LIVE-SAWING:

a way to increase lumber grade yield and mill profits

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ABSTRACT

A study to compare live-sawing with conventional grade-sawing of factory-grade 3 red oak sawlogs revealed that live-sawing results in substantial increases in production rate, overrun, log value per thousand board feet, and significant reduction in size of the break-even log diameter.

LIVE-SAWING

APPLICATION

SAY THAT YOU are the operator of a sawmill, and you handle a lot of low-grade hardwood logs. How can you cut production costs and boost your profits? One way is by live-sawing the low-grade logs.

In a study in West Virginia, we compared live-sawing with conventional grade-sawing of factory-grade 3 red oak sawlogs. We found that live-sawing increased the production rate, increased overrun, and increased the log value per thousand board feet.

LIVE-SAWING

Here's how this method of live-sawing works.

Place the straight or nearly straight log on the carriage with the best face toward the saw. Use full taper set-out. Cut 4/4 boards till you reach the center of the log. Then turn the log 180 degrees and continue sawing the rest of the log through and through.

In this kind of sawing, you need to turn the log only once.

The occasional crooked or sweepy log will have to be turned twice. First saw a slab off one face. Turn the log 90 degrees to place the flat face against the headblocks. Then saw in the same way you sawed the straight logs.

The great advantage of this method of sawing is that you need to turn the log only once or twice. In grade-sawing, you have to turn the log at least three times.

POINTS TO WATCH

- For accurate live-sawing, the carriage should have tong dogs or some other type of dogs that hold the log securely against the carriage knees.
- Live-sawing produces a high percentage of quarter-sawed boards, and boards with heartwood centers and sapwood edges. This may cause greater than normal degrade losses during air-drying and kiln-drying.
- Much of the responsibility for lumber-grade recovery is shifted from the sawyer to the edgerman; so the edgerman should have a sound knowledge of hardwood lumber grading rules.
- Do not live-saw logs with unsound centers or logs with excessive crook or sweep. Both volume and grade are reduced in live-sawing such logs.
- Adjust the material-flow system in your mill so you can dispose of edgings quickly. This could be a problem with live-sawing.

For more detailed information about live-sawing and our study of it, see the following pages.

LIVE-SAWING

DOCUMENTATION

A MAJOR PROBLEM for the hardwood sawmill operator is to convert small low-grade logs into lumber at a profit. This problem is aggravated by a steady increase in the number of low-grade sawlogs received by sawmills, increasing lumber-production costs, and relatively constant lumber prices—especially for No. 2 and No. 3 common lumber. Since most sawmill operators have little or no control over timber quality and lumber prices, their best opportunity for increasing profits from small low-grade logs is to process the logs more efficiently.

In a recent study, we compared live-sawing (through-and-through sawing) with conventional grade-sawing of small low-grade red oak logs. Live-sawing resulted in greater production rates, greater overrun, and higher lumber value.

STUDY METHODS

The study was conducted in southern West Virginia at an all-electric circular sawmill that has a production capacity of about 10,000 board feet of 4/4 lumber per 8-hour day. The major species sawed are red oak, yellow-poplar, and hard maple. The lumber is marketed primarily as furniture and flooring stock.

Mill equipment included a Corley No. 3 special headrig with automatic air carriage, a 56-inch inserted-tooth circular saw, a 27-inch Frick edger, and a Tower double-end trim saw. A blower system is used to transport dust from the edger and headsaw. To increase mill efficiency, a Hosmer debarker and a hydraulic log turner have been installed. (Mention of brand names should not be taken as an endorsement by the USDA Forest Service.)

Factory-grade 3 northern red oak logs (*Quercus rubra*) were selected randomly for the study. The logs were graded according to Forest Service standard log-grading specifications (*Ostrander et al. 1963*) and separated into two groups. Group 1 consisted of 90 logs that were live-sawed; group 2 consisted of 49 logs that were grade-sawed. All logs were scaled according to the Scribner decimal C log rule. Deductions from gross volume were made for sweep, crook, rot, and other scaling defects. (About 10 percent of the logs were below factory-grade 3.) Distribution of log diameters for both sawing methods are shown in figure 1.

