Pulp Chip Production Potentials at Indiana Sawmills

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PULP CHIP PRODUCTION POTENTIALS AT INDIANA SAWMILLS

Forest Resource Development Report

Cooperative Extension Service
PURDUE UNIVERSITY
Lafayette, Indiana
PULP CHIP PRODUCTION POTENTIALS AT INDIANA SAWMILLS*

by Robert H. Perkins and John C. Callahan
Department of Forestry and Conservation

Introduction

Since 1958, utilization of Indiana-grown hardwood timber for the production of paper products has increased greatly. Prior to this time, relatively small quantities of Indiana pulpwood were used by a roofing felt firm and paper and fiber product companies located in Ohio and Illinois, Table 1.

Table 1. Production of hardwood pulpwood in Indiana for selected years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cords</th>
</tr>
</thead>
<tbody>
<tr>
<td>1949</td>
<td>8,688</td>
</tr>
<tr>
<td>1955</td>
<td>18,997</td>
</tr>
<tr>
<td>1957</td>
<td>16,852</td>
</tr>
<tr>
<td>1959</td>
<td>28,494</td>
</tr>
<tr>
<td>1961</td>
<td>68,848</td>
</tr>
<tr>
<td>1963</td>
<td>79,034</td>
</tr>
</tbody>
</table>

Source: Central States Forest Experiment Station

Requirements for the Container Corporation of America mill at Carthage and the Weston Paper Company mill at Terre Haute presently exceed 600 tons of wood daily. Additional mills under construction or in advance planning will increase this consumption in the next several years.

Nation-wide, the output of hardwood fiber products has increased at the annual rate of over 8 per cent for the last 10 years. This is about four times the rate of expansion for softwood fiber products for the same period. Although present and anticipated pulp and fiber plants will rely heavily on Indiana's ample forest resources as a principal source of raw materials, it is probable that chipped residues from other wood-using firms will constitute a significant portion of their total wood consumption in the future. Great strides in the utilization of wood residues have already taken place in the West, South, and Northeast. In 1964, for example, over 20 per cent of the total domestic pulpwood consumption originating in the United States came from chipped residues having a volume equivalent of more than 10 million cords. The rapid increase in the production of chips from mill residues (about 10 fold in the last 15 years) is mute evidence of the desirability of utilizing mill waste and the acceptance of these chips by producers of fiber products.

Indiana has lagged behind several of its neighboring states in the utilization of wood residues, Table 2. This is attributed to the "newness" of the wood-based pulp industry in the state and the availability of minimum-priced round wood. For reasons to be explored, it appears that both the pulp and paper and other primary wood-using industries should consider seriously the use and production of wood-residue chips.

The total amount of potentially available wood residues in Indiana is estimated to be between 150,000 and 200,000 tons, enough to provide the entire raw materials requirements for a large pulp mill or the partial requirements for several. About 90 per cent of those residues are associated with the lumber industry, Table 3. Not all of these residues, of course, are or will become commercially available to other wood-using industries. About 85 per cent of Indiana's 400 widely distributed sawmills produce less than 500,000 board feet of lumber each year, Table 4. Fewer than 30 sawmills produce more than one million board feet of lumber annually. Nevertheless, these sawmills produce 30-35 per cent of all lumber produced in the state and could become the nucleus of a state-wide wastewood pulp chip recovery industry.

* This publication is a contribution from the Purdue Agricultural Experiment Station.
Table 2. Estimated output of pulpwood chips from waste residues and potentially available quantities for selected central states, 1962.

<table>
<thead>
<tr>
<th></th>
<th>Estimated output (tons)</th>
<th>Estimated available (tons)</th>
<th>Utilization (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ill.</td>
<td>2,500</td>
<td>120,000</td>
<td>2.1</td>
</tr>
<tr>
<td>Ind.</td>
<td>2,500</td>
<td>175,000</td>
<td>1.5</td>
</tr>
<tr>
<td>Iowa</td>
<td>17,500</td>
<td>30,000</td>
<td>58.3</td>
</tr>
<tr>
<td>Ky.</td>
<td>12,500</td>
<td>235,000</td>
<td>5.3</td>
</tr>
<tr>
<td>Ohio</td>
<td>12,500</td>
<td>170,000</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Source: Based on unpublished data of the U. S. Forest Service.

