United States
Department of
Agriculture

Forest Service

**Southern
Research Station**

General Technical
Report SRS–111

Analyzing the Feasibility of Utilizing Small Diameter Hardwood Timber for Solid Wood Products and Residues

Brian Perkins, Bob Smith, and Philip Araman

Authors:

Brian Perkins, Graduate Research Assistant, Department of Wood Science and Forest Products, and **Bob Smith**, Associate Dean for Engagement in the College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061; and **Philip Araman**, Wood Scientist and Team Leader, U.S. Department of Agriculture, Forest Service, Southern Research Station, Blacksburg, VA 24060.

Cover photo: Hardwood small diameter logs color coded by diameter classes prior to processing in a mill study. Photo courtesy of Brian Perkins.

November 2008

Southern Research Station
200 W.T. Weaver Blvd.
Asheville, NC 28804

Analyzing the Feasibility of Utilizing Small Diameter Hardwood Timber for Solid Wood Products and Residues

Brian Perkins, Bob Smith, and Philip Araman

Analyzing the Feasibility of Utilizing Small Diameter Hardwood Timber for Solid Wood Products and Residues

Brian Perkins, Bob Smith, and Philip Araman

Abstract

The eastern hardwood forest contains small diameter timber that is often of lower quality and lower value than larger sawtimber. This small diameter hardwood timber has traditionally been utilized for pulpwood, but it can also be used for lumber and residue production. In order to increase the utilization of this resource by sawmills, a number of analyses need to be conducted. These analyses include a resource analysis, yield analysis, economic analysis, and finally a market analysis. This report gives detailed instructions for conducting each of these analyses. The successful completion of these analyses will help hardwood lumber companies determine if using small diameter hardwood timber is a good decision for their company.

Keywords: Feasibility analysis, hardwood, lumber, small diameter timber, wood residues.

Introduction

In the eastern hardwood forest, selection cutting is often the predominant method for harvesting timber. One motivation for forest land owners to harvest timber is to generate revenue from their property. The highest value and usually the largest timber is harvested, and the smaller, lower value timber is left in the stand. This practice, known as high grading, has occurred for decades in hardwood forests and has resulted in timber stands with lower value, lower quality, and smaller timber. The conventional wisdom has been that in order to improve the utilization of this smaller diameter resource, additional markets other than pulpwood would be needed. One potential market for these small logs is sawmills. While most sawmills would not consider trying to cut pulpwood-sized logs, some sawmills have the capability to do so.

A number of questions must be answered before mills can start utilizing small diameter timber (SDT). What is the available SDT resource in my area? What products can be sawn from SDT and what would their yield be? How profitable is sawing small logs and what is the market outlook for products from SDT? The purpose of this publication is to provide a technique to answer many of those questions.

Resource Availability

An adequate and stable supply of raw materials must be available to sawmills. We recommend that you use the Forest Service's U.S. Department of Agriculture Forest Inventory Analysis (FIA) Mapmaker version 3.0 to estimate stand volumes of SDT by county and species. Mapmaker version 3.0 is available at http://fia.fs.fed.us/tools-data/tools/. The volume of growing stock in cubic feet is used to estimate the stand volume. The data can then be filtered for different diameter groups depending on the machinery capabilities of your mill. Next, the Forest Service Timber Products Output (TPO) Mapmaker version 1.0 should be used to determine volumes of SDT presently consumed by species in each county. This program is available at http://fia.fs.fed.us/tools-data/tools/. The volume of all timber removals in cubic feet is used to estimate the consumed volume (CV). Due to differences between TPO data and FIA data, data for some tree species will have to be combined. In order to convert from cubic feet (CF) to board feet (BF) (International ¼"), you need to know the BF/CF ratio. In a study at Virginia Polytechnic Institute and State University (Perkins and others 2006), this ratio was 6.5, meaning that these small diameter hardwood logs scaled 6.5 BF for every cubic foot. For small diameter hardwood logs this ratio should be used or one that a mill has established. Resources on the Internet can also be used to find conversion factors for other log rules.

