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THE HARRICANA STROKE DELIMBER IN RADIATA THINNINGS

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ABSTRACT

A study of a Harricana stroke delimber working in a radiata pine thinning operation indicated that 60 trees could be processed per hour. This rate was achieved over a range of conditions in a piece size of 0.4 m^3.

The delimber worked in both a mechanised "hot deck" system in conjunction with a Bell feller buncher and Cat 518 grapple skidder, and from stacks "cold decked" to the landing.

INTRODUCTION

There has been considerable interest over the last few years in the introduction of mechanised systems to New Zealand. The requirements for successful mechanical delimbing have been well documented (Gordon, 1980; O'Reilly, 1980; Cochrane et al, 1983).

Previous studies of mechanised operations for New Zealand emphasised the successful delimbing of wood of less than 0.35 m^3 piece size, where motor-manual techniques are very expensive. (Gleason, 1982).

In late 1986 and early 1987, two models of stroke delimber were introduced to New Zealand: a Denis and a Harricana. For these delimbers to be accepted by the logging industry they must be proven in both radiata pine thinning and clearfelling operations.

The objective of this study was to undertake a short term evaluation of one model of stroke delimber, the Harricana, in radiata thinnings. The machine's merchandising capability was not studied, as this is generally not a requirement in radiata pulpwood operations.

ACKNOWELDGEMENT

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THE MACHINE

The delimber studied was a Harricana HM-1290-50 stroke delimber mounted on a Caterpillar 215B Special Applications excavator base. The Harricana stroke delimber consists of a standard 50' (15.2 m) boom, giving an effective stroke of 35' (10.7 m).

The delimber uses two chainsaws; one for butt trimming and a topping saw for cutting to length. The rear trimming saw has a 26" bar and is positioned behind the rear (fixed) grapple. The front saw has a 21" bar and both saws run .404 pitch chain. Both saw bars are solid nosed, lubricated from the main hydraulic tank.

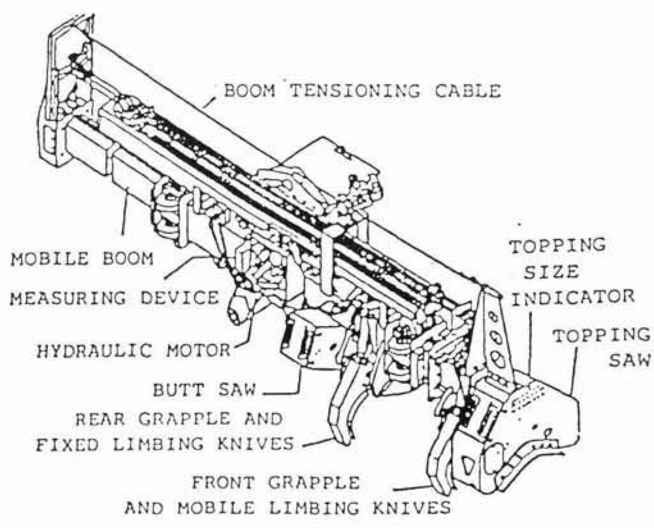

Figure 1 - Harricana delimbing head assembly

Options fitted to the delimber included; a larger main boom hydraulic motor (80 cu. in), a computer length measuring device and a topping size indicator. Modifications to the machine to suit New Zealand conditions included; extensive guarding to hydraulic fittings, extra counterweight for the base unit, and the conversion of the rear grapple to handle larger trees (up to 65 cm diameter). This latter modification involved fitting larger grapple arms and larger hydraulic cylinders.

The excavator is powered by a Cat 3304 diesel engine (85 hp) mounted on a standard Cat 225 track base. Hydrostatic drive with indepedent track motors gives the unit a maximum travel speed of 3.4 km/hr, although operational travel speed averaged 2.8 km/hr.

STUDY AREA

A production study of the delimber was undertaken during August, 1987 in a thinning operation in Kaingaroa Forest.

