LOGGING INDUSTRY RESEARCH ASSOCIATION
NEW ZEALAND
ISSN 0111-6711
REPORT
Vol. 16 No. 14 1991

OPERATOR LOG MAKING ABILITY ON A MECHANISED PROCESSOR

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ABSTRACT

A comparative study was conducted on the ability of a log maker to manufacture logs on a mechanised tree processor against manual processing at the stump. Value recovery was 1.2% lower with the log-maker on the processor. This difference, although small, was statistically significant. The difference was mainly due to not cutting logs close to diameter limits and inability to detect grade changes along the stem. Fitting a diameter sensor to the processor would improve value recovery.

INTRODUCTION

A Hahn Harvester underwent production trials in Kaingaroa Forest in February, 1990. Besides productivity studies, an important aspect of investigation was log manufacturing performance. The ability of the operator to make the best log making decisions needed to be investigated and compared with manual processing practices.

The Hahn Harvester combines two functions, delimbing and processing, which are performed separately in a conventional New Zealand clearfall operation. Inspection and decision making for log manufacturing on the Hahn Harvester occurs under different conditions to normal landing work.

- The operator is not as close to the stem and therefore is unable to inspect the stem as thoroughly.
- Dimensions of knots, sweep, nodal swellings, kinks and wobble must be estimated, whereas on the ground they can be measured.
- On the machine studied there was no diameter sensor, although this option is available.
- The operator completes the delimbing function simultaneously with log manufacturing. Compared with log-making at the landing, the operator must perform other functions to control the machine, making his job more complex.
- Production is higher with less time for inspection and decision making, thereby increasing the risk of error.

Forest Research Institute (FRI) work study in transition crop radiata in Compartment 1036, has shown that 1.79 minutes was the mean time to mark and measure 4.2 logs from a tree of $1.97m^3$. This equates to $66m^3$ per productive machine hour (PMH). Other landing workers perform cutting and trimming. This element time was 2.23 minutes per stem or 53 m^3 per productive hour.

Production studies on the Hahn Harvester, conducted in Compartment 1036 prior to the log manufacturing study, measured total processing time as 1.29 minutes per stem (Hill 1990). Processing time in the Hahn study included delimbing and log manufacturing.

As in manual log making, the operator of a mechanised processor must make the best decisions. In addition, length cuts should be made within specified tolerance limits whilst causing minimal damage to logs.

Length specifications usually require that logs be within $\pm$ 5cm of allowed length. Analysis of data from a previous study by Cossens and Murphy (1988) showed that this was achieved in 92.4% of logs when skidworkers manufactured logs on a landing. Logs were on average 0.84cm longer than nominated length with the standard deviation of length errors being 2.51cm. Previous studies of harvesters operating in radiata pine clearfall in Australia showed that two Scandinavian harvesters produced 79% and 85% of logs within $\pm$ 5cm (C. Terlesk and A. Johansson pers comm). MacDonald (1988) reported a Steyr processor achieving 83% of logs within the $\pm$ 5cm tolerance.

In a study of a group of log makers, Cossens and Murphy (1988) found that 81% of the logs met specifications as assessed by the AVIS system (Assessment of Value by Individual Stems, Geerts and Twaddle 1985).

The objectives of the study were to:

- Compare value recovery from log manufacturing at the stump with log manufacturing by using the Hahn Harvester and identify reasons for differences.
- Measure length variation of logs produced from the Hahn Harvester.
- Measure degrade to sawlogs caused by machine damage.

ACKNOWLEDGEMENTS

LIRO acknowledges Tasman Forestry Limited and the contract crew of Mr. Vern Tuck for their assistance with this study.

METHODS

A paired comparison was made of the ability of a log maker to correctly inspect and select log products for forty nine trees whilst on the ground and whilst being processed by the Hahn Harvester. Trees were selected from those already felled in Compartment 1036 Kaingaroa Forest. These trees were cruised by the AVIS method. Relative log values supplied reflect the demand for log products and not true sales prices. Log values given by the forestry company were scaled to levels that approximate market prices for log grades at the "loaded on truck" point of sale.

The log-maker marked and measured forty nine stems at the stump before they were delimbed. Log grades and lengths marked were recorded. All markings used by the log-maker were removed prior to extraction.

Butt pieces were hauled to the landing and processed through the Hahn Harvester. Broken top pieces were excluded from the study.

A skilled machine operator and the same log-maker who carried out the log making at the stump, occupied the cab. The log-maker gave verbal instructions to the operator on what log products to make and where to make cuts. After each tree was processed into logs, length, small end diameter and log grade were recorded. Optimal solutions found using the optimal log making algorithm AVIS were compared against cutting strategies recorded at the stump, and after processing through the Hahn.