The available volume of SDT can be calculated by multiplying "stand volumes" by a "landowner willingness to manage factor" (LWMF) and then subtracting consumed volume as shown in equation (1). This landowner willingness to manage factor can range from 0.0 to 1.0, with this range representing 0 to 100 percent of forest landowners—those willing to harvest small diameter timber from their forest land. Research (Birch and others 1998) has shown that 40 to 50 percent of landowners are willing to harvest timber. Therefore, it is recommended that you use 0.4 or less for the landowner willingness to manage factor.

$$AV = (SV*LWMF) - CV \quad (1)$$

where

AV = available volume
SV = stand volume
LWMF = landowner willingness to manage factor
CV = consumed volume

The available volume should be compared to your mill's small diameter timber capacity. An ample supply of small diameter timber must be available if you are going to expand your mill's capacity, purchase new equipment, or start a new business. Talk to your loggers and get their input (their selling prices of SDT, supply estimates, etc.) because they may benefit from your utilization of SDT also. They may be leaving what you want in the woods because they have not had a market for the SDT material.

Yield Analysis

Research to identify lumber yield from hardwood SDT has discovered high proportion of lower grade lumber, and these grades are most often used in pallet and flooring manufacturing. Studies have investigated the yield of pallet cants and pallet lumber from pole timber and SDT. Research (Craft 1982, Craft and Emmanuel 1981) has indicated that short length logs with less sweep have greater yield than longer length logs with more sweep. Clearly, in order to maximize the profitability of sawing small logs, one must maximize the product yield from SDT.

When planning a yield study, you should consider what timber resources are available, the capabilities of the available machinery, and the characteristics of the market. A yield study conducted at Virginia Polytechnic Institute and State University (Perkins and others 2006) limited the diameter range to 6 to 10 inches on the small end. Scragg mills and portable band mills will be able to process SDT into cants and side lumber. Each mill's setup will dictate what products can be made in a yield study. If a secondary breakdown such as a gang resaw or a band resaw is available, then this could increase productivity and product choice. Utilization of wood residues such as chips, sawdust, and bark is important for profitable and efficient utilization of SDT. Another important point is that different products can be sawn from different sized logs, and this should make it possible to create more value. A 10-inch log may yield a cross tie, whereas an 8-inch log would yield only a less valuable pallet cant. Below is a step-by-step guide to implementing a yield study:

1. Acquire logs. A good sample would be 50 logs or more.

2. Measure length to the nearest foot and diameter (small-end inside bark) to the nearest 0.1 inch. Include logs with diameters 0.4 inches above and 0.5 inches below the diameter class. For example, a 6-inch diameter log group would include logs from 5.5 inches to 6.4 inches.

3. Separate logs into 1-inch diameter groups. If the yield analysis will use multiple log groups, then color coding with spray paint will help in tracking logs and products.

4. No grading rules exist for logs below an 8-inch small end diameter. For logs above 8 inches small end diameter, use the USDA Forest Service's log grade rules (Rast and others 1973). Mills will have to develop their own grading criteria for 6-inch and 7-inch logs. Logs with large portions of unsound wood or obvious sweep will have a lower yield.

5. The moisture content of logs should be measured. Logs should also be weighed while green, but before sawing. Solid wood products and wood residues should also be weighed after milling in order to calculate the weight yield.

6. Decide on a product and sawing configuration. Decisions should be guided by local market conditions, machinery limitations, and log characteristics. Some mix of cants, ties, and lumber should be a good strategy.

7. Run the group of logs through the mill. Record volume, weight, and grade of lumber, cants, and ties. Record volume and weight of chips, sawdust, and bark. Record the time it takes to run the logs through the mill.

8. Repeat steps 5, 6, and 7 for each log group if there are multiple log groups.

9. Tally the volume for each lumber grade along with cant and tie sizes.

In order to calculate overrun or underrun (equation 2), divide the log tally by the sawn wood tally and then subtract that ratio from 1 and multiply by 100 percent. If the percentage is positive, then the sawn wood tally exceeded the log tally by that percentage (overrun). If the percentage is negative, then the log tally exceeded the sawn wood tally by that percentage (underrun).

$$OR \text{ and } UR = (1 - LT / ST)*100\% \quad (2)$$

where

OR = overrun
UR = underrun
LT = log tally
ST = sawn wood tally

This measure of yield is important when you have to decide how much timber to buy in order to produce a given sawn wood volume. Computer-based spreadsheets can help you chart the solid wood and residue yield by product and grade in order to compare between log groups. The weight yield can be calculated by dividing a product weight by the log weight. For example, the weight of chips divided by the log weight would give you an idea of how much of each log is going to be made into chips. From these ratios, you can estimate revenues.

If your mill has further processing operations such as a pallet part mill, dry kilns, or a dimension mill, then you can also track the wood through these operations to determine yields. It is important to maximize the sawn wood portion from the log in order to increase the profitability of utilizing SDT.