The study area comprised two stands of 18 and 19 year old radiata pine on flat terrain. Details of each stand (Table 1) were obtained from pre-thinning assessment by Timberlands staff.

The location of three landings in each stand allowed flexibility as to the use of the delimber in either hot or cold deck operation. The work method is discussed in a later section.

Table 1 - Stand Details

Description	Stand 1	Stand 2
Stand Age	18	19
Total Stocking (sph)	600	1100
Yield Stocking (sph)	350	850
Yield Mean DBH (cm)	28	25
Mean Merch. Volume (m^3)	0.40	0.36

Scaling of individual trees processed gave an average butt diameter of 29.6 cm and a mean merchantable tree volume of 0.44 m^3 (n = 121). This is a higher volume than the inventory details mainly through loss due to breakage of the smaller diameter trees.

STUDY METHOD

Over the twelve day period of the study, data was collected on :

(i) gross productivity for each of two operators

(ii) total productive machine time worked per day

(iii) nature and duration of mechanical delays

The productive work cycle was then divided into various elements and timed to relate the usual work method to measured tree parameters such as large end diameter, length and volume.

(i) Measurement of Gross Productivity

During the periods of productive machine time each day, the number of trees processed was recorded to give gross hourly rates for each operator.

This was plotted against accumulated time per operator to determine trends in learning ability.

(ii) Measurement of Machine Availability and Utilisation

Each day the amount of time spent in production was recorded in a log book, i.e. the time the machine spent performing the delimbing operation. This included minor operation delays of less than one minute in duration.

All non-productive time exceeding one minute was categorised as either :

(a) Operational delay (such as moving or clearing slash).

(b) Mechanical delay (maintenance and downtime).

(c) Non-mechanical delay (personal and social time).

(iii) Intensive Time Study

All trees extracted to one landing were numbered prior to processing and large end diameters measured. To determine the influence of individual tree characteristics on machine productivity, the delimber was timed processing approximately 200 merchantable trees.

RESULTS AND DISCUSSION

Work Method

Four different approaches were tried to determine an efficient method of operation. Hence the hourly productivity results represent a progressive improvement in both work method and operator experience. All but the last method involved the delimber working out of phase with the rest of the operation, i.e. "cold deck".

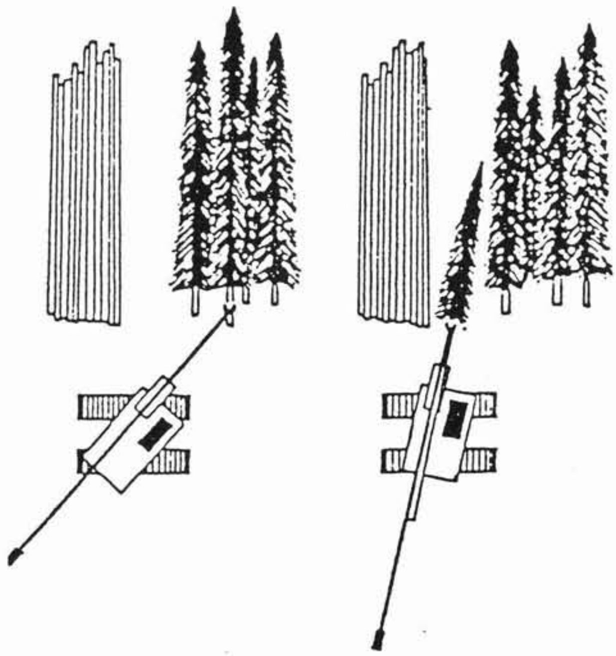

Figure 2 - Diagram of initial work method

(i) The delimber started at one end of the stack of wood and processed the trees into longs and shorts, stacking them parallel to the unprocessed trees (Figure 2). This method was found to be impractical due to excessive clearing times to remove the accumulated slash.

(ii) The delimber then stacked the processed long lengths at right angles to the unprocessed wood. This separated the processed wood from the slash but the logs were not fleeted well enough for load out, resulting in considerable loader fleeting time.

