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MECHANISED FELLING WITH A BELL LOGGER

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Figure 1 - Bell Logger felling and bunching on Matakana Island

INTRODUCTION

Feller-Bunchers have proven to be an effective method of harvesting small trees on easy terrain (Ref. 1). Their advantages include :

- increased productivity and safety
- the ability to cut low stumps which improves the extraction phase and maximises recoverable volumes
- the ability to bunch trees for optimum payload extraction.

One disadvantage of large felling machines in thinnings is their restricted manoeuvrability, especially in highly stocked stands. An alternative is the use of smaller machines better suited to the tree size. The Bell Logger has proven to be an extremely versatile logging machine, capable of felling, bunching, extracting, sorting and loading. It is a small, highly manoeuvrable machine and is well proven in both clearfelling and thinning operations throughout New Zealand (Refs. 2 and 3).

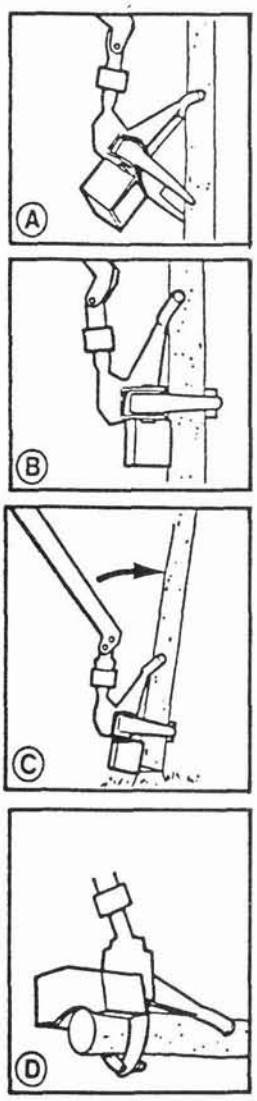
This Report describes a study of a Bell Logger, fitted with a saw felling head, operating in a production thinning operation on Matakana Island.

ACKNOWLEDGEMENTS

LIRA acknowledges the assistance of the contractor, Gary Lett, and his crew, the Matakana Island staff of N.Z. Forest Products Limited and W.L. Gracie and Associates Limited.

THE MACHINE

The Bell Logger studied was a Model 120, fitted with Trelleborg T 414 wide tyres and a Hultdins F45 felling grapple. A new boom had been built which was shorter than the standard boom. Modifications to the felling head included a shortened grapple bar and guarding around the rotator. Operation of the grapple is shown in Figure 2.



The felling grapple is advanced toward the tree and knuckled in.

The grapple is then slid down to the base of the tree. By adjusting the rotator, trees can be felled at any angle in front of the machine.

Co-ordinated cutting and lifting brings the tree off the stump.

The tree is then extracted to the bunch. The grapple can be used for bunching, extracting or fleeting.

Figure 2 - Operation of the Hultdins F45 Felling Head

STAND AND TERRAIN DETAILS

The operation studied was a production thinning of 16-18 year old unthinned radiata pine regeneration (total stocking 3520 sph), on rolling flat sand country (see Figure 3).

Figure 3 - Stand Conditions

Stocking and piece size in these overstocked stands were highly variable. The stocking of merchantable stems averaged 405 sph, with an average butt diameter of 19.5 cm. Extracted piece volumes ranged from 0.22 - 0.43 m^3, with a mean merchantable piece size of 0.28 m^3. A large number of unmerchantable stems (2740 sph) were removed by the Bell Logger prior to extraction thinning.

THE SYSTEM

The sequence of steps in the operation is described below :

1. Outrow Cutting

The operation was a combined outrow and selection thinning, where an outrow was cut to provide access for both the Bell Logger and the extraction machine. The Bell then extracted the stems from the outrow directly to the landing for further processing.

2. **Stand Cleaning**

This operation involves the Bell felling all non-merchantable stems and removing them from the work face. This is necessary to prevent traction problems for the Bell while felling and bunching.

Felling

In this operation no marking of crop stems was carried out. The dominant stems formed the residual crop (target 375 sph). The Hultdins felling grapple left low stumps (less than 10 cm) which assisted mobility and reduced wear on the skidder.

4. **Bunching**

The Bell either felled and bunched each stem or cut two or three stems prior to bunching. Merchantable stems were assembled into bunches averaging 1.9 tonnes (7-11 pieces per bunch). Bunching times were high dependent on piece size and stocking throughout the stand.

5. **Delimbing**

One or two trimmers delimbed the bunches and headed off the stems at an 8 cm diameter by chainsaw.

6. **Extraction**

The trimmed bunches were extracted by a Tree Farmer C7T skidder which collected two to three bunches per cycle. The skidder operated one or two days behind the Bell to eliminate interference delays. The Bell operated seven days per week, while the skidder alternated between extracting thinnings (two days per week) and an adjacent clearfelling operation.

PRODUCTIVITY

Analysis of the productivity of the machine was divided into two parts :

Firstly, the machine was observed in normal operation over a 3.33 hour period. During this time, 67 merchantable stems were felled and bunched. This gave an average cycle time of 2.98 minutes per tree (20.1 merchantable trees per hour).