Economic Analysis

If you have determined that there is an ample supply of SDT and that those logs can yield a variety of products, the question is whether you can make any money by sawing small diameter logs. To determine this you will need to estimate your revenues and costs of sawing. A visit with your accountant is probably in order. You will have to make a few assumptions such as mill capacity, market prices, delivered log costs, and product yields. All of these things change over time but in order to analyze the profitability, we need to hold things steady. If the smaller logs require more handling or the machinery requires more maintenance than it does when you saw your regular sized logs, then you need to add in these extra costs. The following is a step-by-step description of how to go about calculating revenues and costs. An example is shown in the appendix.

1. Divide the product yield by the log scale for that log group. Do this for every product.

2. Decide on a time period for the analysis. Would you be cutting this on an hourly, daily, or weekly basis? The simplest time period may be the hour.

3. Figure out how much sawn wood your mill can cut per hour, day, or week. This is your capacity. One way to do this is to calculate how long it took to run the SDT through your mill.

4. Calculate the required log volume for your chosen time period by dividing the capacity by 1 plus the overrun or underrun for that log group. If your overrun is 10 percent, then you would divide by 1.10. If your underrun is -5 percent then you would divide by 0.95.

5. Multiply the result from step 4 by the result from step 1 to get the product yield per time period. Repeat this for every product.

6. Multiply the product yield by current market prices to get revenues for each product per time period.

7. Add up all of the revenues for each product to get the total revenue per time period.

8. Determine your costs per time period. Depending upon your company, costs may include log cost, wages, residue freight, repairs and maintenance, fuel, health insurance, utilities, supplies, payroll taxes, equipment rental, retirement, marketing, depreciation, interest, insurance, taxes, and administration.

9. Divide revenue by costs to get a rough indication of how profitable a log group would be. Ratios above one indicate that revenues are greater than costs. Ratios below one indicate that costs are greater than revenues. A higher number indicates higher profitability.

10. In order to calculate gross profit, subtract costs of goods sold from revenue and divide by revenue and then multiply by 100 percent. Net profit can be calculated by subtracting total cost from revenue and divided by revenue and then multiplied by 100 percent. Gross profit (excluding the costs of interest, taxes, depreciation, and amortization) above 20 percent and net profit above 5 percent are good for the sawmill industry.

It is important to remember that the results of your analysis are limited to the logs that you studied. If those logs were not typical of the resource in your area, then your results are distorted. If you think market prices are above the long-term average, then lower the price and see what effect this has on profitability. If you think you can get more yield than what you determine in the yield analysis, then adjust the overrun. In the study at Virginia Polytechnic Institute and State University, it was found that log cost, log size, yield, and processing level all affect profitability. In order for your mill to use SDT profitably, you need to figure out what size logs will yield products that make money for your mill.

Market Analysis

The purpose of the market analysis is to figure out what customers want and whether you can supply that. Companies can determine what customers want by simply asking them and by analyzing current trends in the market. Companies must also examine whether they are capable of supplying what the customers demand. First, let us look at how to determine what customers want and then we will discuss how to analyze market trends.

The most important part of a market analysis is determining what your customers like and don't like about your products and what they see as far as their future demand. In the context of utilizing SDT, a number of challenges arise. First, you are limited to the products that can be made from this resource. Second, some traditional markets for medium- and low-grade lumber, such as the domestic furniture industry, have diminished. Nonetheless, contacting your customers and potential customers is important. The easiest way for mills to do this is simply to call them. Sending an email message may be easier but you may not get a response. The following is a step-by-step procedure for conducting a telephone survey of current and potential customers.

1. Develop a list of current and potential customers. Potential customers are harder to find than current customers, but by using sales prospecting techniques you can find new, potential customers.

2. Develop a list of questions to ask customers. You could ask customers what they need in a product or service, what their future demand for a product or service will be, and what their current purchased volume is. Questions that have yes and no answers may not be as helpful as questions that allow customers to describe in detail what they need. For example, asking customers whether or not they like your product gives you less information than asking them what they would like in an ideal product.

3. Contact customers, explain what you are doing, and ask questions. You may need to call them multiple times before you contact them. Some customers may refuse to participate and that is okay. Other customers may refuse to answer some questions and that is okay. Be sure to thank them for their time.

4. Try to get a response from at least 25 percent of customers contacted. The more responses you get, the better your analysis will be.