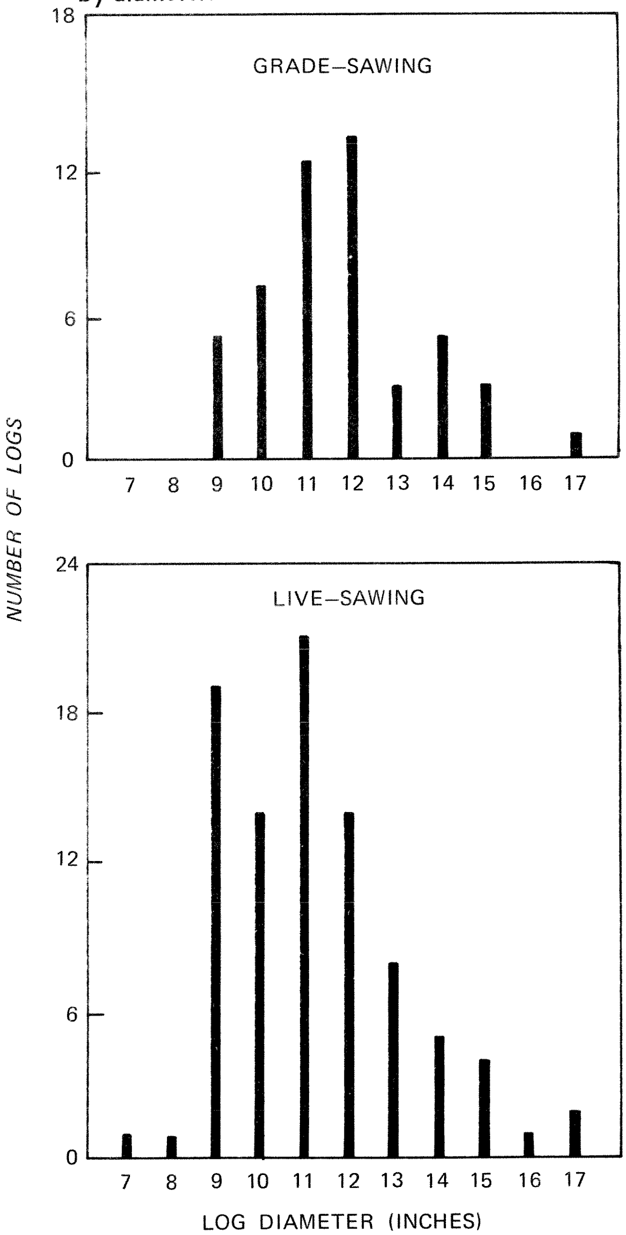
Sawing Techniques

Grade-sawing.—The log was positioned so that visible defects, primarily knots, were located on the edges of the sawing face (fig. 2). In most cases the poorest face (the face with the most defects) was sawed first, without using taper set-out. When the best face was sawed first, full taper set-out was used. Whenever the grade of the face being sawed dropped below the potential grade of adjoining faces, the log was turned. Thus three or more turns were made in grade-sawing a log.

Live-sawing.—Straight or nearly straight logs were positioned on the carriage with the best face towards the saw, using full taper set-out; 4/4 boards were removed until the approximate center of the log was reached (fig. 2). The logs were then turned 180 degrees and sawed the rest of the way through. Thus, each log was turned only once. For a few logs containing sweep or crook, a slab was removed and the logs were turned to place the flat surface to the headblocks. The logs were then sawed in the same manner as straight logs. For those logs containing sweep or crook, two turns were required.

Headsaw time for each log was recorded to the nearest 0.1 minute. The number of saw cuts and turns were also recorded for each log.

Figure 1.—Distribution of grade 3 log samples by diameter.