Estimated value losses calculated by AVIS were compared using a paired t-test.

Machine damage was measured by recording either the length of stem wood that would need to be docked (to waste) to bring the log to acceptable sawlog quality, or down-grading the log to the highest value alternative log grade if no sawlog could be manufactured. From this, volume and value losses were calculated.

RESULTS

The mean piece size of the forty nine extracted butts was 1.87m^3. The mean stem length of 25.74m is equivalent to height to the first break point.

Volumes of each log grade were very similar. However, numbers of logs produced differed (Table 1). Fewer sawlogs produced by the log maker on the Hahn indicated that he cut longer logs than at the stump.

	Sawlogs	Pulp	Waste
Stump (m3)	82.40	7.71	1.26
Number of Logs	133	39	34
Hahn (m3)	82.35	7.53	1.33
Number of Logs	125	43	36

Table 1 - Volumes and Log Numbers by Log Grade

Value

Paired t tests were conducted for mean value difference per stem (Table 2). Two tailed probability indicates the chance that two means are the same. A value less than 0.05 is considered statistically significant. Table 2 shows that there is a significantly higher value of logs manufactured at the stump than on the processor. The value difference averaged 1.2% over all stems.

	Mean Value Loss $/stem	t statistic	Probability (two tailed)
At stump	3.58	2.15	0.036
Hahn	6.18		

Table 2 - Pared t Tests on Value Losses

Of the forty nine stems studied, twenty four were cut to the same pattern on the Hahn as at the stump (Table 3). Four stems were cut to a higher value on the Hahn than at the stump through sawlog material being down-graded to pulp at the stump. The remainder (twenty one) were cut to a lower value on the Hahn. Eleven of these twenty one stems had sawlog quality wood down-graded to pulp, the principle reason being not cutting as close as possible to diameter limits. Upgrading of pulp material on the Hahn occurred on five stems mainly because of lack of recognition of changes in stem quality (e.g. butt defects, stain, branch size). Although length errors were not penalised, the impact of not choosing the best cutting pattern as a result of length errors caused reduced value on the Hahn in five cases.

	Stems (%)	%
Stems cut the same	24	49
Stems cut to higher value	4	8
Stems cut to lower value	21	43
TOTAL	49	100

Table 3 - Comparison of Stem Cutting Patterns

Checks by the AVIS software gave thirty eight log specification errors amongst logs cut in the bush and thirty seven on the Hahn. Reasons for logs being out of specification are given in Table 4.

	Stump	Hahn
Diameter	14	8
Quality	18	18
Sweep	4	3
Multiple	2	8
TOTAL ERRORS	38	37
Total Logs	133	124
% out of spec	29	30

Table 4 - Causes for out-of-Specification Logs

Length Accuracy on the Hahn

Where possible, lengths of unpruned and pruned sawlogs were recorded and compared with nominal lengths. The length measuring instrument on the Hahn can only measure accurately log lengths greater than 4.3m. After this the operator must estimate log length prior to cutting.

For this reason two group means were calculated, one for average variation of all sawlogs and one excluding sawlogs below 4.3m in length (Table 5).

The distribution of length errors for sawlogs greater than 4.3m is given in Figure 1. Eighty three percent of logs were within the allowed length tolerance of ± 5cm. More logs were found to be over-length (sixteen) than under-length (three).

	Sawlogs >4.3m	All Sawlogs
Mean Deviation (cm)	2.87	2.57
Standard Deviation	3.61	3.78
Number of Logs	105	112

Table 5 - Length Variation

Machine Damage

All pruned and unpruned sawlogs were assessed for damage caused by the machine. From the forty nine tree sample only four logs had machine damage serious enough to warrant rejection or downgrading, a loss of 0.45% in volume of sawlog material or 0.41% of the total value.