Operating on a $7\frac{1}{2}$ hour day, with a mean merchantable piece volume of 0.28 m^3, production is calculated at 42.3 m^3/day.

Note the above cycle times include delays and slash removal.

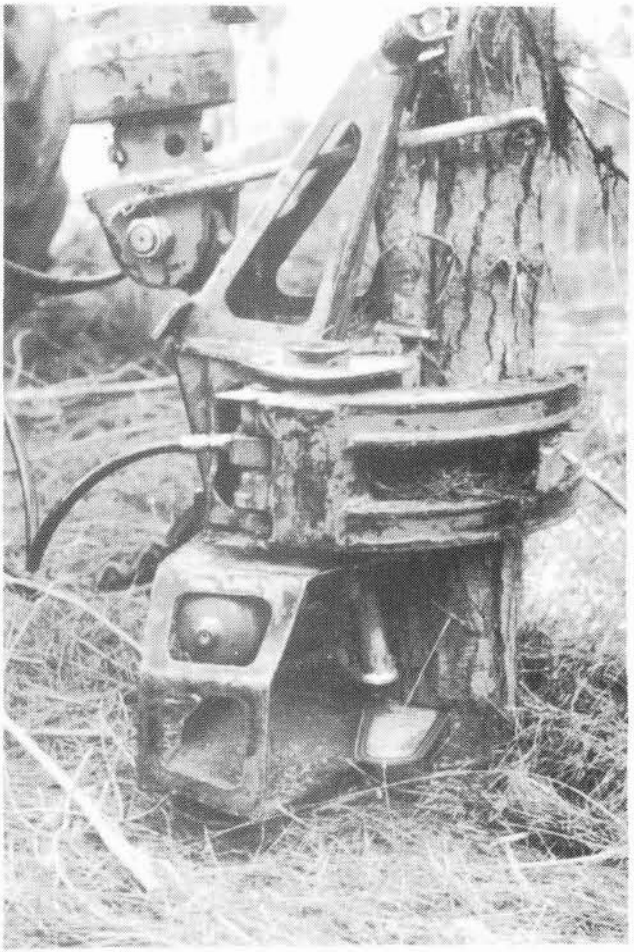


Figure 4 - Hultdin's F45 felling grapple

Delays, including; personal, getting stuck, saw chain sharpening, repairs and adjustments, accounted for 13% of scheduled machine hours. The occurrence of a thrown saw chain was the first since the machine had started operating (1000 hours). Time taken to replace the chain was only 8.0 minutes. The frequency of other delays was estimated. The saw chain was sharpened two to three times daily, and replaced every three weeks. The saw bar was normally replaced after three months, and hydraulic hoses replaced approximately once every fortnight.

Over a $7\frac{1}{2}$ work hour day, 13% delays amount to one hour lost time, reducing to 6.5 productive hours per day.

Secondly, in an attempt to estimate the potential productivity of the machine in more typical conditions with less unmerchantable stems, detailed work study was then undertaken for a period of approximately three hours. Times were recorded only when the machine was felling and bunching merchantable stems (no cutting and removing slash). (During the normal operation (20.1 trees/hour), approximately 30% of the cyle time was spent cutting and removing slash).

A summary of this work cycle is given in Table 1 :

Table 1 - Bell Logger felling and bunching work cycle

Element	Mean Time per Cycle (min)	% of Total Time
Travel/select	0.15	15
Move in	0.23	22
Fell	0.13	13
Remove hangup	0.08	8
Bunch	0.42	42
Total	1.01 mins	100%
(95% confidence interval	0.83 - 1.20 mins)	

Under the conditions in which the machine was studied, expected productivity would average 59.4 stems per productive hour (16.6 m^3/hour). This gives a potential daily productivity over a $6\frac{1}{2}$ productive hour day of 108 m^3/day (range 91-132 m^3/day).

COSTING

The cost of the Model 120 fitted with the Hultdins F45 felling grapple is $75,000. Using the LIRA Costing Handbook (Ref. 4) the estimated cost of owning and operating the machine would be $160 per day, plus $125 per day for the operator. Over a 6.5 productive machine hour day, this cost equates to $43.80 per operating hour.

DISCUSSION

Observation of the actual work showed current productivity to be 6.5 m^3 per productive machine hour, giving a cost of felling and bunching of $6.70/$m^3$.

In more typical conditions (e.g. lower initial stocking and no slash removal), it is expected that productivity would increase to 16.6 m^3/PMH, at a cost of $2.60/$m^3$. Other major influences on productivity observed in this study were; soil and terrain conditions and operator skill. Mobility and travel speeds for the Bell in these soils are reduced in summer when the sand is loose and dry. Ground conditions are generally improved when sandy soils are wet. Operating on more stable soils should therefore increase productivity.

The Bell operator had approximately 500 hours experience on the machine and had adapted to the adverse stand conditions. It is expected that the level of skill and motivation of the Bell operator has significantly influenced productivity.

LIRA NOTE

This evaluation describes equipment and systems that are in a state of development. Further modifications to work methods are being undertaken and the productivity and cost estimates are only indicative. LIRA will continue to monitor and report on further developments of the various Bell Logger models.

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Wells, G.C. "Costing Handbook for Logging Contractors", LIRA 1981.

The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are only an indicative estimate and do not necessarily represent the actual costs for this operation.

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