Options for Small-Diameter Hardwood Utilization: Past and Present
by
Matthew S. Bumgardner, Bruce G. Hansen, Albert T. Schuler and Philip A. Araman

ABSTRACT
Effective and maximum value use of small-diameter hardwood timber has long been of interest to forest managers and researchers. In addition to being a significant component of the standing forest base, small-diameter hardwoods often are available after thinning or other tending operations. Although the use of this material is important to achieving healthy and sustainable forests and other ecosystem management objectives, finding economical uses is sometimes difficult. Much prior research has addressed small-diameter hardwood utilization. After discussing some forest statistics concerning the small-diameter hardwood resource, this paper reviews past small-diameter research and provides an overview of one small-diameter strategy, called System 6. It concludes by looking at evolving markets and utilization opportunities for small-diameter hardwoods.

INTRODUCTION AND BACKGROUND
Conventional hardwood markets do not provide enough economic incentive to remove the excess small low-grade timber so that the best forestry practices can be applied.

Reynolds and Gatchell (1979, p. 2)

Interest in utilization of small-diameter hardwoods is not new. During the 1970's and 1980's, numerous utilization strategies were developed for low-grade and small-diameter hardwoods. A variety of products and production systems were proposed and most seemed, on the surface, economically feasible. Today, there is renewed research interest in utilization of small-diameter hardwoods. Like before, this interest is being driven largely by the role small-diameter markets can play in enhancing forest management options and potential forest health. If tending operations such as thinning or timber stand improvement (TSI) can be conducted with an opportunity to break even or possibly generate a profit with the removed material, management for releasing of crop trees becomes a more attractive option.

Statistics from the southeastern states (VA, NC, SC, GA, and FL) suggest that many treatment opportunities exist for hardwood forests (Figure 1). Approximately 10 percent of the acreage could directly generate small-diameter material through harvests of mature stands, regeneration of poorly stocked stands, and salvage of damaged stands.

Figure 1. Treatment opportunities on hardwood acreage in the Southeast, all ownerships (Johnson 1991, 1992; Conner 1993; Sheffield and Johnson 1993; Brown 1996).

This paper provides an overview of small-diameter hardwood utilization, past and present. Even though the subject of small-diameter utilization is becoming increasing important again as we enter 2000, the opportunities are broader than 30 years ago. After briefly reviewing the forest resource situation, this report samples where we have been with small-diameter utilization. Specifically, it provides a brief overview of one strategy, called System 6. It concludes by looking at emerging opportunities for use of this material.

1 Authors are Research Forest Products Technologist, Project Leader, and Research Forester, respectively, USDA Forest Service, Northeastern Research Station, 241 Mercer Springs Road, Princeton, WV 24740
2 Project Leader, USDA Forest Service, Southern Research Station, Brooks Forest Products Center, Virginia Tech, Blacksburg, VA 24061
THE SMALL-DIAMETER HARDWOOD RESOURCE

The USDA Forest Service defines hardwood sawtimber trees as being at least 11.0 inches dbh and containing at least one 12-foot sawlog or two noncontiguous 8-foot logs. Correspondingly, any tree with a d.b.h. between 5.0 and 11.0 inches is defined as poletimber, and is the resource of interest when discussing small-diameter hardwoods. Figure 2 shows that, across the major hardwood regions of the United States, hardwoods under 11 inches d.b.h. constitute 32 to 42 percent of growing stock volume and 93 to 95 percent of the total number of growing-stock trees.

Figure 2. Hardwood growing stock under 11 inches d.b.h. by region (USDA For. Serv. 1983-98).

In the Northeast, soft maple and "other" hardwoods are abundant in the smaller diameter classes while red oak becomes increasingly important in the larger diameter classes (Figure 3). Other than cherry, much of the "other" hardwoods are nonselect species. This situation may reflect successional dynamics or the fact that red oak is not regenerating sufficiently to remain the dominant component of the hardwood resource. The point is that when we discuss small-diameter hardwoods, we are talking about soft maple and other nonselect hardwoods, and to a lesser extent select hardwoods, which affects utilization options.

