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Direct Comparison of Processing Technology in Hardwood and Softwood Sawmills

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ABSTRACT

This study compares the sawing accuracy of 273 machines in hardwood sawmills to 291 machines in softwood sawmills. Characteristics compared were kerf width, sawing variation (within-board, between-board, and total), machining wood loss per sawline, and oversizing/undersizing practices. While results varied between machine types by region, hardwood sawmills generally performed as well as, or sometimes better than, softwood sawmills for many of the machine characteristics studied.

INTRODUCTION

Published conversion factors indicate that hardwood sawmills require a greater volume of log input (191.2 cu. ft.) than do softwood sawmills (155.1 cu. ft.) to produce one thousand board feet of lumber (1). Thus, on the average, hardwood sawmills require 23 percent more raw material to obtain the same board footage as softwood sawmills. Part of this difference occurs because of the significant difference in thickness between softwood and hardwood lumber.

A recent study showed the average rough green thickness of 4/4 and 8/4 softwood lumber to be 1.021 and 1.790 inches respectively (8). These averages compare with 1.125 inches for 4/4 hardwood lumber and 2.215 inches for 8/4 hardwood lumber calculated from data available in the present study. These relative values indicate that, based on thickness differences, hardwood sawmills require 10 percent more fiber to produce 4/4 lumber and 19 percent more fiber for 8/4 lumber. Confounding a direct comparison of this type, however, is the fact that hardwood sawmills produce a high percentage of 4/4 and relatively little 8/4 lumber, while the opposite is true of softwood sawmills.

Another important aspect of conversion efficiency is relative average lumber width. Softwood dimension lumber, for example, is cut to 2-inch width categories while hardwood lumber is cut to random widths. This increases the relative conversion efficiency of hardwood sawmills to an unknown degree.

The log diameters and lengths processed by these two industries also differ. One study found mean softwood log diameters of 10.9 inches and lengths of 15.3 feet (8). Data from this current study showed mean hardwood sawlogs diameters of 13.4 inches and 13.2 feet in length. Both log diameter and log length influence sawmill conversion factors (7). Larger diameters and shorter logs should increase the relative conversion factor of hardwood sawmills.

Obviously, a comparison of hardwood and softwood sawmill conversion efficiency is confounded by a number of interacting factors but could be undertaken if these factors were removed. This can be accomplished by examining only those factors related to application of technology of the respective sawmill types. Based on the methodology of a previous study which compared softwood sawmills of different sizes (9), machine performance can be considered a relative indicator of the application of technology and of the success of quality control programs in sawmills.

Sawmill management decisions can also influence conversion efficiency. A recent study found that a large percentage of the softwood lumber in final markets is undersized (8). Perhaps differences in market demand for hardwood lumber compared to softwood lumber have contributed to possible differences in oversizing and undersizing practices

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and resultant conversion efficiency. No data are available to substantiate this supposition, however.

The objectives of this study were to compare performances of sawing machines of the same type in hardwood and softwood sawmills and to determine if oversizing practices differ between hardwood and softwood sawmills.

DATA

The analysis data were obtained from Sawmill Improvement Program (SIP) studies of softwood and hardwood sawmills. SIP is a cooperative effort of the USDA Forest Service's, State and Private Forestry Organization, and state forestry organizations. These agencies conducted studies of sawmill conversion efficiency at the request of sawmills. The SIP studies were conducted between 1973 and 1987 for softwood sawmills and between 1977 to 1987 for hardwood sawmills.

The SIP studies examined the sawing accuracy of 273 sawing machines in hardwood sawmills and 291 sawing machines in softwood sawmills. Because the machines were of various ages and were under different maintenance regimes, the data reflects sawing accuracy of machines in service rather than reflecting optimal performance under ideal conditions.

The machines analyzed in this study fell into five machine types: band headrig, circular headrig, single arbor gang resaw, double arbor gang resaw, and band linebar resaw. The numbers of each machine type studied by region are given in Table 2. Several other machine types contained in the SIP database were not examined because their numbers were small.

Sawing variables in softwood sawmills vary greatly between regions (8). Thus, to decrease variance and increase the power of the statistical tests in the current study, softwood sawmills were divided into three regions: Southern, Rocky Mountain, and West Coast (Table 1). A single hardwood region was defined that contained all states in which hardwood sawmill studies were conducted.

