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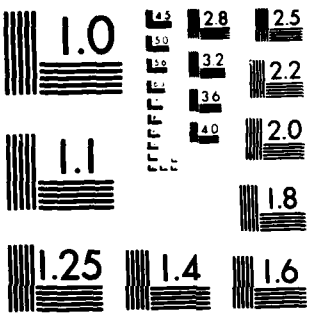

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Research
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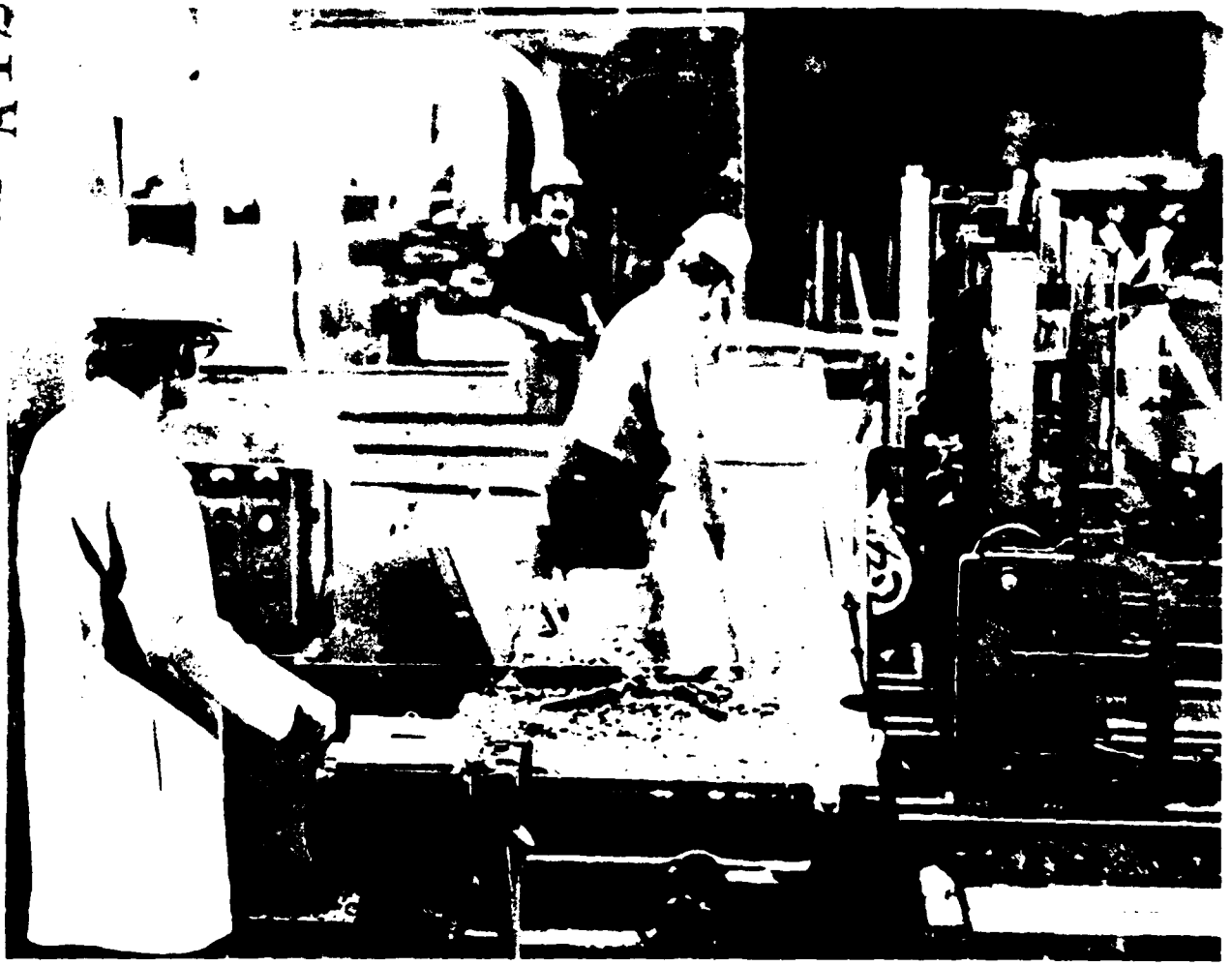
FPL 432

