

YIELDS OF RUBBERWOOD SAWN TIMBER

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Received September 1989

SIM, H. C. 1989. Yields of rubberwood sawn timber. Yields of sawn timber from rubber trees were studied in a processing mill. Significant differences were detected when yields were categorized by diameters of logs and sizes of sawn timber produced. A relative frequency weighted approach was proposed as a better estimation technique to assess the average yields. Yields categorized by log diameters and sawn timber sizes, and weighted with relative frequencies would be a more accurate and useful input for planning and controlling of the sawmilling operation.

Key words: Rubberwood - yields - sawn timber - recovery - sawmilling - weighted means

Introduction

Within the last two decades, rubberwood has evolved from being relatively unknown to one highly sought after as a principal raw material by the furniture industry, both in Malaysia and abroad. As such, the trees, originally planted for latex, have gained much importance contributing to the competitiveness of local wood and wood based industries.

Production of sawn timber from rubber trees has been studied by a number of researchers (*e.g.* Lopez. *et al.* 1980, Ho & Choo 1982, Gan *et al.* 1985). However, these studies have reported results that varied very widely. For example, recovery of rubberwood sawn timber from sawmills equipped with band saws was reported to vary from as high as 46% (Lopez *et al.* 1980) to as low as 22% (Gan *et al.* 1985). As recovery of sawn timber depends very much on factors such as relative frequency of sizes and quality of logs, besides size and quality of sawn timber produced and sawyer skills, such variations reported are not too extraordinary. Nevertheless, these widely varied results are of limited use to mill management. Although the effects on recovery are well recognised, little or no attempt has been made thus far to categorically study them. Accurate assessment of sawn timber yields is critical to the efficient operation of a mill which determines to a large extent the mill's profitability.

Conventional sampling techniques are difficult to apply in mill studies. Most mills would not entertain properly designed mill studies due to perceived disruptions. On the other hand, a 100% sampling is both unpractical and costly. Moreover, influencing factors such as the distribution of log diameter and sawn

output vary not only between mills but also within a mill. Accurate assessment of sawn timber yields can only be achieved if such nuisance variables can be minimized.

It is therefore useful to categorize the output of sawn rubberwood, and adopt a simple yet accurate approach to assess the yields. This paper describes studies carried out at a rubberwood sawmill in Peninsular Malaysia. A relative frequency weightage approach is proposed to achieve a better assessment of overall average output.

Mill description

The mill was equipped with five band saws without carriages. One of these saws was used as a head rig to break down logs into halves. Logs of diameter smaller than 175 mm (7.0 in) were generally not sawn at the headrig. The other four saws served as resaws, and converted the halves as well as small logs into sawn timber of various sizes. Figure 1 shows a simplified layout of the mill.

