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THE BELL LOGGER—BUNCHING PRODUCTIVITY BEHIND MECHANISED AND MOTOR MANUAL SYSTEMS

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ABSTRACT

Two Bell Loggers were studied while they bunched thinnings behind both a conventional motor-manual felling operation and a mechanised processing operation.

Bunching productivity was significantly higher behind the mechanised operation. Malformation can substantially reduce bunching productivity through its effect on piece size in a mechanised operation. A comparison with previous studies shows bunching productivity has increased.

INTRODUCTION

The Bell Logger has been in use in New Zealand since 1980 for bunching smallwood. Since then, minor modifications to the machine, improved operator technique and overall streamlining of the "system" in which it works, have increased the reported bunching productivity of this machine (Gleason, 1985).

This brief Report quantifies the bunching productivity of two Bells in a radiata pine thinning operation in Kaingaroa Forest. It describes the two systems and how the study was carried out, presents the results and draw conclusions.

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* Harry Ashby was a third year B For. Sc. student working at LIRA during the 1987/88 summer vacation.

Figure 1 : Bell Logger bunching logs processed by Lako 3T harvester in an outrow system

ACKNOWLEDGEMENTS

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THE OPERATION

The operation incorporated two different processing systems:

- a mechanised system with a Lako 3T harvester (Raymond et al, 1988)

- a motor-manual system where six chainsaw operators, using conventional motor-manual techniques, felled and delimbed in an adjoining stand.

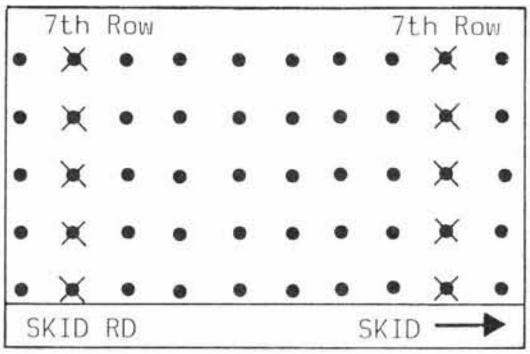
In both systems, two Bell Loggers bunched for extraction by a Clark 664 grapple skidder. The bunches were sorted and stacked on the landing into long pulpwood and short pulpwood by a third Bell Logger. A seventh-row outrow system facilitated harvesting by the Lako, bunching by the Bell Loggers and extraction by the skidder, with minimal damage to the final crop. The outrow system was less strictly adhered to with the motor-manual system. The felling, bunching and extraction patterns are illustrated in Figure 2. The three main activities (felling-processing, bunching and extraction) were out-of-phase to minimise interference.

The Bell Loggers were less than two years old with strengthened booms and square sectional framing. Additional protection for hydraulic hoses and wheel chains were fitted. Both operators were experienced; stand and terrain conditions were generally well suited to the machines.

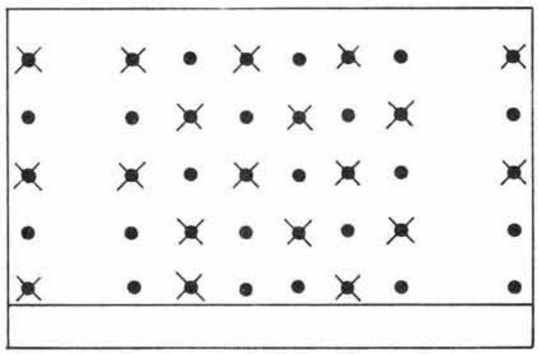
STAND CHARACTERISTICS

In Compartment 1059 (motor-manual system), the terrain was flat and conditions easy. In Compartment 1058 (mechanised system), windrows from the previous crop made conditions more difficult (Table 1).