Economics of Manufacturing Structural Lumber from Low- to Medium-Density Hardwoods



Abstract

Researchers at the Forest Products Laboratory have found that straight structural lumber can be manufactured from low- to medium-density hardwoods using the Saw-Dry-Rip (SDR) process. Economic analysis indicates that by using the SDR process about 50 percent of the SDR sawmill's roundwood input can be recovered as lumber at a cost of about $171 per thousand board feet (MBF) (1981 dollars). By combining the SDR process with the Edge-Glue-and-Rip (EGAR) process, about 57 percent of roundwood input can be recovered at a cost of about $191/MBF. Corresponding free on board (f.o.b.) mill values for each mill's product mix are $237/MBF for the SDR sawmill and at least $270/MBF for the EGAR sawmill.

Keywords: Economics, hardwood utilization, lumber manufacture.

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Economics of Manufacturing Structural Lumber from Low- to Medium-Density Hardwoods

By
GEORGE B. HARPOLE, Research Forester

Introduction

This paper presents an economic assessment and comparison of two hypothetical sawmills for potential location in the Northeastern or Southeastern United States. The mills are designed to make structural lumber from low- to medium-density hardwoods using innovative processing techniques developed at the Forest Products Laboratory (FPL). Both sawmills use commercially available equipment suited for processing structural lumber from domestic softwood of about the same density as low-density hardwoods *(5)*.[2]

Both sawmills utilize Best Opening Face (BOF) sawing techniques *(7)*, via log scanning and computer-controlled sawing at the head rig. The first mill uses a process called Saw-Dry-Rip (SDR). The SDR process is innovative in that it enables the manufacture of quality structural lumber from low- to medium-density hardwoods by eliminating the traditional problem of warp. The logs are live sawn on the same plane into 7/4 (1-3/4-in.-thick) flitches. The flitches are rough edged to make compact kiln loads, dried at 235°F to an average moisture content of 12 ± 3 percent (dry basis), and then ripped to width and dressed for use. Studies support SDR as a viable way for manufacturing straight structural lumber from low- to medium-density hardwoods *(3,4,8,11)*.

The second sawmill also uses the SDR process as well as another FPL process called Edge-Glue-and-Rip (EGAR). EGAR enables the manufacture of any width of structural lumber *(2,5,6)* even when using small logs (5–15 in. diameter). Logs are live sawn into full width flitches, dried, and then edge-glued into wide blanks from which desired widths of structural lumber may be ripped. An EGAR mill can produce both narrow lumber and wide lumber as desired. Such processing techniques are significant because they rely upon a largely underutilized supply of about 68 billion cubic feet of hardwoods now growing on U.S. commercial forest lands east of the Rocky Mountains *(12)*.

The SDR sawmill is estimated to be capable of producing about 60 million board feet of lumber per year, and the EGAR sawmill about 68 million board feet of lumber per year. These estimates are based on producing structural lumber 8 to 20 feet long, and on a two-shift 250-day-per-year operating basis. A more realistic mill size for many circumstances in the hardwood regions would probably be for sawmills designed to produce 6 to 12 million board feet per year. Smaller concentrations of timber and geographic barriers will often limit mill size. For this reason, FPL researchers plan further analyses of mills in the 6 to 12 million board feet per year range. Also, new studies at FPL will include evaluations of the strength characteristics of long-length structural lumber (10 ft and longer) produced via the EGAR process.

Investment, Processing, and Manufacturing Costs

The EGAR sawmill is more efficient than the SDR mill. The EGAR process should recover about 57 percent of trimmed log volume as dry lumber—somewhat above the expected SDR recovery of about 50 percent. The reduction of residue volumes for the EGAR process indicates an equal increase in the volume of dry lumber production (table 1).