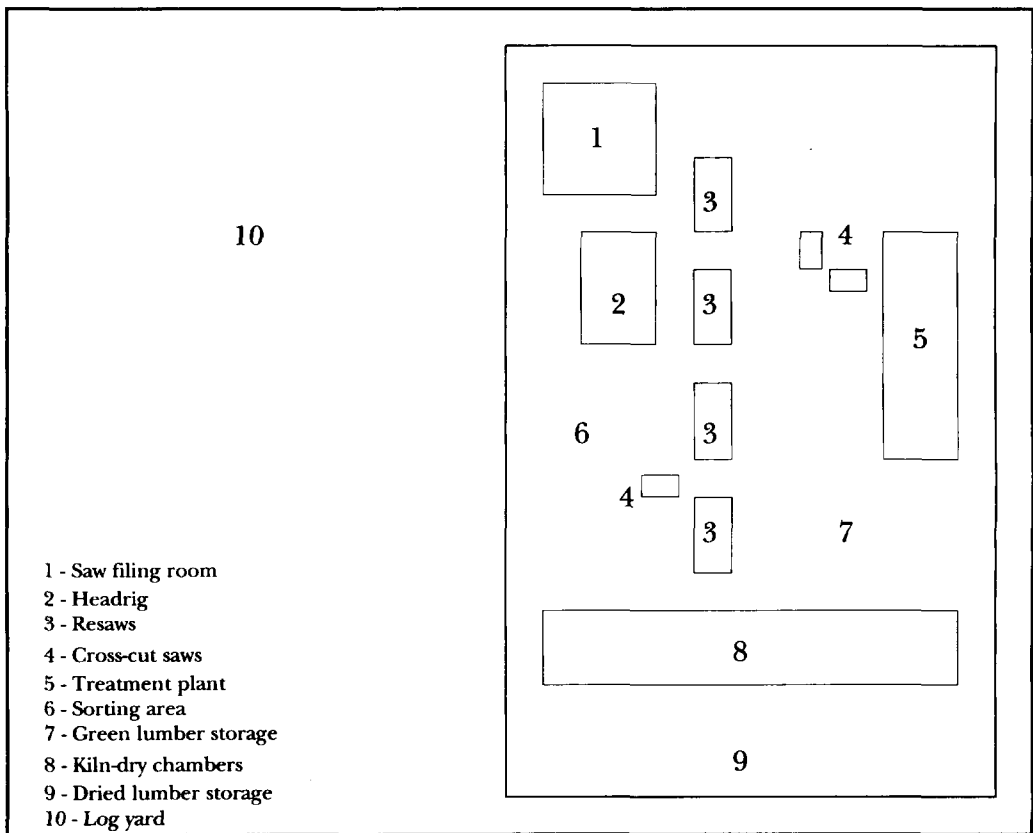


Figure 1. Simplified layout of the study mill

Sawn timbers off the resaws were separated into two batches, one generally free of defects, and the second containing timber having some defective portions. The latter batch was to be cross-cut into shorter lengths of from 0.3 to 1.5 m (1 to 5 ft) to remove most of the defects to upgrade them to the same grade as the full length pieces. The sawn timbers were then tallied according to lengths and sizes. Rubberwood sawn timber is generally being sold in lots of random lengths, as well as random widths.

Study procedures

Diameters of both ends of each log were measured as the logs were being fed to the mill, at the ramp leading to the headrig. Diameter measurements were rounded to the nearest half inch. This is to conform to mill practices where measurements are still in Imperial Units. Since rubberwood logs were all cross-cut to standard 1.8 m (6 ft) length, measuring of length was deemed unnecessary. Each log was also marked at both ends to facilitate tracing the logs through subsequent operations.

As it was costly and impossible to cover all the four resaws simultaneously at the mill, sawn timber tally was recorded at only one resaw. Since all the resaws were fed by the same headrig, and converting flitches to sawn timber according to a single cutting bill, the data collected from a single resaw would be a good representative of all the resaws. In addition, since flitches from a single log might end up at different resaws, sawn timber tally was recorded only for logs which had all flitches processed at the same resaw. This approach would generally filter out variations introduced by different resaws and different sawyers, which otherwise may distort the data. Sawn timber tally and subsequent computation were based on nominal sizes of the lumber which are smaller than the actual sizes (Anonymous 1984). Although this will indicate lower recovery than actually achieved, this approach was chosen to conform to sawmill practices.

Results and discussion

Distribution of log input into the sawmill recorded during the studies and classified by the logs' small end diameters is as shown in Figure 2. To isolate the variations introduced by log sizes, subsequent analysis grouped data into diameter classes according to the logs' small end diameters. The diameter classes comprised three classes of equal class intervals representing about three quarters of the input logs and two classes containing the extremely small and extremely large logs respectively. Likewise, the 12 different sawn timber sizes

produced by the mills were grouped into three lumber size categories based on their thicknesses. Any other means of categorizing the lumber sizes, although may improve the accuracy of the analysis, will result in unpractically large number of categories. The composition of these categories is shown in Table 1.

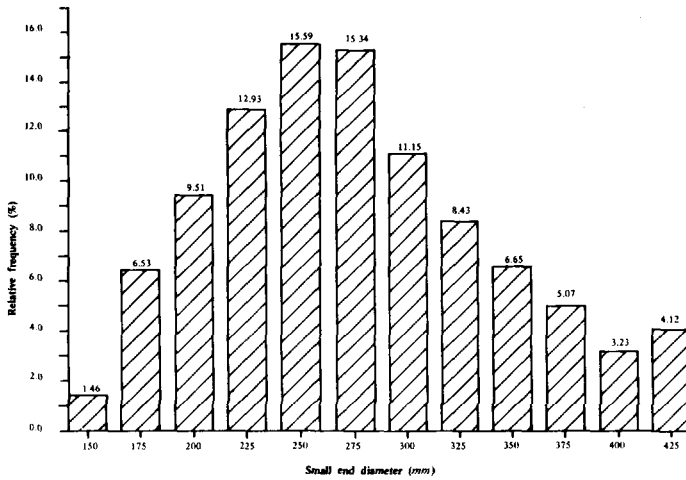


Figure 2. Composition of log input into the mill classified by small end diameters

Table 1. Composition of lumber size categories

Lumber size category	Size of sawntimber included (mm)
Size 1	100 × 100, 65 × 65, 45 × 45
Size 2	30 × 30, 30 × 50, 30 × 75, 30 × 150
Size 3	25 × 50, 25 × 65, 25 × 100, 25 × 125, 25 × 150