(iii) The delimber processed the long lengths then slewed 180° and stacked the processed wood behind it, thus building a progressively higher stack as it moved across the skid. The short lengths were stacked at right angles in front of the delimber.

(iv) The third work method led to an attempt at "hot deck" processing. The skidder pulled wood directly to the delimber and cleared the accumulated slash on its return to the bush.

Although not trialled intensively, this final method showed the best potential for using a stroke delimber on existing radiata thinnings landing patterns. Several factors which could affect the system productivity need closer examination. These include :

(a) the effect on skidder cycle time of slash removal

(b) the effect of long drag distances on the ability of the skidder to keep wood up to the delimber

(c) the safety of both machines working in close proximity

(d) the requirement for a loader to fleet short pulp and to augment the skidder in slash removal.

Gross Productivity

Productivity rates varied markedly; both day-to-day for the same operator, and between operators (Figure 3).

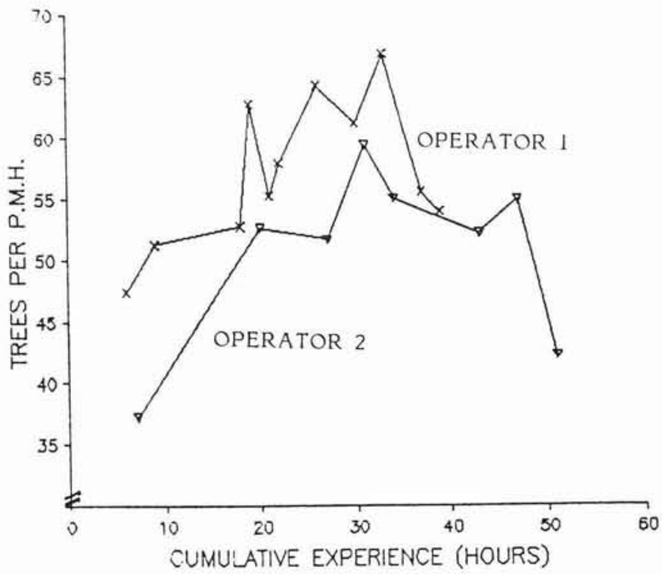

Figure 3 - Gross Productivity (Trees/PMH) vs operator experience

Figure 4 - Harricana delimber working in radiata thinnings

For the same operator, fluctuations in hourly productivity rates averaged for each day ranged up to 23%. These variations were largely due to inexperience and the effect of fatigue due to working long periods without a break. Each operator worked the delimber an average of 3.0 and 3.5 productive hours per day respectively. Ideally, work breaks should not exceed two hours. It is considered important for operators to take regular short breaks (e.g. five minutes). It is essential that two operators are available and are able to substitute each other to keep the machine working to peak production.

It appears that the machine learning time is highly dependent on operator. Over the period of the trial, however, both operators had learnt the basic machine operation. Further improvements to hourly productivity would be slower to achieve and would depend on operator motivation, and improvements to the work method and system layout.