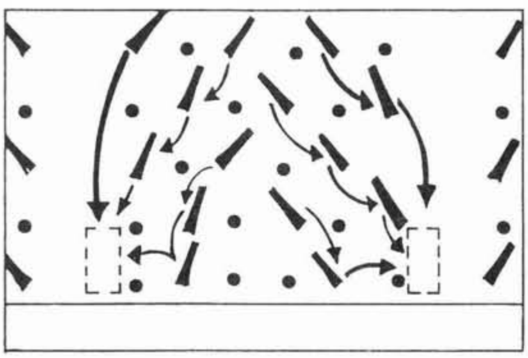
The two stands were established in 1972 at 1700 sph but had slightly different thinning treatments. At age 6, the stands were thinned down to 482 sph (Compartment 1059) and 625 sph (Compartment 1058). This difference in stocking is one reason for the significantly larger piece size in the motor-manual system (0.31 m^3 vs 0.24 m^3). The major reason is the way the Lako processed malformed and heavily branched trees, producing two pieces for extrac-



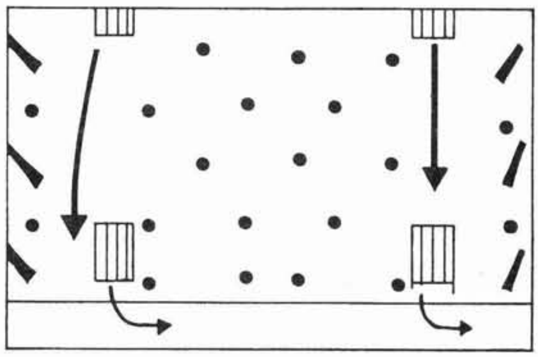
(a) Seventh-row Outrows



(b) Thinnings to be harvested



(c) Bell Bunching into Outrows



(d) Extraction Pattern

Figure 2 : Thinning Pattern used in study

TABLE 1 : STAND DATA FOR TRIAL AREAS

	MECHANISED SYSTEM	MOTOR-MANUAL SYSTEM
Stand age (years)	15	15
Stocking - Initial (sph)	726	614
- Final (sph)	284	256
Mean extracted piece size (m^3)	0.24	0.31
Slope (degrees)	0-5	0-2
General description	Flat but with intermittent windrows	Flat with generally easy conditions

tion and giving a smaller average piece size. The incidence of malformation (double leaders) in these stands was estimated to be around 15%, based on data from similar stands.

STUDY METHOD

Continuous time study was carried out. Each cycle was taken as the time required to travel, acquire and build a bunch.

Delays (mechanical, operational and personal) were recorded but excluded from the calculations of productivity. The large-end diameter over bark (ledob) was measured and recorded for each piece bunched. Piece size was calculated from a regression of volume on large-end diameter, and hence volume per bunch.

RESULTS AND DISCUSSIONS

Operator Differences

Two experienced operators were studied. Although one operator had significantly lower acquire times, there was no significant difference in total bunch time between the operators within each system. Neither was there any significant operator difference in average number of logs per bunch, average bunch size, number of pieces handled per productive machine hour (PMH), nor maximum distance travelled.

System Differences

A comparison of bunching productivity behind the two systems was made using the weighted averages of element times. The data on element times, piece size, bunch size and bunching productivity is summarised in Table 2.

Bunching cycle times behind the mechanised system were 8% faster. This was due to significantly shorter acquire times, a result of partial bunching by the Lako. The crane-mounted processing head could usually reach several trees from the one position. This partial bunching also increased the number of pieces acquired by the Bell (from 1.9 to 2.2 pieces).

As bunch sizes were similar, the smaller piece size produced by the Lako meant 20% more pieces were needed. Another contributing factor to faster acquire times was the better visibility of logs for the Bell operators behind the Lako. This arose from the Lako's ability to directionally fell trees. Motor-manual felling direction depended on tree lean and some logs needed to be turned before bunching (for butt-first extraction).

Bunching productivity was 30% higher behind the Lako in terms of pieces/PMH but only 2% higher in terms of m^3/PMH as a result of the difference in piece size.

TABLE 2 : BUNCHING PRODUCTIVITY BEHIND MOTOR-MANUAL AND MECHANISED SYSTEMS

ELEMENT	MOTOR-MANUAL	MECHANISED
Travel Empty	0.74	0.80
Acquire	1.46	1.21
Travel Loaded	0.93	0.84
Reposition	0.69	0.78
Clear Slash	0.18	0.08
Cycle time (mins/bunch)	4.00	3.71
No. of Pieces/Bunch	7.00	8.40
Ave. Processed Piece Size (m^3)	0.31	0.25
Ave. Bunch Size (m^3)	2.20	2.10
Bunching Productivity (pieces/pmh)	105	136
Bunching Productivity (m^3/pmh)	32	33

Note: All delays excluded

In Table 3, productivity is adjusted to a standard 0.3 m^3 piece size for both systems. This is illustrated in Figure 3(a) and shows this 30% difference. The effects of malformation, in producing 15% more pieces, drops this difference to 10%. This is shown in Table 3 and Figure 3(b).

