre that was cut from the study area under selective logging, the average production cost and lumber value, and the gross returns per acre. In addition the same information is given for two cuts in the future, assuming comparable production costs and lumber values and a growth rate of 1 inch in diameter in five years, which is about 15 per cent slower growth than that of the average tree in the original stand.

TABLE 14.—*Probable gross returns per acre for loblolly pine under selective cutting at 20-year intervals*

Diameter breast high in inches	Trees per acre			Volume per acre dry lumber tally		20 years after first cut		40 years after first cut	
	Standing	Cut	Left	Left	Cut	Trees per acre [1]	Volume per acre dry lumber tally [2]	Trees per acre	Volume per acre dry lumber tally [2]
	Number	*Number*	*Number*	*Board feet*	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*
3	0.9		0.9						
4	1.1	0.2	.9						
5	1.4	.5	.9						
6	5.8	1.0	4.8						
7	14.1	3.0	11.1			0.9			
8	18.4	4.0	14.4	488	135	.9			
9	23.7	4.5	19.2	673	158	.9			
10	23.7	6.0	17.7	1,102	373	4.8			
11	22.0	8.4	13.6	1,245	769	11.1		0.9	
12	17.5	10.0	7.5	899	1,199	14.4		.9	
13	15.9	10.7	5.2	808	1,664	19.2		.9	
14	12.7	9.2	3.5	652	1,715	8.7 9.0	1,510	4.8	
15	11.0	9.6	1.4	323	2,211	13.6	2,820	11.1	
16	7.4	6.6	.8	220	1,816	7.5	1,857	14.4	
17	5.2	4.9	.3	98	1,605	5.2	1,533	19.2	5,659
18	3.2	3.2			1,184	3.5	1,166	8.7	2,897
19	2.2	2.2			851	1.4	487		
20	.9	.9			333	.8	266		
21	.5	.5			207	.3	112		
22	.1	.1			42				
Total	187.7	85.5	102.2	6,508	[3] 14,262		9,751		8,556
					Dollars		*Dollars*		*Dollars*
Lumber value per thousand board feet					24.92		25.53		26.10
Production cost per thousand board feet					16.94		15.89		15.19
Difference per thousand board feet					7.98		9.64		10.91
Gross returns per acre					111.53		94.00		93.35

[1] Under forest management the diameters below 7 inches should be filled in by young trees.
[2] A reduction of 10 per cent is made for loss from windfall, disease, and the like. Values represent volumes above diameter cutting limits.
[3] Includes 286 board feet lost in logging.

The cut as made yielded 14,262 board feet per acre, 13,976 board feet of which came into the mill and resulted in a gross return of $111.53 to cover stumpage, profit, interest, and Federal taxes. If the remaining trees grow at the rate of 1 inch in 5 years, then in 20 years it would be possible to cut with a portable band sawmill 9,751 board feet per acre and obtain a gross return of $94. Similarly, 40 years after the first cut 8,556 board feet could be removed which would yield a gross return of $93.35. With fire protection and average rainfall the area should have seeded, and a stand approaching full stocking should be growing on the land, making a satisfactory return cut available every few years for all time. To some, the interval between cuts may seem too long, and it would be entirely practicable to return every 10 years if the operator is satisfied with a smaller yield per acre. With portable-mill equipment it is entirely practicable to log areas where the cut is only 1,000 to 2,000 board feet per acre, so that it seems probable that short rotations will obtain in many permanent small mill operations. A diameter limit has been used in Table 14 to indicate the results for the two future cuts in the absence of definite figures on selective cutting. In practice the stand should be logged about as indicated by the cut that was made during the study. Only thrifty, well-formed trees should be left uncut so that the quality of the trees occupying the land will improve with time.

If a company desired to operate in a small way and run three of the portable mills similar to the ones described in this bulletin, it would need about 7,000,000 board feet of logs annually. About 17,500 acres of loblolly pineland would be required to grow that amount of timber if an average growth of 400 board feet of lumber could be attained. Taking the land as it would occur in a block of such size probably this estimate of growth is too high for the first several cutting cycles, and it might therefore be necessary to increase the acreage in order to maintain the foregoing output.