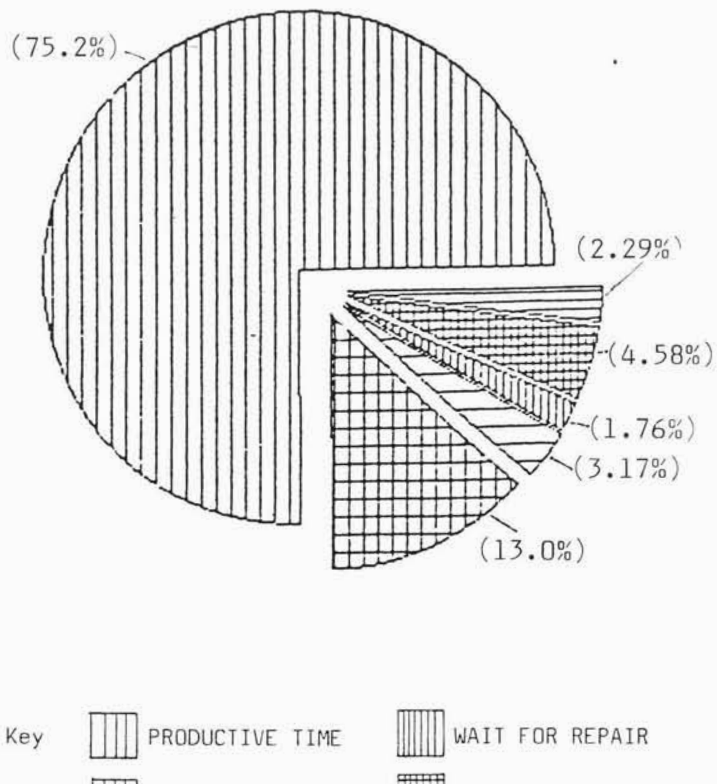

Figure 5 - Breakdown of Work Time (% of scheduled "on-job" time)

Machine Availability and Utilisation

The breakdown of the standard work day is given in Figure 5. Over the twelve day period of the study, total scheduled ("on-job") time averaged 9.5 hours per day. Available machine time (scheduled time less mechanical delays), averaged 7.8 hours per day (82.1%). Gross productive machine time averaged only 6.5 hours per day (68.9%). This figure was adjusted to remove non-allowable delays such as time spent talking to machinery suppliers, visitors and researchers. This adjustment gave a net productive time of 7.1 hours per day (75.2%).

The mechanical availability and the utilisation of the Harricana under the conditions of this study are given in Figure 6.

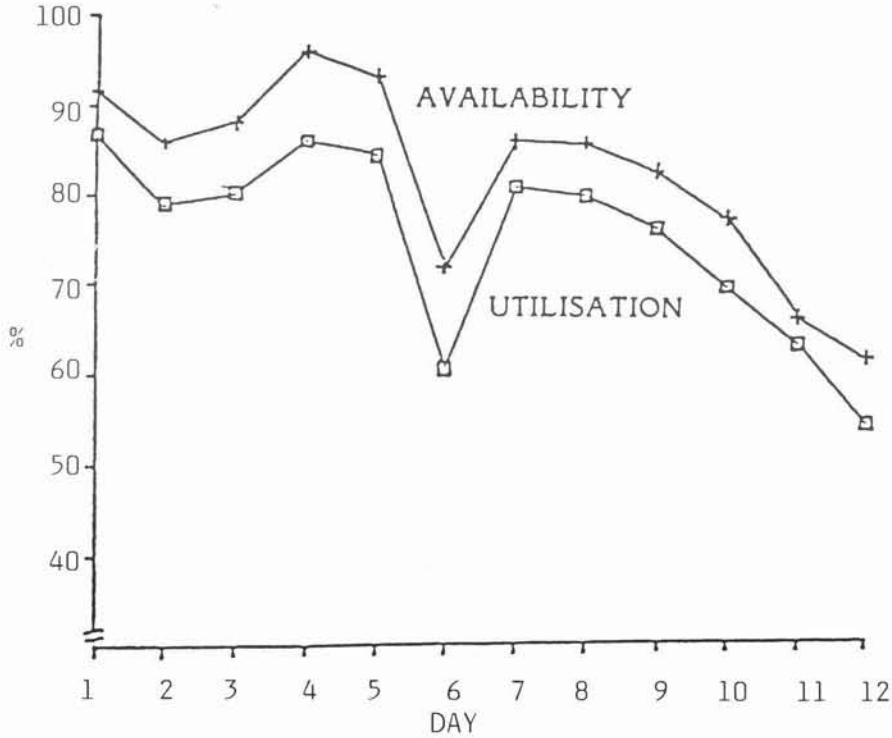

Figure 6 - Adjusted Availability and Utilisation (% of scheduled "on-job" time)

Details of each category of delay are given in Table 2. As can be seen, the major causes of mechanical downtime were related to boom hydraulics, saws and the boom drive. These problems predominantly occurred during the last three days of the trial.