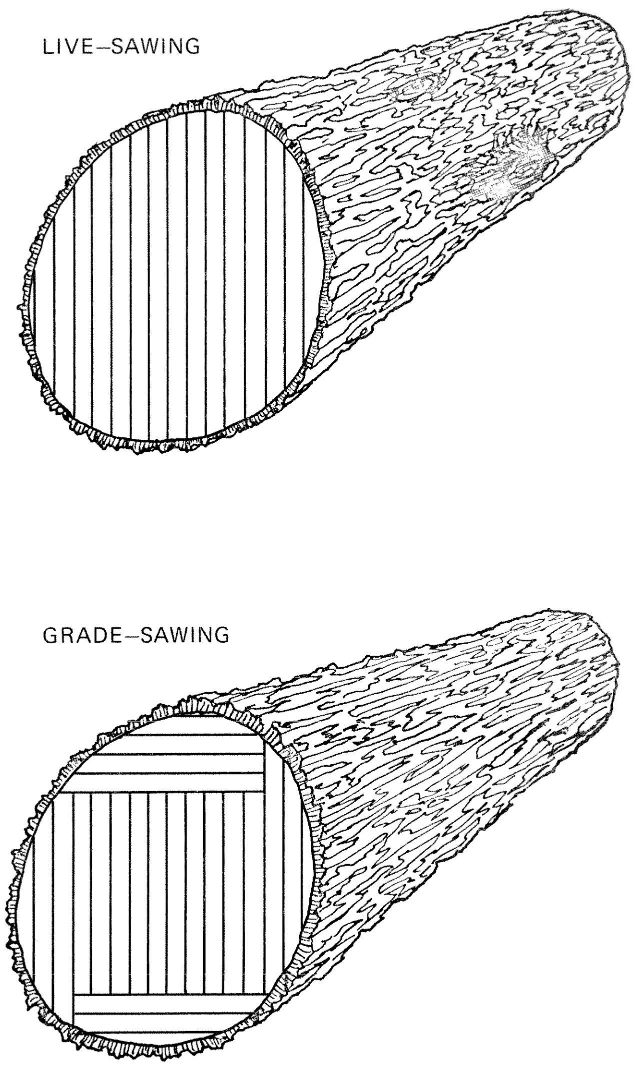


Figure 2.—Sawing patterns for live-sawing and grade-sawing.

Lumber Grade Recovery and Value Determination

The boards recovered from each sample log live-sawed were marked with the number of the parent log and tallied by grade and thickness according to National Hardwood Lumber Association Rules (*1969-70*). The air-dry lumber volume of each log was estimated by deducting 5 percent from the green volume. The value of lumber recovered for each log-diameter class was determined by applying current market prices (*Hardwood Market Report 1970*), by grade, to lumber yield for logs in the class. Overrun was computed as the difference between net log volume and air-dry lumber tally.

In the grade-sawing, lumber recovered from each log was tallied by board-foot volume only. This was done to determine production rates and overrun for the various diameters of logs used in grade-sawing. The lumber grade recovery for grade-sawing was not recorded because a review of lumber grade yield from past research at the study mill disclosed a close relationship between the mill's actual lumber grade yield and predicted yields published by the U.S. Forest Products Laboratory (*Paper FPL-63, 1966*) for logs of similar size. Therefore it was felt that accurate lumber grade yield predictions could be made from FPL Paper FPL-63.

The value of lumber produced in the grade-sawing was determined by multiplying the quality index log value for each log diameter as reported by McCauley and Mendel (*1969*) by the current market price of 4/4 No. 1 common lumber. This procedure was used because the quality index values were developed from the lumber grade yield estimates in FPL Paper FPL-63.

The actual percentage yields of the different grades of lumber recovered were computed for each log diameter for the live-sawing method. These yields were then compared with the percentage yields predicted for similar logs in FPL-63.