Cost for the EGAR sawmill in 1981 is estimated to be about $17.5 million, or about $4.6 million more than an SDR sawmill of similar capacity. The additional investment in the EGAR sawmill is in the buildings, processing, and mobile equipment required for edge gluing and ripping (table 2). Investment is required for working capital as well as for facilities.

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

[2] Italicized numbers in parentheses refer to literature cited at end of report.

Table 1.—Estimates of roundwood input and product outputs for SDR and EGAR sawmills

	Type of sawmill	
	SDR	EGAR
	----Ovendry ton----	
Roundwood input[1]		
Bark and log trim	14,552.7	14,552.7
Trimmed logs	97,019.2	97,019.2
Total	111,571.9	111,571.9
Product outputs		
Dry lumber[2]	[3]48,651.4	[3]55,422.7
Wood chips[2]	27,728.8	20,228.8
Dry sawdust and shavings[2]	10,408.5	11,137.2
Hogged fuel[2]	2,867.4	2,867.4
Fuel for dry kilns[4]	21,915.8	21,915.8
Total	111,571.9	111,571.9

[1] Assumes an average ovendry weight of 28.8 pcf, at green volume.
[2] Marketable output.
[3] Assumes 56.6 ft³/MBF, or 1,630 ovendry lb/MBF of lumber, or about 68,000 MBF of lumber output for the EGAR mill and about 60,000 MBF from the SDR sawmill.
[4] Assumes drying from 85 pct to 10 pct moisture content, dry basis; ovendry weight at green volume of 30.14 lb/ft³; and 2,700 Btu/lb of H_2O removed. Heat energy to steam assumed to be 6,150 Btu/ovendry lb of wood/bark fuel.

Table 2.—Estimates of investment costs for hypothetical SDR and EGAR sawmills (1981 basis)

	SDR mill	EGAR mill
	-----1,000 dol-----	
Facilities investment costs		
Land ($3,500 per acre, 25 acres)	$ 87.5	$ 87.5
Site preparation	371.7	371.7
Buildings	2,842.9	3,899.5
Processing equipment[1]	8,562.2	11,969.4
Mobile equipment	592.3	640.7
Subtotal	12,456.6	16,942.6
Working capital	411.5	548.9
Total	$12,868.1	$17,491.5

[1] Processing equipment costs include engineering, installation, and contingency costs (10 pct of total).

Discounted cash flow methods were used to estimate processing costs. Processing costs are expressed as the average distribution of revenues required to cover all costs—including capital recovery, taxes on profits (48 pct), and after-tax profit (20 pct to provide a reasonably attractive return on investment). An inflation rate of 7 percent is assumed.

Processing costs are different from manufacturing costs in that they do not include costs of roundwood. Manufacturing costs include processing and roundwood costs. Fixed overhead costs of the EGAR sawmill include $15,000 per year for the first 3 years of operation to cover abnormal promotional costs associated with initial marketing of EGAR-type products. Both the SDR and EGAR mills are assumed to have 10-year economic lives.

Estimated processing costs for the SDR mill are about $6.9 million per year (1981 basis), or about $115 per thousand board feet (MBF), based on a two-shift 250-day operating year (table 3). Processing costs for the EGAR mill are estimated to be about $9.3 million per year (1981 basis), or about $137/MBF, again based on a two-shift 250-day operating year. On this basis, processing costs for the EGAR process are only $22/MBF higher than the SDR process.