The yields of sawn timber per log categorized by diameter classes and size groupings are shown in Figure 3. While there were significant differences (by Scheffe's method at the 0.05 level) for sawntimber output size 1 between all

diameter classes, no significant difference was detected for the other two size groupings. This was mainly due to the usual practice of recovering larger sizes (Size 1) first before attempting to recover other smaller sizes (Sizes 2 & 3) from sawing the logs. As the number of pieces of large sizes that could be recovered from a log is largely governed by the size of the log, the larger the log the bigger will be the volume of Size 1 that could be recovered. A major portion of the large logs were recovered into the 'prime' sizes (Size 1). Small sizes (Sizes 2 & 3) were recovered from the remaining portion. For the smaller logs, very little size 1 lumber could be recovered, hence the major portion had to be converted into smaller size lumber. This contributed to the lack of significant difference between the diameter classes on yields of smaller size lumber. Figure 3 also shows the total volume of lumber that could be recovered from each log categorized by its small end diameter. Average sawntimber output per log varied from 0.01 m^3 (0.36 ft^3) for logs having small end diameter smaller than 200 mm (8.0 in) to 0.08 m^3 (2.74 ft^3) for logs having small end diameter of 350 mm (14.0 in) and larger. Statistical comparison using Scheffe's method indicated the outputs were significantly different at the 0.05 level for all classes except those from logs of smaller end diameter less than 250 mm (10.0 in). These significant differences were introduced by lumber in Size 1 category as the volume outputs in the other two categories did not show any significant difference.

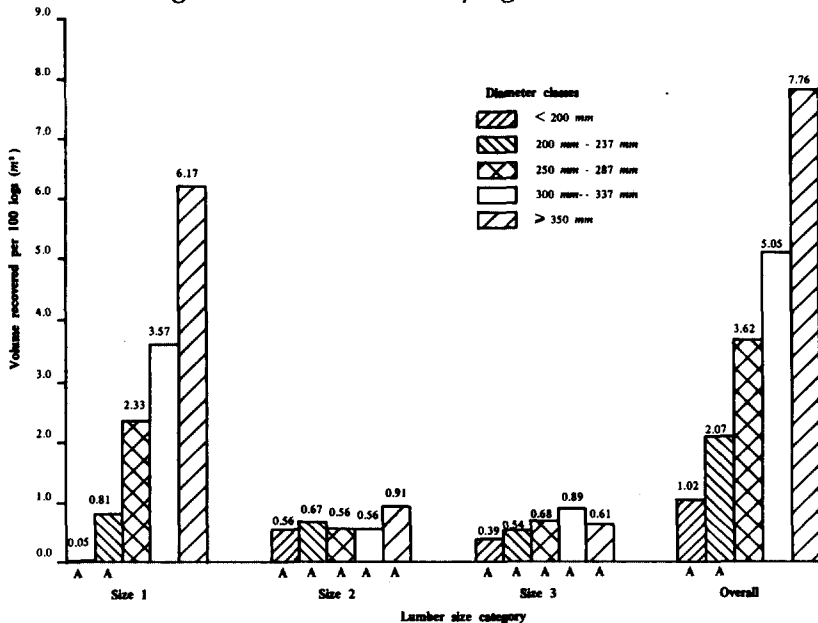


Figure 3. Yields of rubberwood sawn timber categorized by diameter classes and lumber size groupings [bars with the same alphabet(s) within each size grouping are not significantly different by Scheffe's method at 0.05 level]

As logs are typically traded in volumetric units such as m^3 or ft^3 rather than number of logs, the analysis presented above may not be familiar and

understood by sawmill management. Recovery of sawntimber is usually reported as percentage of input log volume, with the log volume computed using Smalian's formula:

$$\text{Log volume} = \frac{1}{2} \left[\frac{\pi (D_1^2 + D_2^2)}{4} \right] L$$

where D_1 is the large end diameter, D_2 is the small end diameter and L is the length of log.

Figure 4 shows the recovery of sawntimber categorised by diameter class and lumber size. Logs of the first two diameter classes (those having small end diameter < 250 mm) have significantly smaller percentage recoveries of size 1 and significantly larger percentage recoveries of Size 2 lumbers. There was, however, no significant difference among the percentage recoveries of Size 3 lumber from logs of all diameter classes. As would be expected, results of comparing the overall recoveries for the diameter classes followed the same pattern as those for Sizes 1 and 2 categories, the no significant difference in Size 3 category had no effect on the overall recoveries. The trends indicated by these results reinforce the explanation presented for the trends suggested by the volume recovered per log.