WHERE WE'VE BEEN

A representative sampling of the thinking on small-diameter utilization in the 1970's is found in the proceedings from a Symposium entitled Utilization of Low-Grade Southern Hardwoods (Stumbo 1981). Product ideas included composite products such as hardboard, waferboard, corn-ply, and I-beams (9 projects), pallets and pallet parts (5 projects), wood furniture and dimension parts (3 projects), and structural lumber from species such as yellow-poplar, sweetgum, and soft maple (2 projects). Return on Sales (ROS) and Return on Investment (ROI) were common measures of economic feasibility used for the projects. Across 17 projects, the average ROS was 28.7 percent and the average ROI was 36.3 percent (Stumbo 1981). Assuming a 2- to 3-year payback period, these projects were in the realm of possibility.

Figure 3. Growing stock volume in the Northeast, by species and diameter class (USDA For. Serv. 1983-98).

Despite the apparent economic feasibility of many of these projects, widespread adoption to date has been generally limited. There are exceptions, such as the production of pallet parts directly from short, low-grade logs (e.g., Reynolds and Gatchell 1970), where mills can process 20 to 30 MBF per day by live-sawing or using Scragg-mill technology. A useful case is System 6, a system designed to add value to low-grade, small-diameter logs by generating dimension parts for furniture and cabinets in addition to traditional lower value products such as pallet parts and pulp chips.

System 6 Basics

System 6 was developed in the late 1970's and promoted as a "new marketing approach" with new technologies for production of furniture and cabinet parts from small-diameter hardwoods like oak and cherry (e.g., Reynolds and Gatchell 1979, 1982; Reynolds et al. 1983). System 6 sought to change marketing at each point in the distribution chain from hardwood stumpage to the dimension mill where furniture parts are produced. Three key trading points affected by System 6 included:

1. the "Logs" trading point (involving the logger)
2. the "Lumber" trading point (involving the sawmiller)
3. the "Stock" trading point (involving the dimension mill operator).
relative advantage, compatibility, there were apparently too many
For the dimension mill, which was
But the ultimate measure of relative
There were too many new
portions of clear wood that can be extracted and used
most low-grade hardwood material contains small
manufacturers.
moving, and warping were of concern to dimension
material and the high concentration of juvenile wood,
was 30 percent. Due to the low quality of the
panels for use as furniture and cabinet components.
two-thirds of the boards produced would fall below
up; each board had to have at least one 1.5 - by 15-
contribution to small-diameter utilization research
in high value products, was an important early
innovation is perceived as difficult to use. It seems a
marketing considerations that inhibited its adoption.
and is still being studied today (e.g., Serrano and
Rogers (1995), there are five attributes of successful
innovations: relative advantage, compatibility,
complexity, trialability, and observability.
advantage is the degree to which an innovation is
better than its predecessor. This was seemingly true
for System 6, which proposed a new way to
manufacture value-added products from an abundant,
low-grade resource, and a new dimension product in
standard-size, edge-glued panels (Araman et al. 1982).
But the ultimate measure of relative
advantage is the extent of adoption, so what was
wrong?
Compatibility is the degree to which an innovation is
consistent with the adopter's needs. System 6, which
proposed sawmill production of cants, was not
compatible with traditional production of standard lumber.
For the dimension mill, which was
acquainted to receiving lumber and processing it
into parts, System 6 also was a different way of doing
things, in terms of both input and output. At all
points in the distribution chain, System 6 introduced
degree of risk absent before, e.g. the loss of
marketing flexibility when selling a specific product
like dimension parts, as opposed to standard lumber
which can be sold to a variety of producers (Smith et
al. 1996).
Complexity - Complexity is the degree to which an
innovation is perceived as difficult to use. It seems a
fundamental problem with System 6 was one of
complexity. There were too many new
responsibilities for too many players. An entirely
new marketing system needed to be put in place,
simultaneously, for all channel members. While
System 6 products could be made from a technical
standpoint, there were apparently too many
marketing considerations that inhibited its adoption.
Trialability and Observability - Trialability and
observability concern the extent to which an
innovation can be tested. With System 6, there was
substantial trialability on the part of researchers (over
22 publications). Also, the research was varied with
respect to the species studied, including red oak,
white oak, and black cherry. Furniture was built by
manufacturers from the edge-glued panels produced in the pilot tests. But for individual mills, the need for new production and marketing systems made it too difficult to conduct trials and observe results on a meaningful scale.