Information on lumber thickness variation in the SIP studies was obtained by measuring maximum and minimum thicknesses of 100 boards randomly selected from the daily production of each machine. The lumber thickness variation values were then adjusted using conversion factors developed by Peterson and Ermer (5). These adjusted values were comparable to values equivalent to four random measurements and lumber thickness variation computation as described by Brown (2).

Kerf was determined for each machine by randomly measuring the width of at least 10 teeth from each sawblade and calculating the mean kerf value. Research has shown that kerf width exceeds average measured sawtooth width by 7.0 percent (4). However, for this analysis, the average sawtooth width was considered an adequate estimate of actual kerf width.

SIP procedures allow for studying all thicknesses produced by a machine. Thickness variation values for 4/4, 5/4, 6/4, and 8/4 lumber were pooled to obtain the mean values for within-board, between-board, and total sawing variation for each machine type.

ANALYSIS PROCEDURES

We analyzed the regional sawing variables by analysis of variance (ANOVA) procedure for unbalanced design in the Statistical Analysis System (6). The means for each machine were compared (Tables 3 to 6) using the least square (LS) means method at the 0.05 level. The LS means method is a modification of the least significant difference method in which adjustment for unequal sample size is performed. LS means are the marginal means that would have been expected had the design been balanced (6).

The model for examination of differences for all sawing variables (kerf width, between-board sawing variation, within-board sawing variation, total sawing variation, machining wood-loss per sawline, oversizing-undersizing, total wood-loss per

Table 3. Mean values (inches) of kerf width for band headrig, circular headrig, single arbor gang resaw, double arbor gang resaw, and band linebar resaw. The asterisks following values indicate that the comparison of means test showed a significant difference for the sawing variables analyzed between softwood and hardwood sawmills. A dash indicates a sample size that was too small to be included.

Machine type	Hardwood	Softwood regions: Southern	Rocky Mt.	West Coast
Band headrig	.162	.179 *	.178 *	.183 *
Circular headrig	.282	.298 *	.308 *	---
Single arbor circ. gang resaw	.260	.251	---	.148 *
Double arbor circ. gang resaw	.238	.226	.180 *	.184 *
Band linebar Resaw	.139	.157	.158	.147

Table 4. Mean values (inches) of within-board sawing variation for band headrig, circular headrig, single arbor gang resaw, double arbor gang resaw, and band linebar resaw. The asterisks following values indicate that the comparison of means test showed a significant difference for the sawing variables analyzed between softwood and hardwood sawmills. A dash indicates a sample size that was too small to be included.

Machine type	Hardwood	Softwood regions: Southern	Rocky Mt.	West Coast
Band headrig	.022	.027 *	.025	.021
Circular headrig	.026	.034 *	.028	---
Single arbor circ. gang resaw	.012	.013	---	.014
Double arbor circ. gang resaw	.011	.014	.008	.010
Band linebar Resaw	.021	.021	.024	.020

Table 5. Mean values (inches) of between-board sawing variation for band headrig, circular headrig, single arbor gang resaw, double arbor gang resaw, and band linebar resaw. The asterisks following values indicate that the comparison of means test showed a significant difference for the sawing variables analyzed between softwood and hardwood sawmills. A dash indicates a sample size that was too small to be included.

	Hardwood	Softwood regions		
Machine type		Southern	Rocky Mt.	West Coast
Band headrig	.016	.062 *	.045 *	.046 *
Circular headrig	.016	.084 *	.066 *	---
Single arbor circ. gang resaw	.006	.065 *	---	.034 *
Double arbor circ. gang resaw	.005	.021 *	.018 *	.019 *
Band linebar Resaw	.013	.046 *	.052 *	.039 *

Table 6. Mean values (inches) of total sawing variation for band headrig, circular headrig, single arbor gang resaw, double arbor gang resaw, and band linebar resaw. The asterisks following values indicate that the comparison of means test showed a significant difference for the sawing variables analyzed between softwood and hardwood sawmills. A dash indicates a sample size that was too small to be included.

	Hardwood	Softwood regions		
Machine type		Southern	Rocky Mt.	West Coast
Band headrig	.047	.069 *	.053	.052
Circular headrig	.054	.091 *	.074 *	---
Single arbor circ. gang resaw	.033	.066 *	---	.037
Double arbor circ. gang resaw	.028	.026	.020	.022
Band linebar Resaw	.040	.051	.058	.045