LOG GRADES

Many mills in the coastal plain buy logs from farmers and wood-lot owners, but there are no generally recognized and accepted rules for separating the logs into quality classes or grades. To assist in development of such grades, all the logs in this study were classified according to a tentative set of rules which follow:

NO. 1 LOGS

Surface-clear logs from 14 to 15 inches and logs 16 inches and over in diameter inside bark, small end, which contain not to exceed three 2 to 4 inch knots. Reasonably straight grained. Length 10 feet and over.

NO. 2 LOGS

Surface-clear logs 6 to 10 inches in diameter and larger containing numerous small knots or more knots than allowed in grade No. 1. Length 8 feet and over.

NO. 3 LOGS

Coarse, knotty, crooked logs that do not fall in either grades No. 1 or No. 2. No limitations on size or quality of lumber produced.

NO. 4 LOGS

All logs that are less than one-third sound.

Table 15 shows the results of the study and indicates the net value ln logs of different grades taking into account the variation in overrun as well as the difference in quality.

TABLE 15.—*Value of loblolly pine logs by grades for use in purchasing and selling*

Log grade No.	Description of log grades	Contents (lumber tally) of the average log	Overrun	Average value of the dry lumber in 1,000 board feet [1] of logs	Production costs per 1,000 board feet [1] from log deck to shipping platform	Difference between value and log deck to shipping platform cost per 1,000 board feet [1]	Average value of 1,000 board feet [1] of dry lumber
		Board feet	*Per cent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	Surface-clear logs 14 and 15 inches in diameter. Logs 16 inches in diameter and over, but having not more than three knots	136	17.1	36.73	11.68	−25.05	31.37
2	Surface-clear logs 6 to 10 inches in diameter. Larger logs with small knots	77	41.5	36.83	12.94	−23.89	26.03
3	Coarse, knotty, crooked logs	41	92.8	43.01	15.30	−27.71	22.31
4	Logs that are less than one-third sound	[2]	[2]	[2]	[2]	[2]	[2]

[1] Gross scale Doyle. [2] Cull.

Owing to the extremely high overrun that obtained for the No. 3 logs, the lumber in a thousand board feet gross scale of logs was worth more than for the higher grade No. 1 logs. On a thousand-foot lumber-tally basis, however, the lumber from the No. 1 logs was worth $9.06 more than that from the No. 3 logs. In addition the cost of cutting the No. 1 logs, which averaged 136 board feet each, into lumber was less per thousand board feet than for the No. 3 logs, which ran only 41 board feet per log.

From Table 15 it is possible for a millman to determine the price he can pay for logs of a given grade and average size and yet make a profit of a given amount. Suppose a deck of logs were offered to a millman at a given price. He could classify the logs and then by reference to Table 14 determine that the lumber in No. 1 logs, at the prices obtaining during the study, was worth $31.37 per thousand board feet and that the overrun would be about 17.1 per cent. Suppose his milling cost and margin for profit for logs of this size amounted to $14. Under these conditions he could afford to pay $20.34 per thousand board feet gross log scale (overrun per cent of 1.171 times $31.37 minus 1.171 times $14). Similarly, with a production cost and profit charge of $18, he could afford to pay about $8.31 per thousand board feet log scale for No. 3 logs. These data are based on 2,000 logs and should be representative.

Table 16 is for the use of the log buyer or seller who wishes to set up a value for his logs using different lumber prices from those obtained in this study. The grade percentages indicate a reasonable separation into quality classes. For example, grade No. 1 logs contain 22.2 per cent B and better, No. 2 logs 10.7 per cent, and No. 3 logs only 1.6 per cent. There is also a good spread in value, No. 1 logs being worth $5.34 more per thousand board feet than No. 2 logs and $9.06 more than No. 3 logs. Cull logs vary so widely in value that no attempt has been made to evaluate them.