**Modified System 6 Adoption**

It should be noted that portions of System 6 have been adopted in modified forms, largely through reducing the complexity of the original system. In some cases, the same company purchases the small-diameter logs, uses System 6 processing, and sells cut-to-size blanks. What the customer does not see are the steps that the framers of System 6 envisioned being taken by different companies. Other modifications that have resulted are the use of log lengths other than 6 feet and the production of higher grade molding stock with the use of finger jointing.

**WHERE WE ARE NOW**

**Engineered Wood Products**

Engineered wood products (EWP) such as oriented strand board (OSB) are an emerging market for small-diameter hardwoods. We estimate that OSB accounted for approximately 10 percent (or 480 million cubic feet) of the industrial hardwood roundwood used domestically in 1999. This represents an 84-percent increase from 1990. Timber Product Output (TPO) data suggests that composites accounted for approximately 6 percent of the hardwood roundwood used in the United States in the early- to mid-1990s (USDA Forest Service 1996). However, we know of several EWP companies in the Northeast that use large quantities of hardwoods that were either not in operation when the most recent TPO canvasses were conducted, or were grouped into other product categories. In West Virginia, for example, Georgia-Pacific and Weyerhaeuser began operating OSB mills in the mid-1990's and Trus Joist Macmillan began operating a yellow-poplar LVL mill around the same time. Figure 4 shows that hardwoods account for a substantial portion of the roundwood used in EWP in all regions. Table 1 shows that, in the South, hardwood use in EWP has been increasing.

<table>
<thead>
<tr>
<th>State</th>
<th>Period</th>
<th>Quantity used in 1995 (MCF)</th>
<th>% change over period</th>
<th>% of total hardwood used in 1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td>89-95</td>
<td>3,012</td>
<td>288</td>
<td>6.0</td>
</tr>
<tr>
<td>S.Carolina</td>
<td>94-95</td>
<td>70</td>
<td>89</td>
<td>0.1</td>
</tr>
<tr>
<td>Georgia</td>
<td>89-95</td>
<td>10,343</td>
<td>50</td>
<td>4.0</td>
</tr>
<tr>
<td>Virginia</td>
<td>89-95</td>
<td>11,373</td>
<td>32</td>
<td>5.0</td>
</tr>
<tr>
<td>Mississippi</td>
<td>76-95</td>
<td>10,603</td>
<td>&quot;0&quot; in 76</td>
<td>3.0</td>
</tr>
<tr>
<td>Tennessee</td>
<td>89-95</td>
<td>548</td>
<td>&quot;0&quot; in 89</td>
<td>0.3</td>
</tr>
<tr>
<td>Arkansas</td>
<td>87-96</td>
<td>187</td>
<td>&quot;0&quot; in 87</td>
<td>0.1</td>
</tr>
<tr>
<td>N.Carolina</td>
<td>90-95</td>
<td>12,959</td>
<td>-26</td>
<td>5.0</td>
</tr>
<tr>
<td>average</td>
<td>88-95</td>
<td>6,137</td>
<td>86.6%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Table 1, Use of hardwood roundwood in engineered wood products in the South (Johnson and Stratton 1998).

Of interest are the species being used in EWP (Table 2). As expected, aspen dominates in the North Central states, In the Northeast, soft maple is used the most, and seems an ideal candidate for increased use in EWP (it is the only species listed in all three regions). It is somewhat surprising that species such as hard maple and select red oaks are listed in the Northeast. This might reflect merchandising activities that send tops from sawlogs to EWP mills. In the South, low-density species like yellow-poplar and sweetgum are common, but there is also a substantial oak component.