Analysis-of-variance techniques were used to determine whether differences in lumber grade yield between logs that were live-sawed and the lumber grade yield predicted in FPL-63 for similar logs were statistically significant.

Mill Production and Cost Determination

To standardize computations for both sawing methods, sawing time for each log (in minutes) was converted to sawing time per thousand board feet (M bd. ft.) air-dry lumber for the various diameter and length classes. Sawing time per M bd. ft. of lumber from logs of the same diameter and length was computed as the ratio of log sawing time to log volume, expressed in M bd. ft. Delay time was not considered in the computation. When a delay occurred while the log was being sawed, delay time was recorded and then subtracted from the total time to arrive at an actual sawing time. The sawing time per M bd. ft. for live-sawing was compared to that for grade-sawing to determine the relative lumber-production rates for the two sawing methods.

Sawing cost per M bd. ft. for both sawing methods was determined by multiplying the average time required to saw one M bd. ft. by the hourly cost values pertaining to the study mill. Costs of air-drying, selling, and indirect administrative cost were excluded from the analysis. A raw-material cost (log cost adjusted for overrun) of $45 per M bd. ft. Scribner decimal C log scale, was added to the sawing cost to determine the lumber-production cost. The lumber-production cost and lumber value (per M bd. ft. mill tally) were then analyzed to determine the break-even log diameter for both sawing methods.

RESULTS AND DISCUSSION

Lumber Grade Recovery

There was no significant difference (5-percent level) in the yields of First and Second (FAS) or First One Face (FIF) lumber between live-sawing and that predicted for grade-sawing. Also, diameter of the log had no effect on the yield of FAS or FIF lumber produced by either sawing method (table 1).

The effect of sawing method on the No. 1 common grade yield was highly significant (1-percent level). Live-sawing produced 8.1

Table 1.—Air-dry lumber yield for grade 3 red oak sawlogs, by sawing method

Sawing Method	Logs	Lumber grade FAS	FIF	1COM	2COM	3ACOM	3BCOM	Volume
	No.			*Percent yield*				*Bd. ft.*
Grade-sawing[a]	90	0.2	0.6	14.0	22.2	15.4	47.6	4,757
Live-sawing[b]	90	.5	.9	8.4	41.8	34.5	13.8	4,814

[a] Percent yields predicted from FPL-63.
[b] Actual air-dry lumber yield from live-sawing.

Table 2.—Overrun and adjusted log cost[a] for grade 3 sawlogs, by diameter classes

Log diameter (inches)	Overrun (Scribner decimal C) live-sawed	Log cost per M bd. ft., mill tally	Overrun (Scribner decimal C) grade-sawed	Log cost per M bd. ft., mill tally
	Percent	*Dollars*	*Percent*	*Dollars*
8	16.1	38.76	14.5	39.30
9	13.9	39.51	11.4	40.39
10	11.7	40.29	8.2	41.59
11	9.5	41.10	5.1	42.82
12	7.3	41.93	2.0	44.12
13	5.1	42.82	−1.2	45.55
14	2.9	43.73	−4.3	47.02
15	.7	44.69	−7.4	48.60
16	−1.4	45.64	−10.6	50.34
All diameters	7.3	41.93	2.0	44.12

[a] Assumed log cost of $45/M at the point of use.

percent No. 1 common lumber as compared to the 14.2 percent predicted yield for grade-sawing (table 1). Most of this difference in yield occurred in the 8- to 12-inch diameter logs because the opportunities to upgrade boards produced from small logs by ripping at the edger are negligible. But, with larger logs and wider boards, some No. 1 common can be ripped from the outer edges of the boards.

Sawing method also had a significant effect on the No. 2, 3A, and 3B common lumber yield. Live-sawing produced about 20 percent more No. 2 common, 19 percent more 3A common, but about 34 percent less No. 3B common than predicted for grade-sawing. In grade-sawing low-grade logs, the higher grades of lumber are cut from the outer portion of the log by turning several times; the remaining boxed heart yields a high percentage of No. 3B common lumber. In live-sawing, the higher quality outer portion of the log occurs on the edges of the middle boards, therefore upgrading the otherwise 3B common to No. 2 and No. 3A common.