5. Enter data in a spreadsheet to develop charts and analyze trends.

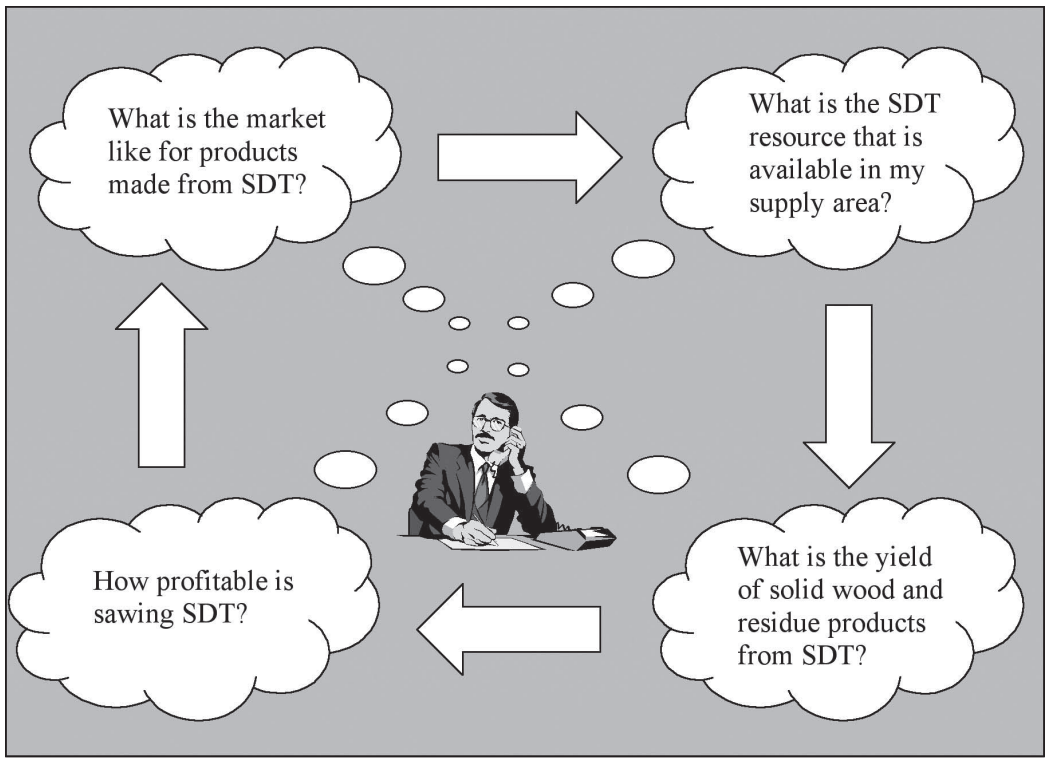
6. Repeat steps 1 through 5 for each market segment such as flooring, pallets, dimension, cabinets, and residue.

Your market analysis should also look at secondary sources of data. First, what is going on with your company and what is going on in the marketplace? This analysis is known as a SWOT analysis, which stands for strengths, weaknesses, opportunities, and threats. The company's strengths and weaknesses are evaluated along with the opportunities and threats in the marketplace. Another useful analysis is the PEST (political, economic, social, and technological) analysis. Trends in each of these categories are examined and their impact upon the company's decisions is evaluated. Some good sources for secondary information include the major market reports, trade magazines, the U.S. Census Bureau, the Bureau of Labor Statistics, and the Internal Revenue Service. A webpage with sources can be found at http://www.cfpmm.vt.edu/index_files/Links.htm.

After talking to your current and potential customers and analyzing your own company and the marketplace, you should have a good idea of whether products made from SDT are needed. In a market survey conducted via telephone at Virginia Polytechnic Institute and State University, opportunities for SDT solid wood products included steady lumber and pallet part usage by flooring and pallet segments. This survey also indicated that furniture frame manufacturers, wood residue users, and dimension manufacturers predicted no change or a decrease in the quantity of products that they would consume.

Conclusion

After conducting all four analyses, companies should have a good idea of whether it is feasible for them to saw small diameter hardwood timber. It is important that the results of all four analyses point towards using this resource. If one analysis turns out downbeat or weak, you could reexamine that particular analysis or just accept that using small logs is not for your company. A number of lumber and pallet companies are using these small hardwood logs profitability and this process (depicted on next page) should help other companies decide if using small diameter timber would be good for them.