Processing Sawmill Residues

Research and development in the last 10 years has resulted in the manufacture of well-engineered equipment that has enabled some sawmills to produce marketable wastewood chips or debarked slabs and edgings. Markets may consist of other sawmills producing and transporting chips or pulpmills equipped to utilize purchased chips or slabs.

For the sawmill operator, there may be distinct advantages to debark logs and to produce pulp chips or slabs. Debarking has these advantages:

1. Reduces down-time for saw filing and saw changing;
2. Reduces cash expenditures for saws, teeth, holders and filing labor;
3. Exposes bark-concealed defects;
4. Increases grade yields and production rates;
5. Makes logs easier to handle;
6. Reduces problems associated with sawing frozen logs.

Chipping or selling slabs or trims has these advantages:

1. Log recovery is increased from about 50 per cent to around 75-80 per cent when waste wood is utilized for chips;
2. Income flow may be increased and leveled out through sale of chips or slabs;
3. Costs associated with the disposal of waste wood are essentially eliminated.

The accepted procedure is to debark the entire log prior to sawing. Slabs, edgings and trims are then ready for chipping. The chips are screened and then loaded into a surge bin, truck or railroad car. The actual production of hardwood slabs per thousand board feet (M b.f.) of sawed lumber depends on log size, species and method of sawing. In the Central States Region, about 1.5 tons of chips are produced for each one M b.f. of lumber sawed.

Table 3. Estimated wood residues potentially available from Indiana wood-using industries by type of material.

<table>
<thead>
<tr>
<th></th>
<th>Course*</th>
<th>Fine**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Lumber</td>
<td>47.1</td>
<td>44.0</td>
<td>91.9</td>
</tr>
<tr>
<td>Veneer and plywood</td>
<td>2.4</td>
<td>3.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Other</td>
<td>1.1</td>
<td>1.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Total</td>
<td>50.6</td>
<td>49.3</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Slabs, edgings, cores, and trimmings.
**Sawdust, and shavings.

Table 4. Classification of Indiana's estimated 400 sawmills by production classes.

<table>
<thead>
<tr>
<th>Production class M bd. ft.</th>
<th>Number of mills</th>
<th>Relative frequency (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-49</td>
<td>60</td>
<td>15</td>
</tr>
<tr>
<td>50-499</td>
<td>280</td>
<td>70</td>
</tr>
<tr>
<td>500-999</td>
<td>32</td>
<td>8</td>
</tr>
<tr>
<td>1,000-1,499</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>1,500 +</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Cooperative Extension Service Circular 511, Purdue University.
Some additional manpower may be required to produce chips. However, many sawmill operators who have installed debarkers and chippers have eliminated the need for additional manpower by reassigning labor utilized formerly for waste disposal. Although labor requirements for a chipper operation will vary with individual circumstances, a mill with a daily output of 10-15 M b.f. will ordinarily require 1 or 2 men to handle the debarking and chipping operation including labor required for the screening and loading of chips.

Minimum daily sawmill production of 5 to 15 M b.f. is necessary before an operator should consider purchasing any debarking or chipping equipment. However, before investments are made, it is essential that a comprehensive cost and market analysis be made of the entire operation.

Equipment

Pulp chip production requires three basic machine units:

1. Debarker
2. Chipper
3. Screens

Debarkers: The rosser-head debarker is recommended for sawmill installations in Indiana. The debarking head rotates parallel to the axis of the rotating logs, removing the bark by a combination crushing-abrasive action. This type is recommended over other type machines because of cost, maintenance and wood loss considerations.

Initial cost of a rosser-head debarker suitable for sawmills annually manufacturing 1-2 million board feet will range from $10,000 to $15,000. Installation costs are extra and will vary depending on the renovation required to fit the debarker into the production line. Other costs which may vary include power, maintenance and bark disposal. Generally, debarkers require no greater mechanical skills for maintenance than other sawmill machinery.

Chippers: Initial cost of small chippers suitable for sawmill installation range from about $8,000 to $13,000 including the cost of the drive motor. Mill renovating, installation, and power costs will be additional. Electric horsepower requirements for chipping hardwood residue range from 100 to 125 horsepower.