Overrun

Live-sawing resulted in a 7.3-percent greater overrun based on the Scribner decimal C log rule (table 2). Greater overrun from live-sawing is attributed mainly to two factors: (1) less volume is lost to saw kerf, because fewer saw cuts are needed; (2) because the log is turned only once, volume loss due to slabbing is reduced. For 8- and 9-inch diameter logs, overrun for live-sawing was slightly greater than for grade-sawing. As log diameter increased above the 9-inch diameter class, live-sawing became progressively better than grade-sawing in terms of overrun, although overrun declined for both sawing methods as larger diameter logs were sawed (fig. 3).

Figure 3.—Percent overrun for grade 3 red oak sawlogs, by diameter.

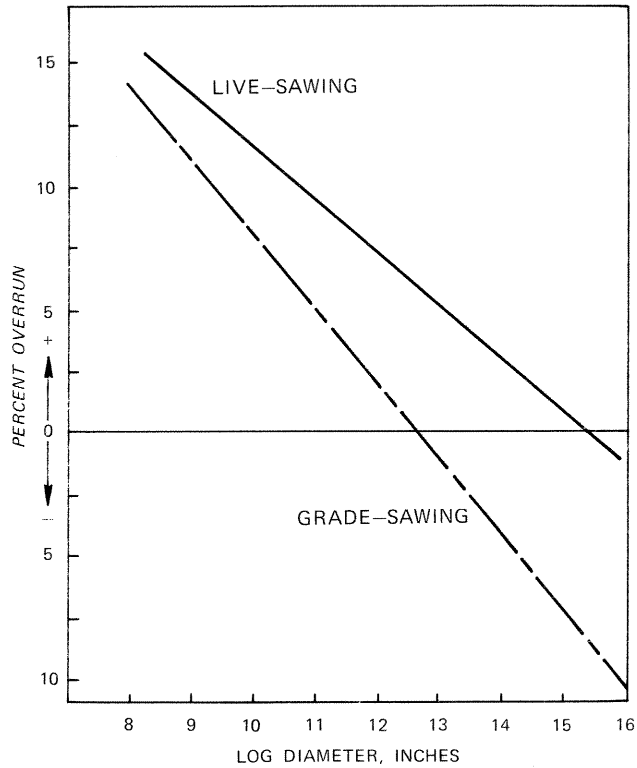
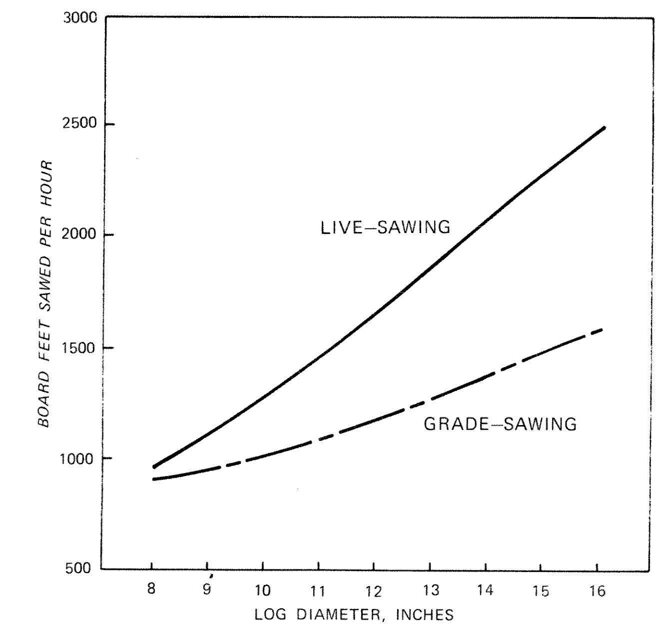


Figure 4.—Volume of factory-grade 3 sawlogs sawed per hour, by diameter: grade-sawing versus live-sawing.