Table 3.—Summary of processing costs[1] for SDR and EGAR sawmills (1981 basis)

	SDR mill	EGAR mill
	-----Dol/MBF-----	
Variable costs		
Resin (37¢/lb, solids)	$ 0	$ 2.88
Electricity (2.5¢/kWh)	[2]1.74	1.64
Shipping ($3/MBF)	3.00	3.00
Mobile equipment operations	1.00	1.00
Operating labor	20.60	24.62
Subtotal	$ 26.34	$ 33.14
Fixed costs		
Overhead	$ 28.52	$ 31.26
Depreciation	14.27	14.06
Subtotal	$ 42.79	$ 45.32
Other costs		
Tax costs (48 pct)	$ 21.12	$ 26.92
After-tax profit (20 pct)	25.02	31.78
Subtotal	$ 46.14	$ 58.70
Total	$115.27	$137.16

[1] Processing costs do not include roundwood costs.
[2] EGAR has lower electric cost assuming less ripping is done to manufacture wide width dimension.

As mentioned, manufacturing costs include roundwood costs (less revenues from marketable residues) and processing costs. Manufacturing costs for the SDR sawmill are estimated to be about $171/MBF (table 4). Manufacturing costs for the EGAR sawmill are estimated to be about $191/MBF. Including wood costs, the cost difference between SDR and EGAR decreases by $2/MBF to a difference of $20/MBF. This is because the EGAR process recovers more lumber from the same volume of log input. Revenues per MBF, however, are somewhat reduced by reductions in residues produced.

For both estimates of manufacturing costs, roundwood was estimated to cost $40 per ovendry ton (ODT); and revenues from residues to be about $40/ODT for wood chips, $12/ODT for dry sawdust and planer shavings, and $8/ODT for hogged fuel. Roundwood costs increase working capital requirements and therefore increase the amount of financing required for operation. Increases in after-tax returns (20 pct) to financing requirements and profit-associated tax costs (48 pct) add about 5¢/MBF to manufacturing costs for each dollar of increase in variable costs (e.g. roundwood) per MBF.

Estimates of Free on Board (F.O.B) Mill Realization

Both the SDR and EGAR sawmills appear to be viable investment opportunities based on the comparison of manufacturing costs to likely revenues. Manufacturing costs include a 20 percent return on investment. Consequently

returns that exceed the manufacturing costs would improve the expected return on investment.

To provide estimates of the f.o.b. mill value of lumber output, southern pine framing lumber prices for sawmills located in the Southeastern United States were taken from Random Lengths price reporter *(10)*. Prices were observed between January 1979 and December 1981. High prices were taken from the October 5, 1979 price report; low prices were taken from the April 25, 1980 price report; and average prices are the average of these high and low prices.

Southern pine framing lumber prices were used because they reflect competitive market prices with which low- to medium-density hardwood lumber is likely to compete. The shipping distances from primary market centers are also comparable and shipping weights about equal. Low- to medium-density hardwoods (specific gravity of .45 or less) cannot be expected to compete with southern pine for engineered uses on a one-to-one basis because of lower strength properties. Such species as yellow-poplar and sweetgum, however, can be used in truss fabrication where their strength properties will satisfy design specifications. Price differentials that may result from use limitations are not speculated upon here.

Using the BOF program—a computerized sawing model *(7)*—and a sample of actual southern pine logs ranging in diameter from 5 to 12 inches from four Sawmill Improvement Project (SIP) studies, lumber recovery was found to run about 25 percent 2 by 4, 19 percent 2 by 6, 40 percent 2 by 8, 13 percent 2 by 10, and 3 percent 2 by 12. Lengths were about 85 percent 10 feet and longer with about 30 percent to 16-foot lengths. Assuming 2 by 4's will run about 30 percent to truss framing grades, 60 percent Standard and Better, and 10 percent Utility; and, assuming 2 by 6 and wider will run 90 percent No. 2 and Better and 10 percent No. 3, the average f.o.b. mill value of the SDR product mix will be about $237/MBF—based on the average high and low values (table 5). On the same basis, an EGAR mill would average from $270 to $340/MBF, depending on whether 2 by 10's or 2 by 12's are produced. On this basis, an EGAR mill might average from $33 to $103/MBF more than an SDR sawmill. This assumes that about the same demand and scarcity of supply will continue for wide dimension (2 by 10's and 2 by 12's). Floor trusses manufactured from 2 by 3's and 2 by 4's have been replacing wide widths in many applications. To continue this replacement, inplace costs for fabricated trusses will, of course, have to be at least price competitive with wide width lumber. Potential investors in new sawmills should consider this factor.

