Options for Small-Diameter Hardwood Utilization: Past and Present

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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 TSI and thinning treatments. Another 34 percent of the acreage could generate some small-diameter material through harvests of mature stands, regeneration of poorly stocked stands, and salvage of damaged stands.

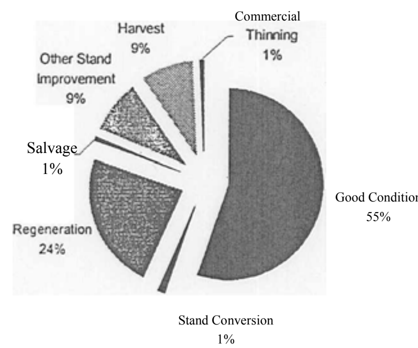

Figure 1. Treatment opportunities on hardwood acreage in the Southeast, all ownerships (Johnson 1991, 1992; Conner 1993; Sheffield and Johnson 1993; Brown 1996).

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.

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THE SMALL-DIAMETER HARDWOOD RESOURCE

The USDA Forest Service defines hardwood sawtimber trees as being at least 11.0 inches d.b.h 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.

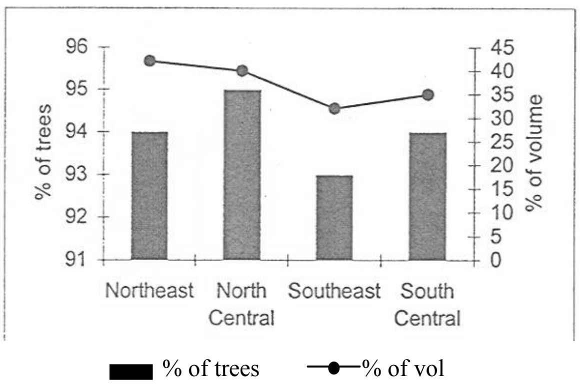

Figure 2. Hardwood growing stock under 11 inches d.b.h. by region (USDA For. Servo 1983-98).

In the Northeast, soft maple and "other" hardwoods are abundant in the smaller diameter classes while reef 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, com-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.

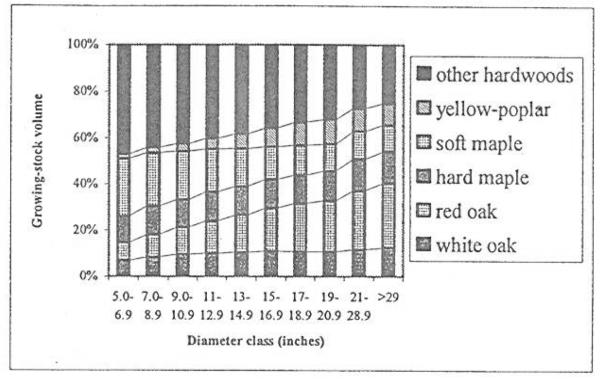

Figure 3. Growing stock volume in the Northeast, by species and diameter class (USDA For. Servo 198398).

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 livesawing 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 nom 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).

The Logs Trading Point - With System 6, small-diameter logs (7.5 to 12.5 inches d.b.h.) are bucked to 6-foot lengths of sound and solid quality (sound defects without limit). In addition to making bucking decisions, the logger was to sort the 6-foot logs into System 6 logs, pallet logs, and pulp logs. The System 6 bolts would then be sold to sawmills equipped with Scragg-type sawing technology.

The Lumber Trading Point - An important impetus for System 6 was the difficulty of making a profit sawing small factory grade 3 logs to lumber, since less than 20 percent of the lumber produced is No.1 Common and Better. Thus, System 6 called for the sawmiller to convert logs into 2-sided cants instead of lumber. These cants then became the material sold to the dimension manufacturer (as opposed to lumber). Since there was no need to grade and sort lumber, the System 6 cants could be sold by the sawmiller at a lower price than lumber. Although it was relatively simple for the sawmiller to produce the System 6 cants (there were only two thickness options when sawing), the key was to locate a dimension manufacturer that would purchase cants.

