Live-sawing low-grade red oak logs

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Abstract

This paper discusses grade-sawing, live-sawing, and modified sawing that produces a cant, to determine which method produces the most value. In this study, 66 low-grade red and black oak logs were divided into three groups and processed by each of the three methods. The boards were graded for maximum volume and value before and after edging. Grading for maximum value after edging showed that live-sawing produced more value than cant-sawing and cant-sawing more than grade-sawing. Live-sawing produced more value per unit of time than cant-sawing and cant-sawing produced more than grade-sawing.

A subject of substantial discussion among North American hardwood sawmill operators and researchers has been What sawing method is best? Is the best method grade-sawing (sawing around), live-sawing through and through, or modified live-sawing that produces a cant, to process various grades, diameters, and species of logs?

In general, most hardwood logs are processed by grade-sawing or sawing around the log. Intuitively, it is believed this method will produce the highest volume of upper grade lumber since the sawyer can "work" the four log faces. That is, when the lumber grade of the next board to be processed from a log face drops below that of a remaining face, the sawyer can turn the log to the next best face and process it (11). This method does, however, require substantial time in turning loge during the primary breakdown process.

On the other hand, a few operators claim to live-saw logs of all species while others restrict live-sawing to certain species and diameters (4). For example, live-sawing small diameter black walnut logs has been common practice by a number of mills in Indiana and Kentucky. Numerous research reports on actual mill studies and computer simulation studies for different log species have indicated that live-sawing generally produces more volume in less time and may even produce more value in some cases (2, 7, 13,15,16, 18-21). Furthermore, in Europe, live-sawing is common practice and the entire log is maintained as one unit.

In addition to the actual sawing process, Boris and Kersavage (1) have indicated that live-sawn lumber, under proper drying conditions, does not dry or warp any differently than grade-sawn lumber. Furthermore, Pavlovich (14) indicated that 80 percent of the lumber-using firms in a Pennsylvania survey would purchase or consider purchasing live-sawn lumber. Reasons for negative responses included reduced all-heart and all-sap lumber, no cants, and more edge-grain.

Richards and Newman (20) provide excellent data for comparing live- and grade-sawing methods for high quality red oak logs. These 12-foot long logs ranged in diameter from 13.2 to 24.2 inches and averaged 18.5 inches. Live-sawing and skillful reripping of the flitches resulted in more value than traditional grade-sawing. Without skillfull reripping, however, live-sawing showed no great advantage. Sawing times for the two methods were not considered.

Flann (4) has done an excellent job summarizing sawmill studies. He indicated that government and university extension personnel should expend more effort in an attempt to encourage live-sawing of hardwoods. As a result, this study's objectives were to compare yield in terms of value, volume, lumber grade yield and sawing times for low-grade red and black oak sawlogs processed by grade-sawing, live-sawing, and cant-sawing.

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TABLE 1. — *Numbers of logs and characteristics by sawing method. All logs are true red oak unless otherwise noted.*

Forest Service grade	No. of logs	Average Diameter[a]	Average Length	Average Doyle scale	Sawing time	Number of turns
		(in.)	---------- (ft.) ----------		(min.)	
Grade-sawn						
2	5	16.1	11.2	495	22.09	22
3	11	14.6	11.2	831	47.66	51
Cull	6	14.1	11.2	434	22.67	24
Average		14.8	11.2	80	4.20	4.4
Cant-sawn						
2	4	15.8	11.3	387	17.15	16
3	12[b]	15.2	10.8	1,012	46.22	54
Cull	6[c]	13.8	11.0	411	22.22	26
Average		14.9	11.0	82	3.89	4.4
Live-sawn						
2	4	16.0	10.8	380	15.01	12
3	12[d]	15.6	10.6	1,034	54.89	34
Cull	6[c]	14.0	10.8	409	21.68	18
Average		15.2	10.9	83	4.16	2.9

[a]Inside bark.
[b]Contains two black oak.
[c]Contains three black oak.
[d]Contains one black oak.

Materials and methods

Logs

A group of 70 red and black oak logs were selected and measured for study. The diameters were measured in two directions inside the bark on the small end of the logs and averaged. The logs were scaled using the Doyle rule, based on the small end diameter, log length, and percent defect. The logs were then graded by the USDA Forest Service rules (17).

After measuring and grading, the logs were divided into three groups of 22 logs each. These groups were as carefully matched as possible. As a result, four logs were discarded. The three groups were then randomly assigned to each of the three sawing treatments: grade-sawing, cant-sawing, and live-sawing.