Maintenance costs for chippers in the form of repairs are generally low, requiring maintenance similar to other sawmill machinery. However, correct knife adjustment and sharpness are essential to the production of saleable chips. *

Chippers are available with both gravity discharge and fan discharge. Gravity discharge will in most cases require a conveyor belt between chipper and screens. Chips are also easily moved by air streams. Chipper discs equipped with fins make it possible to move chips short distances with the movement of air created during the chipping process. **

Screens: Screens used in sawmill chip production are economical to operate. Purchase price will run about $2,000 to $4,000.

* Chipper knives may be ground on a planer-knife grinder, or a grinder costing $2,000 to $4,000 made specifically for chipper knives. When investment and labor costs are considered, it would probably be more economical to have chipper knives custom ground if such a service is available.

**This is common practice in moving chips from chipper to screen in sawmill installations, although this increases the initial cost of the chipper about 8 to 12 per cent.
There are two basic types of screens, rotating flat and sloped vibrating. Both types give equally good results when properly set up. Maintenance costs for both types are generally low.

Chip Specifications

Chip size, amount of bark and dirt content are the principal criteria used in determining market acceptability of pulp chips. As pulpmills continue to expand their purchase of chips from sawmills, the specifications for these chips may become more exacting. Depending on individual pulpmills and type of paper produced, the bark content of sawmill chips is now generally limited to about 1 percent, the desired uniform length is specified, and definite limits are set on the percentage of oversized and undersized chips that may be included in any given volume. A representative set of specifications is:

<table>
<thead>
<tr>
<th>Chip Category</th>
<th>Size</th>
<th>Percent total wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferred size</td>
<td>1/2-7/8&quot;</td>
<td>at least 85</td>
</tr>
<tr>
<td>Oversize</td>
<td>1 - 1-1/8&quot;</td>
<td>not over 10</td>
</tr>
<tr>
<td>Undersize</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fines;</td>
<td>1/8-7/16&quot;</td>
<td>6</td>
</tr>
<tr>
<td>Sawdust;</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bark</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Chip Transportation

Since chips are a low-value, low density, bulky commodity,* close attention must be given to their transportation. Factors to consider in selecting economical transportation include:

1. Length of haul;
2. Road conditions;
3. Load limits;
4. Loading and unloading facilities.

Recommended equipment for 15-20 mile hauls are three-axle, dual-drive trucks equipped with dump bodies capable of holding 8-10 tons of chips. This type of equipment is easily maneuvered, and has good traction and stability. The principal advantage is fast unloading without special unloading facilities required at the mill. For longer truck hauls, the end-dump semi-trailer and tractor is a good choice because of ease of handling with increased capacity. Where pulpmills have no facilities for end dumping, belt-unloading equipment for semi-trailers might have to be purchased.

Sawmills that are beyond economical trucking distance to chip markets, but have sufficient volume and close proximity to a railhead might be able to ship chips economically by rail.

Economics of Residue Recovery

Investment and Returns of Sawmill Chipping

A budgeted cost-analysis of a representative small mill producing 1.5 million board feet per year is shown below. The following assumptions are used:

1. Total equipment and installation cost; $25,000.**
2. Labor required; 1 man @ $1.50/man hour.
3. Electric power required; 150 horsepower @ .02/K.W.H.***

* Hardwood chips weigh 19-26 pounds per cubic foot.
** Higher capacity sawmills may require a more costly installation. The installed price of such machines may reach $40,000.
*** Required horsepower multiplied by .746 equals required kilowatt hours.
4. Depreciation schedule; straight line, 5 years.
5. Interest charges; 6% on average investment.
6. Insurance charges; 4% on average investment.
7. Maintenance and supplies; $500/year.

8. 200 working days; 7500 b.f./day; 1,500 M b.f./year.
9. Chip price; $6.00/ton, green, f.o.b. sawmill.
10. 1.5 tons chips/M b.f. lumber sawn.