**Why the Growth in EWP?**

Much of the growth in EWP hardwood consumption can be explained by the adoption framework previously discussed (Rogers 1995). For example, there are advantages for EWP in terms of relative advantage, compatibility, and complexity. With EWP, lower value resources are going to lower value products (as opposed to dimension, furniture, etc.); there is little need for special handling or manufacturing. With respect to compatibility, the technology for EWP (e.g., flaking, adhesives) emerged in regions where EWP have been important for a number of years (i.e., North Central) and has spread to other regions. Finally, the marketing and distribution systems for EWP already were in place, so there was little need to develop channels to handle entirely new intermediate and final products. EWP often have been direct substitutes for the materials they have replaced (e.g., OSB for plywood).
Table 2. Top five hardwood species used in EWP, by region (USDA For. Serv. 1996).

<table>
<thead>
<tr>
<th>Region</th>
<th>Hardwood species</th>
<th>% of total EWP roundwood (softwood and hardwood)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>soft maple</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>hard maple</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>sel. red oaks</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>beech</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>ash</td>
<td>9</td>
</tr>
<tr>
<td>North Central</td>
<td>aspen</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>birch</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>soft maple</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>hard maple</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>basswood</td>
<td>1</td>
</tr>
<tr>
<td>South</td>
<td>oth. red oaks</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>yellow-poplar</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>sweetgum</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>sel. white oak</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>soft maple</td>
<td>2</td>
</tr>
</tbody>
</table>

Perhaps the most important reason for the growth of EWP like OSB is the economics associated with timber supply and cost. OSB is replacing long-standing products like southern pine plywood because of the associated cost savings of using relatively abundant, inexpensive, low-quality hardwoods such as aspen. While much of the OSB production originated in the North Central region, it has spread to the South and Northeast where low-density hardwoods are abundant. For example, in the mid-1980s, OSB mills in Minnesota alone accounted for 25 percent of OSB production in the United States. Today, that figure has dropped to about 10 percent even though Minnesota’s production has increased (Krantz 1999). Sinclair (1992, p.129) has stated the situation well: “... in most cases these [OSB] technologies were available long before they were used to make panels commercially. The driving force behind the implementation... has been timber supply and cost.”

Other Hardwood Markets

It is important to note what is happening in other major hardwood sectors, such as pulp and lumber. Hardwood pulpwood prices are increasing faster than softwood pulpwood prices in the South (10 and 6 percent, respectively), as shown in Figure 5. Table 3 shows that use of hardwoods in pulp has increased dramatically in the South due to many reasons with availability being a key. This has helped hardwood pulpwood prices climb and reduced their cost advantage over softwoods. While this news can be good for forest-land owners seeking markets for small-diameter material, it also suggests that new pressures are being placed on the smaller diameter hardwood resource in some locations.


<table>
<thead>
<tr>
<th>Species</th>
<th>Roundwood to pulp – 1976 (MCF)</th>
<th>Roundwood to pulp – 1995 (MCF)</th>
<th>Change over period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softwood</td>
<td>1,975,276</td>
<td>2,399,152</td>
<td>21.5%</td>
</tr>
<tr>
<td>Hardwood</td>
<td>726,450</td>
<td>1,494,829</td>
<td>105.8%</td>
</tr>
</tbody>
</table>

Prices for lower grade hardwood lumber have also been increasing. Table 4 shows that the price of lower grade hardwood lumber increased at a faster rate than the price for higher grades for many species during the 1990s. This suggests that markets for low-grade lumber have improved. This might be explained in part by the spread of optimization equipment, strong growth in lower-value product markets (e.g., hardwood flooring), and growing popularity of lower value species (e.g., hickory used in cabinets). We estimate that 60 percent of hardwood sawmill output is now No. 2 Common or lower in grade.