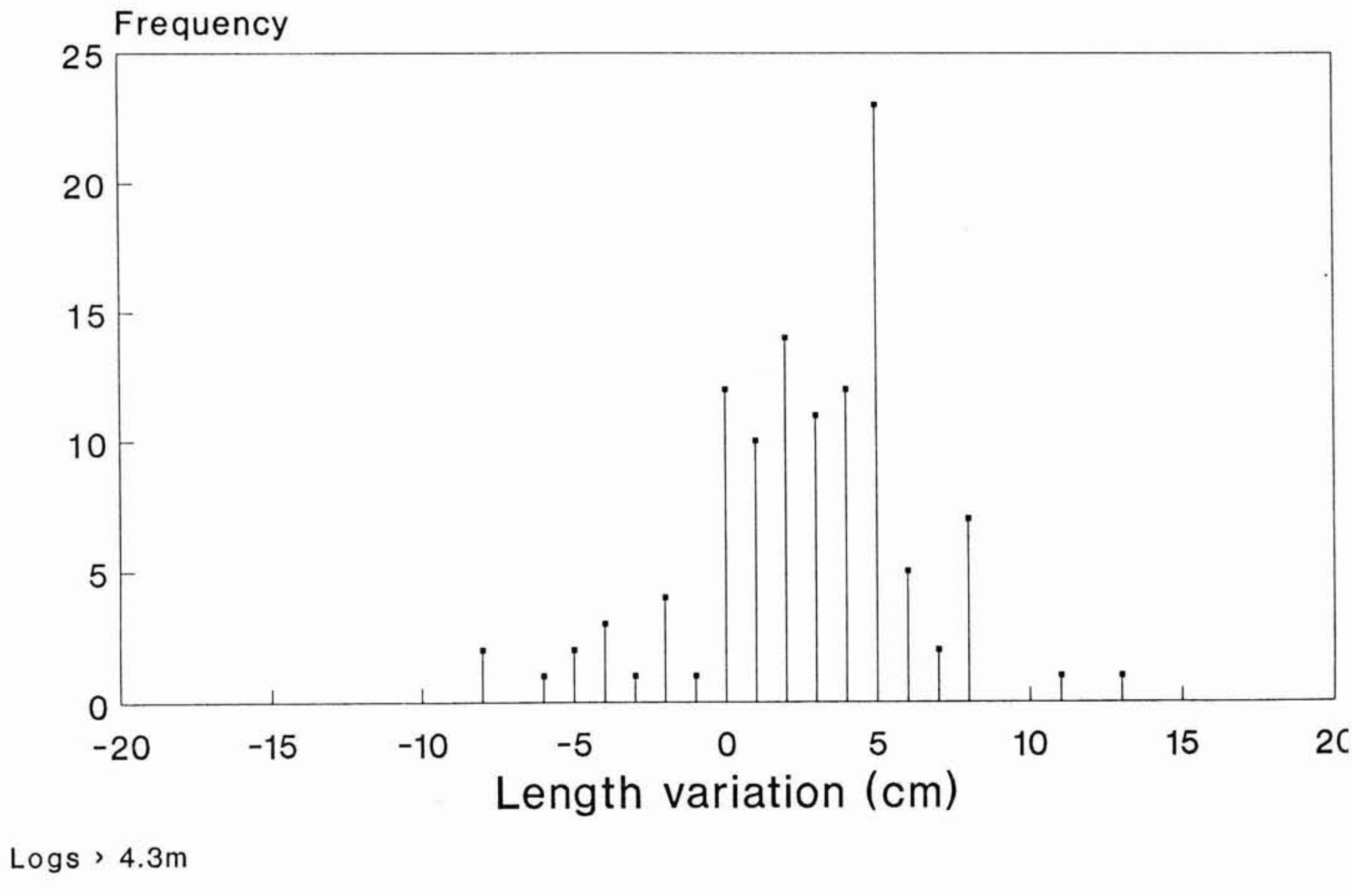

Figure 1 - Log Length Variation

DISCUSSION AND CONCLUSIONS

Considering that the Hahn Harvester is a relatively new machine in the New Zealand logging scene and the trial was undertaken whilst the machine was still being introduced, the level of value recovery was high and comparable to levels observed in other operations (Cossens and Murphy 1988). The results of this study should be viewed as preliminary. If the opportunity arises, the study should be repeated using a operator who is both skilled in log making and machine operation.

One common cause of reduced value recovery by the log maker on the Hahn Harvester was failure to maximise sawlog recovery by cutting as close as possible to sawlog diameter limits. In general, the log-maker on the Hahn was conservative in estimating small end diameter. Addition of a diameter sensor would improve the ability to recover more valuable log grades. Further economic analysis would be required to indicate whether addition of such a device is justified.

Comparison of cutting patterns for individual stems suggests that grade changes along the stem, which were detected during log making on the ground, were sometimes missed by the log- maker working on the processor.

Machine damage caused minimal downgrading amongst the small sample of logs observed. Damage to logs was mainly caused by the action of the delimbing knives. Operator skill could have a large effect on machine damage. Observation over a longer period may show different results as vigilance may decline under non-study operating conditions.

The accuracy of log length cutting of the Hahn Harvester operator differs from that observed with manual marking and measuring. The Hahn Harvester operator cut logs about 2cm longer than has been found in previous studies of manual operation. Variation is also slightly greater on the Hahn harvester. Fewer logs were within length specifications than has been observed in manual measuring and cross-cutting. The proportion of logs produced by the Hahn Harvester within the ± 5cm length tolerance is similar to that documented for other processors.

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