TABLE 16.—*Quality and value of dry lumber from loblolly pine logs of different grades*

Lumber grade	No. 1 logs		No. 2 logs		No. 3 logs	
	Dry lumber	Value per M feet b. m.	Dry lumber	Value per M feet b. m.	Dry lumber	Value per M feet b. m.
	Per cent	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*
B and better	22.2	47.13	10.7	44.13	1.6	42.78
No. 1 and C	15.8	36.90	12.9	33.62	4.4	32.85
No. 1 box	56.7	24.18	62.1	22.75	77.5	22.27
No. 2 box	1.8	20.77	9.3	19.04	12.7	18.31
B and better bark strips	2.6	30.00	2.5	30.00	.6	30.00
Box bark strips	.9	13.00	2.5	13.00	3.2	13.00
Total or weighted average	100.0	31.37	100.0	26.03	100.0	22.31

In the old-field loblolly pine stand covered by this study 9.6 per cent of the logs graded No. 1, 54.1 per cent No. 2, 35.9 per cent No. 3, and 0.4 per cent No. 4 on the basis of gross log scale.

VOLUME AND VALUE OF INDIVIDUAL LOBLOLLY PINE TREES

Table 17 gives the average volume and value for trees of different diameters. For example, 10-inch trees have an average volume of 62 feet, board measure, and a value of $1.36, but production costs are $1.49, so that such trees result in a loss of $0.13 each, whereas 20-inch trees have a volume of 370 board feet and a value of $9.63, which is sufficient to cover production costs and leave a balance of $4.41 to cover stumpage, interest, Federal taxes, and profit. The figures in Table 17 should be useful in determining the value of individual trees in connection with the marking of a stand for selective cutting and in sales of trees from wood lots.

TABLE 17.—*Average volume and value of old-field loblolly pine trees of different diameters*

Diameter breast high	Volume of dry lumber per tree	Cost of cutting each tree into lumber	Value of lumber in each tree	Difference	Stumpage [1] value of each tree
Inches	*Board feet*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
8	34	1.03	0.72	−0.31	−0.52
9	35	.95	.76	−.19	−.38
10	62	1.49	1.36	−.13	−.43
11	92	1.98	2.08	+.10	−.30
12	120	2.35	2.79	+.44	−.03
13	155	2.81	3.70	+.89	+.33
14	186	3.20	4.57	+1.37	+.73
15	230	3.78	5.80	+2.02	+1.26
16	275	4.36	7.05	+2.69	+1.82
17	328	5.03	8.53	+3.50	+2.49
18	370	5.51	9.73	+4.22	+3.12
19	387	5.62	10.20	+4.58	+3.46
20	370	5.22	9.63	+4.41	+3.37
21	414	5.72	10.59	+4.87	+3.73
22	420	5.65	10.63	+4.98	+3.85

[1] Stumpage value is the production cost, plus a 20 per cent margin for profit, subtracted from the value of the lumber.

CONCLUSIONS

The following conclusions are drawn from a study of the use of portable band sawmills in the selective logging of an old-field second-growth loblolly pine stand in North Carolina:

Portable band sawmills were operated successfully with a full-time filer in the woods to take care of the saws for a group of three mills.

The portable band sawmills studied put out well-manufactured lumber and obtained more lumber from logs of a given size than did a large band sawmill in the same locality.

Edging and trimming the lumber after it had passed through the kiln worked out satisfactorily.

Partial cutting, or selective logging, proved a satisfactory economic method of logging old-field loblolly pine stands in the coastal plain.

Production costs were lower under selective cutting than under clear cutting until a high diameter limit was reached.

The greatest gross return was obtained from the least volume; that is, a 14-inch cutting limit removed 54 per cent of the volume and yielded 76 per cent of the highest possible return.

Loblolly pine trees under 11 inches in diameter did not pay their way when cut into lumber, not including the cost of stumpage, Federal taxes, or interest. If these items are included, a tree would need to be at least 13 inches in diameter to pay its way.

The small hardwoods cut in this operation did not pay their way.

A logger who has no interest in establishing a permanent operation and who has the same costs as obtained at the operation studied would make the most money per acre by cutting only trees 11 inches in diameter and larger.

Inasmuch as an old field produced a stand 80 per cent stocked without management and with only partial fire protection, the chances of obtaining full stocking under management and complete fire protection are good.

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