The Stock Trading Point - It was the responsibility of the dimension manufacturer to convert System 6 cants to edge-glued panels. First, the cants were resawn (in one pass) to boards and immediately stacked for drying. Once dried, the boards were cut up; each board had to have at least one 1.5 - by 15inch clear cutting. It was estimated that one-half to two-thirds of the boards produced would fall below 3A Common grade. The key points for the dimension manufacturer were focusing on throughput since they were processing low-quality material and retrieving even the smallest amounts of clear material from the boards.

The clear material was glued into standard-size panels for use as furniture and cabinet components. The estimated yield of rough panels from the cants was 30 percent. Due to the low quality of the material and the high concentration of juvenile wood, product-quality issues such as glue lines, color matching, and warping were of concern to dimension manufacturers.

Adoption of Innovations

System 6 was an inventive and a technically feasible strategy for hardwood utilization that addressed an important issue of its time. Its basic premise, that most low-grade hardwood material contains small portions of clear wood that can be extracted and used in high value products, was an important early contribution to small-diameter utilization research and is still being studied today (e.g., Serrano and Cassens 2000). However, System 6 was not adopted on a large-scale basis. As we will argue, economic conditions and new technologies have brought improved markets for small-diameter hardwoods that were not prevalent 20 to 30 years ago. Another consideration is the literature on adoption of innovations as it applies to System 6. According to Rogers (1995), there are five attributes of successful innovations: relative advantage, compatibility, complexity, trialability, and observability.

Relative Advantage and Compatibility - Relative 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 traditiol1al production of standard lumber. For the dimension mill, which was accustomed 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 a 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 - Trialabillty 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 smalldiameter 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 round wood 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 L VL 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.

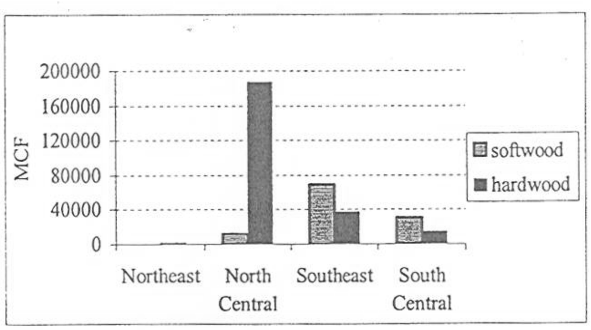

Figure 4. Roundwood use in engineered wood products, 1996 (USDA For. Serv. 1996).

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

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

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).

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

Perhaps the most important reason for the growth of EWP like OSB is the economics associated with timber supply and cost. OSB is replacing longstanding 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 lowdensity 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.

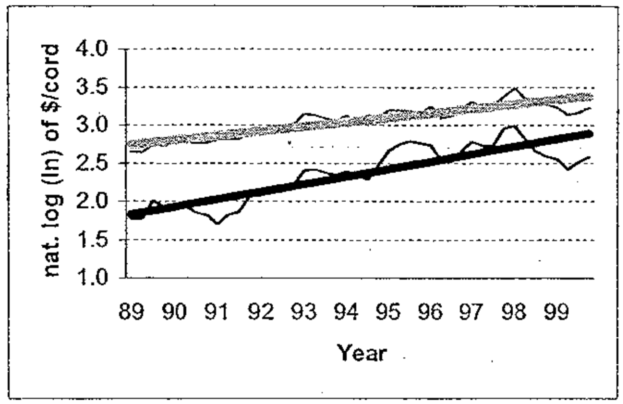

Figure 5. Average annual rate of price increase for softwood pulpwood (light line) and hardwood pulpwood (dark line) in the South (Timber Mart-South 1989-99).

Table 3. Trends in roundwood pulpwood production in the South, 1976-1995 (Johnson and Stratton 1998)

Species group	Roundwood to pulp - 1976 (MCF)	Roundwood to pulp - 1995 (MCF)	. Change over period
Softwood	1,975,276	2,399,152	21.5%
Hardwood	726,450	1,494,829	105.8%

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 4. Average annual rate of price increase for 1990-99, by species and lumber grade, 4/4", Appal. Region (Hardwood Market Report 1990-99).

Species	No.1 Common	No.2 Common	No. 3A Common
Cherry	5%	8%	4%
Red oak	4%	7%	8%
White oak	3%	5%	6%
Hard maple	8%	7%	6%
Soft maple	5%	5%	-
Y. Poplar	4%	4%	-
Hickory	7%	7%	-

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).

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