Sawing

All of the sawing was done in the same sawmill with the same crew. The log batches were sawn as groups, handling the lumber from one treatment at a time.

Grade-sawing.–All four faces of the log were cut into 4/4 lumber, allowing the sawyer to return to any face at any time. Generally, the sawyer would cut on a given face until a grade change was noted in the next piece to be cut; the sawyer would then turn the log to the next face, and again cut until a grade change was noted. This procedure was followed until all faces were cut and an 8/4 dog board resulted.

Cant-sawing. —All four faces of the log were cut into 4/4 lumber, allowing the sawyer to return to any face at any time. The rotation of the log was similar to that for grade-sawing but the final product was a cant of about 4 by 6 inches by log length.

Live-sawing. –The initial plan was to orient the log on the carriage with the major defects straight up or straight down, saw 4/4 boards on the first face, about to the center of the log, and then rotate 180 degrees and finish cutting. The last piece would bean 8/4 dog board. Because of difficulties in holding the logs, this procedure was modified for safety reasons after the first two logs either slipped from the dogs or caught on the saw husk. With the modified procedure for this treatment, a very light slab was removed from the first face, that face was turned down and then processed as in the initial plan. This method corrected the slippage of the logs that was noted initially.

Edging, trimming, and grading. —In sawmill studies of this nature, concern is often expressed over the effect of edging on both the volume and value of lumber produced. As a result of this concern, none of the lumber produced in this study was edged or trimmed initially. All boards were cleared from the mill and graded on the basis of both maximum volume and value. With this method, the grader estimated the width to which the waney edged pieces would be ripped. Each piece was then graded for "maximum volume" on the basis of this estimated width. A second set of grades was assigned if the grader thought the piece could be ripped or cut to produce one or more pieces with a higher value (called "maximum value") than that assigned to the piece as graded for maximum volume. This is not a standard procedure and this data should be considered an estimate. The lumber was then edged and regraded for maximum volume and maximum value. The edger operator was instructed to edge for maximum width. Observations indicated that the operator ran the saws in the wane much of the time and did not "clean the boards up" as is common practice in many hardwood mills. No boards were split to improve the grade. The lumber was not end trimmed. All grading was done using the National Hardwood Lumber Association grading rules (12). A retired and well-respected National Hardwood Lumber Association grader was used.

Time study. –Sawing times were recorded for each log, as were the number of times each log was turned. The sawing times and the number of turns were averaged for each of the three treatments. In addition, the sawing times and number of turns are reported as a subgroup for the last 14 logs in the live-sawing treatment. Since the sawyer was not experienced with live-sawing, some difficulty in processing the first few logs was encountered. After sawing the first 8 logs, the sawyer's technique improved and the remaining 14 logs were processed more efficiently. Therefore, the results reported for the subgroup of 14 logs are more representative of what might be accomplished, as compared to the results for all 22 logs, which include the initial learning experience of the sawyer.

Results and discussion

Log and processing information

Table 1 shows the size and Doyle scale of the logs, sawing times, and number of turns during sawing. Each treatment contained 22 logs. The average diameter was 14.8,14.9, and 15.2 inches, respectively, for grade-sawn, cant-sawn, and live-sawn treatments. The average log lengths for the treatments were 11.2,11.0, and 10.9 feet, respectively. The average scaled Doyle volume per log for the three treatments was 80, 82, and 83 board feet

(BF), respectively. The average sawing time per log for the treatments was 4.20,3.89, and 4.16 minutes, respectively. The average number of turns per log was 4.4,4.4, and 2.9, respectively. The average values for the subgroup of 14 live-sawn logs are: 14.6 inches in diameter, 10.6 feet in length, 74 BF Doyle log scale, 3.59 minutes of sawing time, and 3.0 turns per log.

Statistical analysis of the data showed no significant difference in the log diameters, lengths, or BF scale for the three initially matched groups or the subgroup of live-sawn logs.

Lumber volume and value

To calculate lumber values, the prices used were $715 per thousand board feet (MBF) for FAS, $705/MBF for 1 Face and Selects, $450/MBF for No, 1 Common, $190/MBF for No. 2 Common, and $160/MBF for No. 3 Common (5). Prevailing mill prices of $50/MBF for cull and $160/MBF for cants were also used.

After the lumber was edged, the grader reported more volume for each of the three treatments than before edging. The grader also reported more value after edging in every case except for the live-sawn treatment graded for maximum value. As a result, it appears that no volume potential was lost during the edging operation. Some value potential appears to have been lost during edging in the live-sawing treatment. However, this loss simply makes the live-sawing data somewhat conservative. Therefore, only the data collected after edging is reported (Table 2).