<table>
<thead>
<tr>
<th>Species</th>
<th>No. 1 Common</th>
<th>No. 2 Common</th>
<th>No. 3A Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cherry</td>
<td>5%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Red oak</td>
<td>4%</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>White oak</td>
<td>3%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Hard maple</td>
<td>8%</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Soft maple</td>
<td>5%</td>
<td>5%</td>
<td>--</td>
</tr>
<tr>
<td>Y. Poplar</td>
<td>4%</td>
<td>4%</td>
<td>--</td>
</tr>
<tr>
<td>Hickory</td>
<td>7%</td>
<td>7%</td>
<td>--</td>
</tr>
</tbody>
</table>
SUMMARY
The use of hardwoods in EWP is increasing and, where EWP mills are available, can offer markets for small-diameter hardwoods and non-sawlog portions of sawlog trees. Such opportunities can help make intermediate silvicultural treatments more financially attractive. Additional research is needed to better understand the impact of EWP on the hardwood resource in the East, where they are becoming a major component of many species' utilization.

Other promising research areas for utilization of small-diameter hardwoods include green dimension (Lin et al. 1995; Bratkovich et al. 2000) and curve sawing of hardwood logs and lumber. Research into "value-added" processing of small-diameter hardwoods similar to the concepts of System 6 also continues. Also, there may be regional opportunities for specialty products such as rustic rail fencing, which accounts for about 20 manufacturers in West Virginia alone (West Virginia Bur. of Commer. 1997).

LITERATURE CITED


Proceedings of the Annual Meeting of the
Southern Forest Economics Workers
(SOFEW)

Hardwoods - an
underdeveloped resource?

March 26-28, 2000, Lexington, Kentucky

Edited by Matthew H. Pelkki

Published by the
Arkansas Forest Resources Center
School of Forest Resources
University of Arkansas at Monticello

July 2001
Letter from the Editor

These are the proceedings of the 30th Annual Meeting of the Southern Forest Economics Workers held at the Embassy Suites Hotel, Lexington, Kentucky on March 26-28, 2000. The conference was hosted by the University of Kentucky, College of Agriculture and Department of Forestry. Lexington is the most northern location ever for the SOFEW meeting, and we enjoyed hosting many of our “northern” colleagues from the Pacific Northwest, New England, and Lake States as well as international presenters from Finland, Sweden, and Russia. All in all, the 86 participants represented 21 states in the U.S.A. and four countries.

The 2000 workshop focused on hardwoods as an undeveloped resource, but also included presentations on international forestry, best management practices, regional economic analyses and timber supply, non-timber economics, timber trend analysis, agroforestry, and cost/price functions. The participants in SOFEW 2000 had the opportunity to hear 43 presentations during the two-day program. Since this was the last SOFEW meeting of the 20th Century, Marcella Szymanski, facilitated a discussion of forest economics issues for the 21st Century. Participants identified four major issues that will impact forest economics during the start of the new century and listed current conditions, the desired future state, and listed ways forest economists could assist in moving from current conditions to the desired state. The four issues identified are:

1) The U.S. is a net importer of wood fiber
2) Growing public opposition to growing trees (for fiber)
3) Land-use planning (urbanization, land use changes)
4) Increasing awareness of forest practices

The results of this special session can be found in the final paper of this proceedings.

I'd like to extend a special thanks to Dean C. Oran Little of the University of Kentucky College of Agriculture for his keynote address. And special thanks to Don Graves, Jim Ringe, and Natalia Kirillova for their help before and during the conference. A special thanks to all the session moderators who kept the program running and on time – I really appreciated those who volunteered so readily.

Finally, thanks to the authors and participants – the high quality of the presentations and papers are in keeping with SOFEW’s tradition of excellence.

Copies of the proceedings are available for $20 per copy and may be ordered through the SOFEW homepage or by contacting me at the address listed below.

Best wishes,

Matthew H. Pelkki
George H. Clippert Endowed Chair of Forest Resource Economics, Management and Policy
University of Arkansas at Monticello
School of Forest Resources
Arkansas Forest Resources Center
Monticello, AR 71656

Phone: (870) 460-1949
E-mail: pelkki@uamont.edu