Lumber-Production Rates

Lumber production rates in board feet per hour (mill tally basis) were nearly 41 percent greater for live-sawing than for grade-sawing (fig. 4). Headsaw time for live-sawing averaged 39.2 minutes per M bd. ft. as opposed to 51.7 minutes per M bd. ft. for grade-sawing.

The higher lumber-production rate per hour for live-sawing is the result of two factors: (1) logs were turned on the carriage only once; and (2) fewer sawcuts were required (table 3). To illustrate, at the study mill a log 12 inches in diameter and 12 feet long required about 0.08 minutes per turn and 0.16 minutes per sawcut for conversion to 4/4 lumber. Grade-sawing required at least 3 turns and 14 sawcuts; whereas live-sawing required only 1 turn and 9 sawcuts. Thus 2.48 minutes were required for conversion in grade-sawing, while live-sawing required only 1.52 minutes.

Mill Profit

There are three ways in which a mill operator can increase his profit: (1) lower sawing cost per unit by increasing the production rate; (2) increase the value of the product by increasing the volume yield (increased overrun) or increasing the yield of higher lumber grades; (3) and some combination of (1) and (2).

Live-sawing increased both production rate and overrun. But to fully judge these two factors, we must look at how live-sawing affects lumber values and the cost of lumber production.

Sawing cost per M bd. ft. decreased for both sawing methods as log diameter and length increased. However, sawing cost by live-sawing averaged \$30.03 per M bd. ft. while that for grade-sawing averaged about \$34.59 per M bd. ft. Thus live-sawing reduced the sawing cost by \$4.56 per M bd. ft., or about 12 percent (table 4).

To arrive at a total lumber-production cost, a log cost of \$45 per M bd. ft. (adjusted for overrun) was added to the sawing cost. The total lumber-production cost for live-sawing average \$71.96 per M bd. ft. as compared with \$78.71 per M bd. ft. for grade-sawing (table 4). Therefore, an overall reduction in

Table 3.—Average number of sawcuts and turns for two sawing methods

Sawing method	Logs	Average log diameter	Average length	Average number of sawcuts	Average number of turns
	No.	*Inches*	*Feet*	*No.*	*No.*
Grade-sawing	49	11.8	11.3	14	3
Live-sawing	90	11.2	12.3	9	1

Table 4.—Contrasted live-sawing and grade-sawing production costs per M board feet for grade 3 sawlogs

Log diameter (inches)	Log cost per M bd. ft.		Milling cost per M bd. ft.		Total cost per M bd. ft.	
	Live-sawing	Grade-sawing	Live-sawing	Grade-sawing	Live-sawing	Grade-sawing
8	$38.76	$39.30	$37.55	$39.01	$76.31	$78.31
9	39.51	40.39	35.28	37.91	74.79	78.30
10	40.29	41.59	33.28	36.80	73.57	78.39
11	41.10	42.82	31.52	35.70	72.62	78.52
12	41.93	44.12	30.03	34.59	71.96	78.71
13	42.82	45.55	28.78	33.49	71.60	79.04
14	43.73	47.02	27.79	32.39	71.52	79.41
15	44.69	48.60	27.05	31.28	71.74	79.88
16	45.64	50.34	26.54	30.18	72.18	80.52
Average, all diameters	$41.93	$44.12	$30.03	$34.59	$71.96	$78.71