### Annual Costs & Returns

**Costs:**

**Fixed**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation; $25,000/5 yrs.</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Interest; $15,000 x .06</td>
<td>900.00</td>
</tr>
<tr>
<td>Insurance; $15,000 x .04</td>
<td>600.00</td>
</tr>
<tr>
<td><strong>Total Fixed</strong></td>
<td><strong>$6,500.00</strong></td>
</tr>
</tbody>
</table>

**Variable**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor; $1.50/hr. x 8 hrs./day x 200 days</td>
<td>$2,400.00</td>
</tr>
<tr>
<td>Power; 150 H.P. x .746 x .02/K.W.H. x 8 hrs./day x 200 days</td>
<td>3,984.00</td>
</tr>
<tr>
<td>Maintenance;</td>
<td>500.00</td>
</tr>
<tr>
<td><strong>Total Variable</strong></td>
<td><strong>$6,884.00</strong></td>
</tr>
</tbody>
</table>

**Total Costs** 

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$13,384.00</td>
</tr>
</tbody>
</table>

**Total Returns:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500 M b.f. x 1.5 tons/M x $6.00/ton</td>
<td><strong>$13,500.00</strong></td>
</tr>
</tbody>
</table>

**Net Returns**

<table>
<thead>
<tr>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$116.00</td>
</tr>
</tbody>
</table>

Producing sawmill chips is certainly not a "get-rich-quick" scheme and about 1,500 M b.f. of timber may have to be produced to reach a break-even point for chip production. Although the above case is hypothetical, it is considered to be fairly typical of actual gross costs and returns which can be expected in a small sawmill chipping operation in the Central States Region with an hourly chip production of about 1.4 tons.

However, if one considers the fringe benefits of actual cash savings in saw teeth and filing labor, decreased downtime, and increased production in volume and grade resulting from sawing debarked logs, the aspects of financial returns are greatly improved.
Taking Advantage of Chipping Potential

Greatest returns accrue to the sawmill operator who can purchase wastewood from other mills to augment his own production. By doing this, the operator is able to take advantage of the production potential of his chipper. Even running at half capacity, a single small chipper would be able to chip waste wood from four or five mills in the 1,500 M b.f. production class. Increased costs for labor and facilities for handling slab bundles from other mills would be offset by lower unit fixed costs and higher volume production.

The cost and return advantages can be seen below if the hypothetical mill analyzed previously raises its chip production level to eight tons an hour by outside purchase of slabwood. It is assumed that debarked slabs are purchased for $5/ton, that one forklift* and one man is added to the original operation, and that space is readily available for stockpiling slabs prior to chipping.

Annual Costs & Returns

Costs:

Fixed
Depreciation; $35,000/5 yrs. .......................... $7,000.00
Interest; $21,000 x .06. ............................. 1,260.00
Insurance; $21,000 x .04. ............................ 840.00

Variable
Labor; 2 men x $1.50/man-hr. x 8 hrs./day x 200 days .. $4,800.00
Electric Power; ........................................... 3,984.00
Forklift Operating; $.60/hr. x 8 hrs./day x 200 days .... 960.00
Maintenance .............................................. 1,000.00

Purchased Slabs
6.6 tons/hr. x 8 hrs./day x 200 days x $5.00/ton ........... $72,800.00

Total Costs ............................................. $72,644.00

Returns:
8 tons/hr. x 8 hrs./day x 200 days x $6.00/ton ........... $76,800.00
Net Returns ............................................ $ 4,156.00

Production of Peeled Slabs for Sale as Chippable Material

For sawmills producing less than 1.5 million board feet a year, installation of a debarker may be quite feasible. Many mills in the Northeast have found that sales from debarked

* The purchase price of the forklift is assumed to be $10,000, and the average overall yearly maintenance cost is assumed to increase $500.
slabs and edgings have increased their net income $4-$7 per M b.f. These debarked slabs and edgings are usually hauled to a centralized chipping facility located where it can concentrate debarked slabs and edgings from several mills. This chip plant can be owned by a pulpmill, an independent producer, a large sawmill, or possibly a wood-marketing cooperative made up of several sawmill owners.*

In some areas of the Central States $3-$5 a ton, green weight, is being paid for debarked slabs delivered to concentration points. Prices paid depend upon species, transport distances and competitive factors.

The slabs and edgings are delivered in strapped or wired bundles weighing 1 to 1.5 tons, generally in random lengths as produced. The most convenient mode of transportation for the small sawmill is the flat bed trailer and tractor combination. A 30-foot trailer will carry 18 to 20 tons of hardwood slabs. A forklift truck is usually used to load and unload slab bundles from the trailers. Truck transportation costs can be estimated at 30 cents a round trip mile.