COMPARISON WITH OTHER PRODUCTIVITY DATA

A comparison of Bell Logger bunching productivity with earlier studies, is summarised in Table 4. It covers a wide range of initial and final crop stockings and a narrower range of piece size. Most studies were carried out at Kaingaroa Forest.

TABLE 3 : BUNCHING PRODUCTIVITY ADJUSTED FOR PIECE SIZE AND MALFORMATION

	MOTOR-MANUAL	MECHANISED
Bunching productivity (m^3/pmh) for 0.30 m^3 piece size	32	41
Daily production for 0.3 m^3 piece size (m^3)	208	267
Bunching productivity (m^3/pmh) for 0.30 m^3 piece size, adjusted for malformation (see Notes)	32	35

Notes:

1. *Average piece size of 0.3 m^3 in the motor-manual system corresponds to a processed piece size of 0.26 m^3 in the mechanised system, with an incidence of 15% of malformation.*
2. *Daily production assumes a work day of 6.5 productive machine hours*

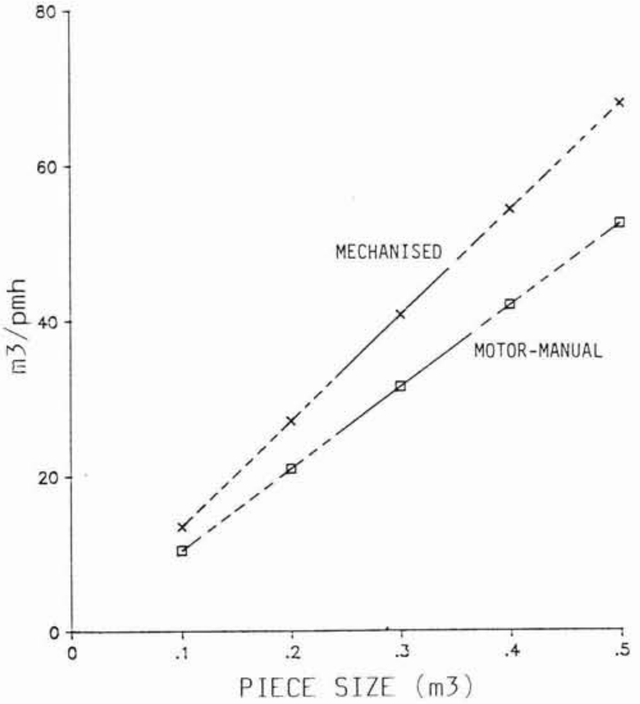


Figure 3(a) : Bunching Productivity System Difference - Same Piece Size

__Note__: Dotted lines indicate range of piece size in stand

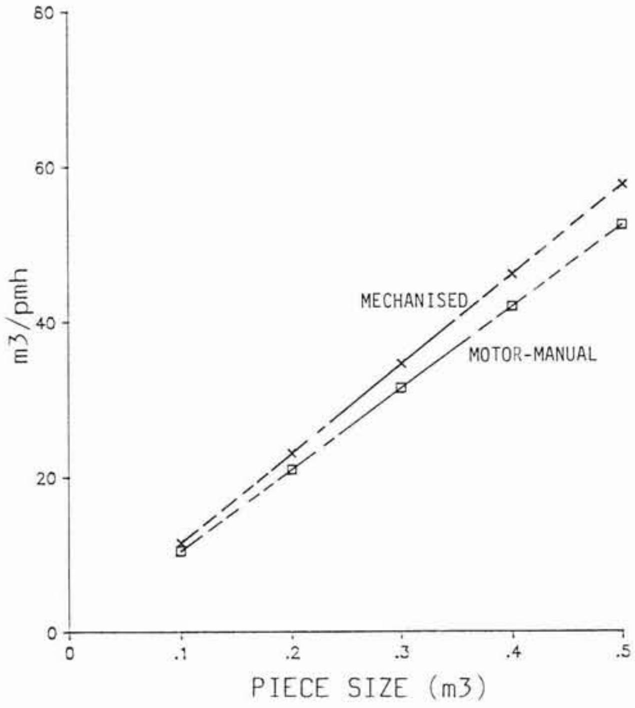


Figure 3(b) : Bunching Productivity System Difference - 15% Malformation

__Note__: Dotted lines indicate range of piece size found in stand

__TABLE 4 : COMPARISON OF BELL BUNCHING PRODUCTIVITY__

	EARLIER STUDIES							RECENT STUDIES		
CHARACTERISTIC	1	2	3	4	5	6	7	8	9	10
Ave Piece Size (m^3)	0.16	.19	.17	.15	.15	.29	.26	.35	.31	.24
Stocking - Initial	950	550	590	630	535	600	550	645	613	726
(sph) - Final	425	200	235	305	345	375	250	250	256	284
Cycle Time	15.46	7.93	8.15	7.89	9.58	4.74	9.34	3.56	4.00	3.71
Bunch Size (Pieces/Bunch)	20.3	12.2	12.3	11.9	12.0	6.3	8.9	7.8	7.0	8.6
Bunch Size (m^3)	3.34	2.76	2.13	1.75	1.84	1.83	2.30	2.35	2.17	2.05
Productivity (Pieces/PMH)	79	92	91	90	75	79	57	131	105	136
Productivity (m^3/PMH)	13	17.1	15.7	13.3	11.5	23.2	14.8	39.6	32.6	33.2

** Mechanised processing with lako reduced piece size from merchantable tree size of 0.3 m^3*

__STUDY__ 1 Gleason, A.P.; Stulen, J.A. (1984) : "Prebunching in Thinnings". LIRA Report. Vol 9 No 3

2-5 McConchie, M. (1984) : "Production Thinning 12 Year P. Radiata in Kaingaroa Forest". Unpublished FRI Report

6-7 Gleason, A.P. (1984) : Unpublished LIRA data

8-10 Ashby, H. (1988) : Unpublished data