Literature Cited

Birch, T.W.; Hodge, S.S.; Thompson, M.T. 1998. Characterizing Virginia's private forest owners and their forest lands. Res. Pap. NE-707. Radnor, PA: U.S. Department of Agriculture Forest Service, Northeastern Research Station. 10 p.

Craft, E.P. 1982. The effect of sawbolt length on the yield of pallet materials from small-diameter hardwood trees. Res. Pap. NE-499. Broomall, PA: U.S. Department of Agriculture Forest Service, Northeast Forest Experiment Station. 6 p.

Craft, E.P.; Emanuel, D.M. 1981. Yield of pallet cants and lumber from hardwood poletimber thinnings. Res. Pap. NE-482. Broomall, PA: U.S. Department of Agriculture Forest Service, Northeast Forest Experiment Station. 6 p.

Perkins, B.; Smith, R.L.; Bond, B. [and others]. 2006. A business model for a red oak small diameter timber processing facility in southwest Virginia. M.S. thesis. 149 p.

Rast, E.D.; Sonderman, D.L.; Gammon, G.L. 1973. A guide to hardwood log grading. Revised. GTR-NE-1. U.S. Department of Agriculture Forest Service. http://www.fs.fed.us/ne/newtown_square/publications/technical_reports/pdfs/scanned/gtr1.pdf. [Date accessed: May 5, 2008].

Appendix

Step-by-Step Description of How to Calculate Revenues and Costs

Product	Yield (bf or tons)	Log scale (bf or tons)	Product yield/ log scale	Time frame	Capacity per time (bf/time)
3 Common (bf)	127	1,272	0.100	hour	5,000
2 Common (bf)	233	1,272	0.183	hour	5,000
1 Common (bf)	133	1,272	0.105	hour	5,000
FAS (bf)	6	1,272	0.005	hour	5,000
Cants (bf)	899	1,272	0.707	hour	5,000
Chips (tons)	2.36	1,272	0.002	hour	5,000
Sawdust (tons)	2.06	1,272	0.002	hour	5,000
Bark (tons)	0.82	1,272	0.001	hour	5,000

Product	Overrun (+%) or underrun (-%)	Required log volume per time (bf)	Product yield per time	Market price ($/bf or $/ton)	Revenue per time
3 Common (bf)	10	4,545	453.85	0.430	$195
2 Common (bf)	10	4,545	832.65	0.505	$420
1 Common (bf)	10	4,545	475.29	0.613	$291
FAS (bf)	10	4,545	21.44	1.080	$23
Cants (bf)	10	4,545	3213.10	0.313	$1,006
Chips (tons)	10	4,545	8.43	22.00	$186
Sawdust (tons)	10	4,545	7.36	10.00	$74
Bark (tons)	10	4,545	2.91	14.00	$41
				Total revenue	**$2,236**

Cost component	Cost per time	Cost component	Cost per time
Required log volume per time	4,545	Administration	$7
Log price ($/bf)	0.200	Marketing	$101
Log cost	$909	Depreciation	$78
Wages	$312	COGS and operating expenses	**$2,039**
Residue freight	$187	Interest	$57
Repairs and maintenance	$119	Taxes	$21
Fuel	$89	**Total cost**	**$2,117**
Contract labor	$80		
Health insurance	$36		
Insurance	$31		
Utilities	$28		
Supplies	$26	Revenue / cost ratio	1.06
Payroll taxes	$24		
Equipment rental	$10	Gross profit	17%
Retirement	$5		
Cost of goods sold	**$1,854**	Net profit	5%

bf = board feet; COGS = cost of goods sold.

Perkins, Brian; Smith, Bob; Araman, Philip, 2008. Analyzing the feasibility of utilizing small diameter hardwood timber for solid wood products and residues. Gen. Tech. Rep. SRS–111. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 6 p.

The eastern hardwood forest contains small diameter timber that is often of lower quality and lower value than larger sawtimber. This small diameter hardwood timber has traditionally been utilized for pulpwood, but it can also be used for lumber and residue production. In order to increase the utilization of this resource by sawmills, a number of analyses need to be conducted. These analyses include a resource analysis, yield analysis, economic analysis, and finally a market analysis. This report gives detailed instructions for conducting each of these analyses. The successful completion of these analyses will help hardwood lumber companies determine if using small diameter hardwood timber is a good decision for their company.

Keywords: Feasibility analysis, hardwood, lumber, small diameter timber, wood residues.

The Forest Service, United States Department of Agriculture (USDA), is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.

The USDA prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.