The results based on maximum volume after edging are 2,375 BF valued at $744.98 for grade-sawing, 2,520 BF valued at $763.69 for cant-sawing, 2,558 BF valued at $733.44 for live-sawing, (Table 2). On the basis of the value calculated for the maximum volume produced, it would appear that cant-sawing is the best choice of the three sawing methods.

However, if the lumber is edged for maximum grade (and therefore value), a different choice develops (Table 2). In this case, we find a slight decrease in the volume of lumber but a notable increase in the value of the lumber produced. Grade-sawing resulted in 2,351 BF valued at $772,42, cant-sawing produced 2,477 BF valued at $807.86, and live-sawing produced 2,352 BF valued at $872.37. Grade-sawing and live-sawing resulted in nearly the same volume of lumber, but the live-sawn lumber was valued at $100 more than the grade-sawn lumber. There was over 100 BF more lumber from cant-sawing, but the value was only intermediate between the other treatments. The greatest increase in grade yield was in No. 1 Common for the live-sawn treatment.

When sawing time is considered, a more complete picture is evident of how these three sawing methods perform relative to each other (Table 3). With the initial 22 log groups, the lumber value produced per thousand board feet of log scale was $438.90 for grade-sawn, $446.30 for cant-sawn, and $478.50 for live-sawn. On the basis of value per thousand board feet of lumber scale, the figures were $328.55 for grade-sawn, $326.15 for cant-sawn, and $370.90 for live-sawn. For the live-sawn subgroup of 14 logs, the value per thousand board feet of log scale was $487.80, and the value per thousand board feet of lumber scale was $356.90. Using lumber values as a basis, the values generated per minute are

TABLE 2. — *Board feet produced and value by lumber grade for grade-, cant-, and live-sawn lumber after edging, based on grading for maximum volume or grading for maximum value.*

Lumber grade	Maximum volume		Maximum value	
	(BF)	($)	(BF)	($)
Grade-sawn				
FAS	130	92.95	150	107.25
1 Face	100	70.50	146	102.93
Selects	4	2.82	4	2.82
1 Common	828	372.60	819	368.55
2 Common	678	128.82	602	114.38
3 Common	414	66.24	409	65.44
Cull	221	11.05	221	11.05
Cants	--	--	--	--
Totals	2,375	744.98	2,351	772.42
Cant-sawn				
FAS	114	81.51	142	101.53
1 Face	108	76.14	189	133.25
Selects	--	--	--	--
1 Common	768	345.60	753	338.85
2 Common	613	116.47	470	89.30
3 Common	156	24.96	162	25.92
Cull	25	1.25	25	1.25
Cants	736	117.76	736	117.76
Totals	2,520	763.69	2,477	807.86
Live-sawn				
FAS	75	53.63	150	107.25
1 Face	82	57.81	140	98.70
Selects	--	--	--	--
1 Common	693	311.85	1,192	536.40
2 Common	1,306	248.14	618	117.42
3 Common	381	60.96	252	12.60
Cull	21	1.05	--	--
Cants	--	--	--	--
Totals	2,558	733.44	2,352	872.37

TABLE 3. — *Volumes, values (on maximum present), and sawing times for oak processed by different sawing methods.*

Sawing method	Total log volume	Total lumber volume	Total sawing time	Total value	Value/MBF of log scale	Value/MBF of lumber scale	Sawing time/ MBF of log scale	Sawing time/ MBF of lumber scale	Value/min.
	(Doyle)	(BF)	(min.)	($)			(min.)		($)
Grade-sawn	1,760	2,351	92.42	772.42	438.90	328.55	52.5	30.3	8.35
Cant-sawn	1,810	2,477	85.59	807.86	446.30	326.15	47.3	34.6	9.45
Live-sawn (total including subgroup)	1,823	2,352	91.58	872.37	478.50	370.90	50.2	38.9	9.55
Live-sawn (subgroup only)	1,034	1,413	50.21	504.34	487.80	356.90	48.6	35.3	10.05

$8.35 for grade-sawn, $9.45 for cant-sawn, $9.55 for live-sawn, and $10.05 for the live-sawn subgroup treatment.

The mill where this study was conducted was not familiar with live-sawing. The performance of the sawyer improved as the study progressed and he became more experienced with live-sawing. With additional experience, it is expected that production would improve even more.

An analysis of variance showed no significant difference at the 5 percent level in the sawing time for the three treatments. However, there was a significant difference in the sawing time between the grade- and cant-sawn treatments and the live-sawn 14 log subgroup. The average sawing times per log were less for the live-sawn treatment than for the other two treatments. A significant difference also exists between the three treatments in regard to the number of turns made per log.