It's unlikely small sawmills will use railroad transportation except in those situations where slab bundles can be stockpiled in rail car quantities. Rail rates for slabs have been found in other parts of the country equivalent to that charged for pulpwood.

From the budget analysis (below) it appears the break-even point for debarked slab production occurs at a point where a sawmill is producing about 1 million board feet annually if the delivered price is $5.00 a ton.

Assumptions:

1. Debarking, baling & slab loading equipment cost; $15,000.
2. Labor required; 1 man @ $1.50/man hour.
3. Electric power required; 25 horse power @ .02/K.W.H.
4. Depreciation schedule; straight line, 5 years.
5. Interest charges; 6% on average investment.
6. Insurance charges; 4% on average investment.
7. Maintenance & supplies; $.30/M b.f. sawn.
8. 200 working days; 5000 b.f./day; 1000 M b.f./year.
9. Slab price; $5.00/ton delivered to chipper.
10. 1.5 tons slab/M. b.f. lumber sawn.
11. Hauling distance; 20 miles one way.
12. Hauling costs; $.30/round trip mile.
13. Debarker operates 4 hours each day, the operator is used full time debarking, bundling and loading slabs on the trailer.

* In the Northeast there is a definite trend toward cooperative chipping to effect reduced unit chipping costs.
Annual Costs & Returns

Costs:

Fixed

Depreciation; $15,000/5 ........................................... $3,000.00
Interest; $9,000 x .06 ............................................. 540.00
Insurance; $9,000 x .04 .......................................... 360.00

$3,900.00

Variable

Labor; 1 man x $1.50/man hr. x 8 hrs./day x 200 days ... $2,400.00
Power; 25 H.P. x .746 x .02/K.W.H. x 4 hrs/day x 200
   days ................................................................. 298.00
Maintenance; 1,000 M b.f. x .30/M b.f. ......................... 300.00
Hauling; $.30/rd. trip mi. x 20 mi. x 75 trips* ............... 450.00

$3,448.00

Total Costs .................................................. $7,348.00

Returns:

1,500 tons x $5.00/ton ........................................... $7,500.00

Net Returns .................................................. $ 152.00

The advantages of log debarking to the sawmill owner disregarding possible added income from sale of debarked slabs and edgings have already been presented.

Financing

Purchase of wastewood processing equipment may be financed by:

1. Banks and other private lending institutions;
2. Federal agencies;
3. Equipment manufacturers.

The latter may have some advantage over the customary money lending agencies in that they are better qualified to assess the potentials and capabilities of a wood processing venture with possibly less reliance on past budget and operating records of the operator. In most cases, equipment companies accept more risk since they are in a better position to resell repossessed machinery than banks and loan associations. Equipment salesmen also are able to work closely with pulps mills regarding chip specifications, and can provide engineering services and cost analyses.

* 1000 M b.f. x 1.5 tons slabs/M b.f. ÷ 20 tons/trip = 75 trips
Correction for page 10, Mimeo F-52, Pulp Chip Production Potentials At Indiana Sawmills.
Bottom line should read: about 1500 M.b.f.
SUMMARY

Since 1958, the utilization of Indiana grown hardwood timber for the production of paper products has increased rapidly. It is anticipated that the consumption of hardwood timber will increase through expansion of present conversion units and by the construction of new plants.

Pulp chip production at sawmills is a promising source of inexpensive and quality chips. There appears to be significant economic and operating advantages for both sawmill firms and pulp and fiber mills in the state to take advantage of this virtually untapped resource.

From the analysis, the break-even point where additional costs of producing chips are balanced by additional receipts is reached at an annual lumber production of about 1.5 M b.f. However, substantial increases in a firm's net returns might accrue even at this level because of savings associated with reduced saw teeth wear, filing labor, decreased downtime, and increased lumber production efficiency resulting from the sawing of debarked logs. For mills producing debarked slabs and not producing chips, the break-even point would be as much as 50 percent lower.

The sawmill operator contemplating entry into combined sawmill and wood residue recovery operations must carefully consider potential markets, production and delivery costs, and expected sales value of slabs and/or chips. Close attention to costs and cost-control measures will be required to obtain net returns on the operation. Nevertheless, there are real opportunities and potentials for the development of a statewide wastewood pulp chip recovery industry in Indiana.
Selected References