Table 5.—Log values[a] per M board feet for live-sawing vs. grade-sawing

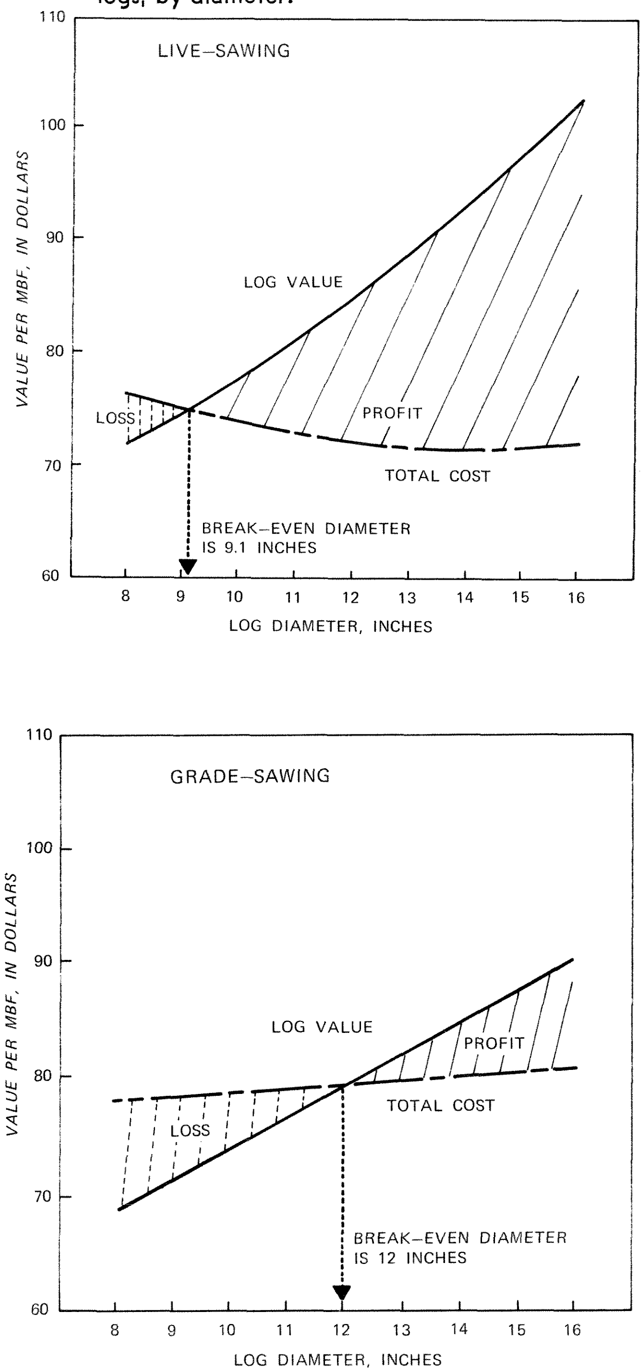
Log diameter (inches)	Value/M bd. ft. live-sawing	Value/M bd. ft. grade-sawing	Difference per M bd. ft.	Increase
	Dollars	*Dollars*	*Dollars*	*Percent*
8	$ 71.95	$69.13	$ 2.82	4.1
9	74.43	71.90	2.53	3.5
10	77.31	74.38	2.93	3.9
11	80.59	76.87	3.72	4.8
12	84.27	79.35	4.92	6.2
13	88.35	81.83	6.52	8.0
14	92.83	84.46	8.37	9.9
15	97.71	86.80	10.91	12.6
16	102.29	89.15	13.41	14.7
Average, all diameters	$ 85.52	$79.32	$ 6.21	7.8

[a] Air-dry lumber prices per M bd. ft. FAS—$245, No. 1 common—$138, No. 2 common—$85, No. 3A common—$75, No. 3B common—$40.

total production cost of $6.75 per M bd. ft., or about 9 percent, was realized from live-sawing.

In addition to the reduction in total lumber-production cost per M bd. ft., live-sawing increased the value of lumber produced by 7.8 percent over grade-sawing. The average value of live-sawed lumber was $85.52 per M bd. ft., and the comparable value for grade-sawing was $79.32 per M bd. ft. (table 5). This increase is a direct result of live-sawing producing more No. 2 and 3A common lumber, less No. 3B common lumber, and more overrun

Figure 5.—Log value and total production cost per M board feet for live-sawing (top) and grade-sawing (bottom) factory-grade 3 saw-logs, by diameter.



than grade-sawing. These factors more than offset the greater amounts of No. 1 common lumber produced by grade-sawing.