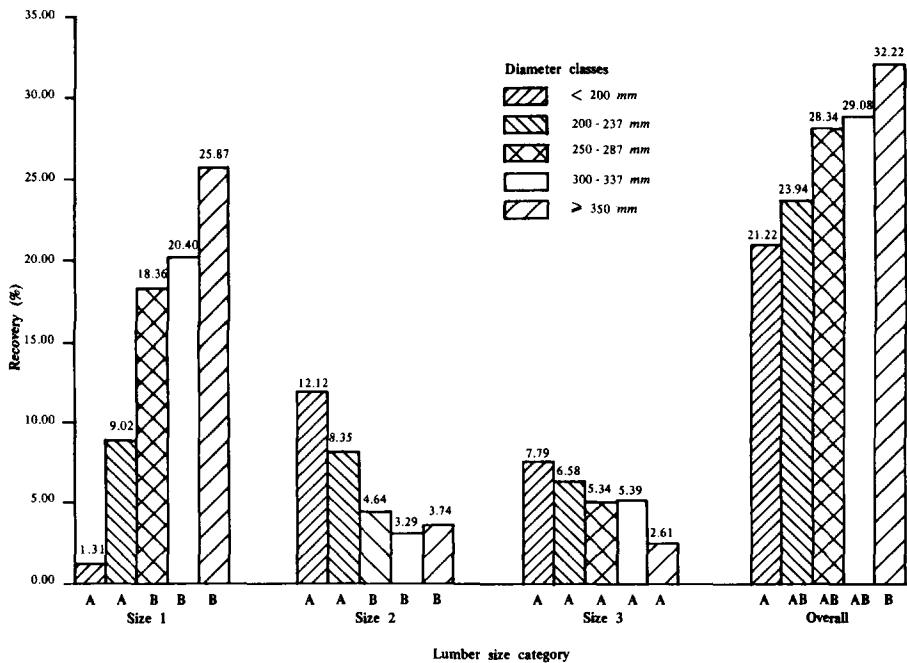


Figure 4. Percentage recovery of rubberwood sawntimber categorized by diameter classes and lumber size groupings [bars with the same alphabet(s) within each size grouping are not significantly different by Scheffe's method at 0.05 level]

Weighted means approach

To compute the average recovery for the mill, a simple average based on total log volume and total sawntimber produced is frequently used by saw millers. This method, although simple to compute, is far from accurate as the sawn timber output depends substantially on sizes of logs as indicated above. Without knowing the frequency distribution of the log sizes such simple estimates can only be accurate for a mill that has uniformly distributed log inputs. Stratified random sampling, which gives a better estimate of means than random sampling (Cochran 1963), would be a good solution to this problem. However, due to the perceived disturbances the mill managers would resist conducting a properly designed experiment. A close approximation to stratified random sampling which would improve the accuracy of estimation of population mean is estimating by summing up the class means weighted with the class relative frequencies (Dixon & Massey 1969). The computation formula is as follows:

Estimated population mean,

$$\bar{y} = \sum_{i=1}^C \frac{N_i}{N} \bar{x}_i$$

where i equals to 1,2,, C , N_i is the total number of logs in the i^{th} class in the population, N is the total number of logs in the population, C is the total number of classes in the population and \bar{x}_i is the sample mean for logs in the i^{th} class.

Table 2. Work example to estimate expected yield using the weighted mean approach

Diameter class frequency (mm)	(1) Relative frequency		(2) Estimated average volume recovery (m ³ /100 logs)	[(1) x (2)] Weighted average volume recovery (m ³ /100 logs)	
				Batch 1	Batch 2
	Batch 1	Batch 2		1	2
< 200	0.20	0.10	0.42	0.084	0.042
200 - 237	0.25	0.15	0.71	0.177	0.106
250 - 287	0.30	0.30	2.27	0.680	0.680
300 - 337	0.15	0.25	2.69	0.404	0.673
≥ 350	0.10	0.20	3.12	0.312	0.623
Weighted total				1.657	2.124

(For conversion to Imperial Units, to conform to normal mill practices, calculate the value by 35.32)

The above formula could be applied to estimate the mean recovery, or yields of certain groups of lumber produced for a batch of logs with known composition (frequency distribution). This approach could be extended to compute expected yields from a batch of logs of known composition using yield data categorized by log diameter and lumber sizes that have been estimated and maintained by the mill. A work example is as shown in Table 2. The example also illustrates the substantial effects introduced by a slight change in the input log composition.

Conclusion

Recovery of sawn timber from rubberwood was found to be significantly affected by sizes of both the logs and sawn timber. Categorizing yields by diameter classes and size groupings could provide a better tool in assisting mill management in production planning and control. Such a data base would assist the mill manager in computing what and how much he would get by sawing a batch of logs of known composition (size distribution), and therefore be able to plan accordingly to build up a desired inventory or scheduling production to meet delivery dates.

Yields of sawn timber categorized by log diameters and lumber sizes could be used together with the weighted means approach to estimate the expected sawn timber output and assist in better planning and control of sawmilling operations.

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