Conclusions

Using the EGAR processing concept, a sawmill can recover about 57 percent of roundwood input as dry finished lumber at a processing cost of about $137/MBF. About 50 percent of the SDR sawmill's roundwood input can be recovered as lumber at a processing cost of about $115/MBF, $22/MBF less than for the EGAR process. Wood costs, assumed to be $40/ODT, need to be added to processing costs to obtain manufacturing costs. The manufacturing costs for the EGAR sawmill are $191/MBF and $171/MBF for the SDR mill.

Both the SDR and EGAR sawmills appear to be viable investment opportunities based on returns on investment. The average f.o.b. mill value of the product mix from the SDR sawmill is estimated to be about $237/MBF. The potential f.o.b. mill value of the output from the EGAR sawmill is estimated to be at least $270/MBF or higher. In both cases, the average return that might be expected exceeds the estimated manufacturing costs for both sawmills. The EGAR sawmill, however, can produce any exact width of lumber desired, and thus provides a unique opportunity to increase revenues by manufacturing higher priced widths of structural lumber.

Table 4.—Total manufacturing costs for SDR and EGAR sawmills

	Costs	
	SDR mill	EGAR mill
	----Dol/MBF----	
Processing costs	$115.27	$137.16
Roundwood costs ($40/ODT)[1]	74.38	65.63
Subtotal	$189.65	$202.79
Less residue revenues		
Wood chips ($40/ODT)	$ 18.49	$ 11.90
Sawdust and shavings ($12/ODT)	2.08	1.96
Hogged fuel ($8/ODT)	.34	.34
Subtotal	$ 20.91	$ 14.20
Plus profit and tax costs for increase in working capital[2]	$ 2.57	$ 2.47
Total	$171.31	$191.06

[1] ODT is ovendry ton.
[2] Increases in working capital are an increase in investment that requires corresponding profit and taxes, increasing costs by about 5¢/MBF for each $1/MBF increase in variable costs.

Table 5.—High, low, and average f.o.b. mill values for southern pine lumber from the Southeastern United States since January 1979[1]

Dimension size	Average	High	Low
In.	----Dol/MBF----		
2 by 4's	227	290	165
2 by 6's	236	298	174
2 by 8's	225	265	185
2 by 10's	270	327	214
2 by 12's	342	402	282
SDR mill average[2]	237	290	185

[1] *Assumes 2 by 4's run 30 pct truss-framing grade, 60 pct* Standard and Better, and 10 pct Utility; and 2 by 6 and wider run 90 pct No. 2 and Better and 10 pct No. 3. High prices are from Random Lengths October 5, 1979 price report. Low prices are from Random Lengths April 25, 1980 price report. Average values are the average of high and low prices.
[2] Assumes an average product mix of 25 pct 2 by 4, 19 pct 2 by 6, 40 pct 2 by 8, 13 pct 2 by 10, and 3 pct 2 by 12.

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U.S. Forest Products Laboratory

Economics of Manufacturing Structural Lumber from Low- to Medium-Density Hardwoods, by George B. Harpole. Madison, Wis., FPL 1983.

5 p. (USDA Forest Serv. Res. Pap. FPL 432).

Presents an economic assessment and comparison of two hypothetical sawmills that process structural lumber from low- to medium-density hardwoods using innovative processing techniques developed at FPL. One mill uses the Saw-Dry-Rip (SDR) process for manufacturing straight structural lumber from low- to medium-density hardwoods. The second mill uses SDR combined with the Edge-Glue-and-Rip (EGAR) process that enables the manufacture of any width of structural lumber even when using small logs. Both processes appear to be viable investment opportunities based on returns on investment.

Keywords: Economics, hardwood utilization, lumber manufacture.