Bell Logger bunching productivity in this study was found to be significantly higher than recorded in previous studies. These earlier studies involved bunching for extraction with cable skidders. This required the Bell Logger to build a bench (to assist stropping on) and increased cycle times by around 20% (Gleason, 1985).

In this study, the use of an outrow system assisted bunching productivity. The outrows are generally clear of debris, high stumps and slash. The Bell Loggers can travel quickly along the outrow, especially when extracting backwards, as operators do not need to check for obstructions. A good standard of directional felling assisted extraction, as few logs required turning before bunching, particularly behind the Lako. The use of out-of-phase operations minimised interference between the Bell Logger and the fallers, Lako or the skidder. The generally flat conditions were well suited to the Bell Loggers. The bunching productivity dropped rapidly on sloping or broken terrain. Larger logs (up to 0.5 m^3) posed few problems in handling, as the Bell Loggers were not usually required to turn them.

CONCLUSIONS

The Lako harvester greatly increased Bell bunching productivity over a conventional motor-manual system. This was attributed to partial bunching of logs during processing, the use of an outrow system, good directional felling, and improved visibility of logs.

The Bell Logger can only maintain these higher levels of productivity in very good conditions. This requires flat terrain, good directional felling, out-of-phase operations, an outrow system and grapple skidder extraction.

Increased in bunching productivity behind a mechanised processing system can be lost if malformation levels exceed 15%. The highest levels of production will be achieved in stands with least malformation.

Comparison with previous studies behind motor-manual felling shows significant increases in bunching productivity. This is due to the use of an outrow system, better directional felling techniques and the use of a grapple skidder for extraction.

REFERENCES

Gleason, A.P. (1985) : "Bell Logger Operations Manual". LIRA

Raymond, K.A.; McConchie, M.; Evanson, T. (1988) : "Tree-length Thinning with the Lako Harvester". LIRA Brief Report Vol 13 No 11.

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