Problem of grain pattern

While these data indicate some real value advantages to using the live-sawing technique, there is a potential disadvantage for the small mill. Most of the red oak lumber sold to furniture plants is flat-grained, such as that achieved when grade- or cant-sawing. The live-sawing technique results in a substantial amount of rift- and quartersawn lumber or a mixture of the two in the same board. There is a high value market for rift- and quartersawn lumber if sufficient quantities can be accumulated. However, if the production of a small mill will not yield enough of this specialty product, it maybe difficult to market.

In this study we classified the lumber as flat-, rift-, or quartersawn. For the live-sawing treatment, all of the 8/4 dog boards from the middle of the log were of the quartersawn or rift pattern. Twenty-two percent of the 222 pieces of 4/4 lumber were rift- or quartersawn. However, most of these pieces were from the center of the log and thus contained more board feet per piece than the others. The concern about the grain pattern applies most to those woods, such as oak, that have a very distinctive ray pattern. Grain pattern should not be as much of a problem with species such as maple, yellow-poplar, and birch.

Lumber grade proportions

The hardwood lumber grades, in part, are dependent on the size of the lumber and the number of defects in each piece. The grading of lumber in the rough unedged form is difficult and should be considered an estimate of the grade. The data for the lumber after edging are realistic.

The estimated lumber grade yield on a volume basis before edging for the 22 log-groups showed 46.8 percent No. 1 Common and better for grade-sawn, 43.0 percent for cant-sawn, and 27.6 percent for live-sawn. After edging for maximum volume, the actual proportions of No. 1 Common and better lumber were 44.7 percent for grade-sawn, 39.3 percent for cant-sawn, and 33.2 percent for live-sawn.

The estimated grade on the highest value basis before edging for the 22 log-groups showed 47.4 percent No. 1 Common and better for grade-sawn, 41.7 percent for cant-sawn, and 68.8 percent for live-sawn. After edging for maximum grade, the actual proportions of No. 1 Common and better lumber were 47.6 percent for grade sawn, 43.8 percent for cant-sawn, and 63.0 percent for live-sawn.

An analysis of variance for lumber graded for maximum value after edging showed no significant difference in yield for FAS, 1 Face, Selects, No. 2 Common, and No. 3 Common at the 5 percent level for each of the three treatments. However, there was a significant difference in the percentage yield of No. 1 Common and cull. Grade-sawing produced 221 BF of cull lumber as compared to 25 BF for cant-sawing and none for live-sawing. Live-sawing produced 1,192 BF of No. 1 Common lumber compared to 819 BF for grade-sawn and 753 BF for the cant-sawn treatment.

Although the study has shown that edging for maximum grade is necessary for live-sawing to yield positive results, it might be advantageous for a mill to do the final edging after drying if the facilities are available. Studies on the Saw-Dry-Rip (SDR) process (3,6,8-10) have indicated an increase in lumber quality when the green flitches are first dried and then ripped. Live-sawing balances longitudinal growth stresses in the lumber and permits the ripping of the dried material without the warp degrading effect that can cause volume loss. If the lumber is edged green, stresses are often released as crook, especially when the edging is not balanced. Unbalanced edging may be necessary to maximize grade and when done on the dried product, it will not result in crook.

Conclusions

The results of this study are in agreement with the results of the various studies by Flann and Richards. Even when using lower grade logs, live-sawing yields a higher value of lumber than grade- or cant-sawing. To get the higher value, however, it is necessary to edge the lumber for maximum grade recovery. Live-sawing without edging for grade would result in substantial losses compared to the other sawing procedures. If edging for grade can be delayed until after drying, it is believed that even more value recovery can be made.

A major concern of the small sawmill may be the higher percentage of rift and quartersawn material that is produced by live-sawing. It maybe difficult to market small quantities of lumber with these grain characteristics. However, if sufficient quantities of rift- and quartersawn lumber can be accumulated and markets developed, an even higher value may be realized (5). The problem with rift- and quartersawn lumber may only be applicable to oak, which has predominant rays that radically change the appearance of the lumber.

A word of warning to sawyers who have not used the live-sawing method. Especially with small or rough logs, it maybe necessary to put a third face on the log to add enough stability so that the log can safely be cut to the center. In this study, one face was lightly slabbed before sawing the lumber. Other sawyers will remove several boards on the first face, turn the face down on the carriage, cut a second light face, and then place the

first face against the knees to finish sawing. Either technique will help to insure safe, stable sawing conditions.

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