The effects of reduced lumber-production cost per M bd. ft. and increased value of lumber produced per M bd. ft. is substantial for live-sawing. The overall gain for live-sawing exceeded $13 per M bd. ft. This means that the study mill, which has a production of about 10 M bd. ft. per day, could increase mill profit by as much as $130 a day if the grade 3 logs were live-sawed rather than grade-sawed.

Perhaps more important is how live-sawing affects the size of the break-even log. A graphic comparison of total lumber-production cost and average lumber value by log diameter shows how the break-even or zero-profit log diameter can be determined for both methods of sawing. The diameter of the break-even log for live-sawing is 9.1 inches as compared with 12.0 inches for grade-sawing (fig. 5). Thus live-sawing actually permits the profitable manufacture of smaller diameter grade 3 red oak logs than does the more conventional grade-sawing. Also, the profit margins are progressively greater for live-sawing as log diameter increases above the break-even point (table 6).

CONCLUSIONS

In this study, live-sawing factory-grade 3 red oak logs resulted in significant gains over grade-sawing in lumber-production rates (40.7 percent), decreases in the yield of No. 3B common lumber, more overrun, an increase in average lumber value (7.8 percent), and a reduction in size of the break-even log. Although live-sawing produced less No. 1 common and better lumber than grade-sawing, the added overrun, the increased production, and the reduction in yield of No. 3B common lumber more than offset the loss of high-grade lumber.

The live-sawing method can be adopted by the sawmill industry without major changes in mill layout or expenditures in capital equipment. A mill operator who must gain mill efficiency to cope with the increase in the ratio of low-grade to high-grade logs should consider live-sawing.

Although these results are based on operat-

Table 6.—Margin of profit for live-sawing versus grade-sawing factory grade 3 red oak sawlogs, by log diameter

Log diameter (inches)	Production cost per M bd. ft.		Lumber value per M bd. ft.		Profit margin per M bd. ft.	
	Live-sawing	Grade-sawing	Live-sawing	Grade-sawing	Live-sawing	sawing Grade-
8	$76.31	$78.31	$71.95	$69.13	$—4.36	$—9.18
9	74.79	78.30	74.43	71.90	—0.36	—6.40
10	73.57	78.39	77.31	74.38	3.74	—4.01
11	72.62	78.52	80.59	76.87	7.97	—1.65
12	71.96	78.71	84.27	79.35	12.31	0.64
13	71.60	79.04	88.35	81.83	16.75	2.79
14	71.52	79.41	92.83	84.46	21.31	5.05
15	71.74	79.88	97.71	86.80	25.97	6.92
16	72.18	80.52	102.29	89.15	30.11	8.63
Average, all diameters	$71.86	$78.71	$ 85.52	$79.32	$13.66	$0.61

ing conditions at one study mill, they should prove generally applicable to most other operations using a single circular headsaw without resaw equipment. However, consider the following before adopting the live-sawing method:

- For accurate live-sawing, the mill carriage should have tong dogs or some other type of dogs that grip the log or cant securely on both edges and hold it tightly against the knees of the carriage.
- The live-sawing method produces a high percentage of quarter-sawed lumber and boards with heartwood centers and sapwood edges. Thus higher than normal degrade losses may be experienced in air-drying or kiln-drying this lumber.
- Much of the responsibility for lumber grade recovery is shifted from the sawyer to the edgerman. Therefore, the latter should have a sound knowledge of hardwood lumber-grading rules.
- Logs with unsound centers or excessive crook or sweep should not be live-sawed. Both lumber volume and grade yield are reduced greatly by live-sawing such logs.
- The material flow system in the mill should permit edgings to be disposed of quickly. Although this was not a problem in the study mill, it is conceivable that problems could arise from disposal of edging materials.

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