Boom hydraulic problems arose from; leaking fittings around the rear trimming saw; a blown hose on the motion control valve, and a leaking fitting on one of the main boom pipes (two stoppages averaging two hours each).

It should be noted that hydraulic problems are inherent in the commissioning of all logging machinery. Many of these problems could have been avoided by the use of good quality fittings and the addition of extra guarding prior to the machine commencing operation.

Saw problems were largely eliminated through guarding to prevent limbs jamming the saw or flicking the chain off. The speed of the hydraulic ram activating the saw bar may need to be dampened. The high speed of the bar coming down on to the stem created sufficient force to break the bar mounting bolts and locating dowels, on at least four occasions.

The boom foot bolts needed constant tightening due to the impact of delimbing heavy branched trees. This problem has since been alleviated by the mounting of a large pin through the boom to prevent the bolts from loosening, and the use of Nylock nuts or "Locktite" on existing bolts.

TABLE 2 : SUMMARY OF DELAYS
(minutes per working day)

TYPE OF DELAY	NUMBER OF OCCURRENCES	RANGE (min)	MEAN PER OBSERVATION (min)	MEAN PER DAY (min)	% OF SCHEDULED TIME
MECHANICAL DELAYS					
Servicing & Maintenance					
- Grease & Oil	3	12-23	17	4	0.7
- Fuel Up	6	4-18	10	5	0.9
- Warm Up/Adjust	8	5-30	13	9	1.6
				18	3.2%
Repair					
- Saws	10	3-55	23	19	3.3
- Boom Drive	4	10-60	35	12	2.1
- Boom Hydraulics	7	18-123	68	40	7.8
- Track Base Repair	2	7-30	18	3	0.5
				74	13.0%
Wait for Repair	1	-	119	10	1.8%
Total Mechanical				102 min	18.0%
NON-MECHANICAL DELAYS					
Operational					
- Talk to crew/supervisor	6	1-22	6	3	0.5
- Position on skid	26	1-6	2	5	0.9
- Travel between skids	17	5-21	11	15	2.6
- Interference loader/ skidder	7	1-9	4	2	0.4
- Tree stuck on tray	4	1-7	5	1	0.2
				26	4.6%
Personal					
- Smoko/Personal	12	1-34	11	11	1.9
- Swap operator	7	2-6	3	2	0.4
				13	2.3%
Total Non-Mechanical				39 min	6.9%
TOTAL DELAYS				141 min	24.8%
PRODUCTIVE MACHINE TIME				427 min	75.2%

Intensive Time Study

Results of timing the machine operating under work method (iii) are given below :

(a) Operator 1

Element	N	Mean per Observation (min)	Mean per Cycle (min)	% of Total Cycle
Pick up	94	0.265	0.24	30.1
Process	94	0.554	0.50	62.9
Clear	2	1.233	0.02	3.0
Sort	10	0.318	0.03	3.9
Stack	1	0.150	0.00	0.1
Total	104		0.79	100.0%

Productivity:

104 trees in 82.9 min = 75.3 trees/PMH

(b) Operator 2

Element	N	Mean per Observation (min)	Mean per Cycle (min)	% of Total Cycle
Pick up	92	0.356	0.33	27.1
Process	92	0.892	0.84	67.8
Clear	3	0.683	0.02	1.7
Sort	6	0.486	0.03	2.4
Stack	3	0.400	0.01	1.0
Total	98		1.23	100.0%

Productivity :

98 trees in 120.9 min = 48.6 trees/PMH

The data obtained was from a relatively small sample of the machine's operation. Therefore the elemental time values do not represent the overall performance of the machine. Rather, the gross results in Figure 3 represent the range of productivity over the period of the trial and the intensive time study highlights this range.

Productivity and Cost

Over the duration of the trial, Operator 1 average 57 trees/PMH on a daily basis and Operator 2, 51 trees/PMH, to give a weighted mean productivity of 54 trees/PMH. In this study, differences in productivity between operators of similar experience, working under the same conditions, were measured as high as 33% (56 vs 42 trees/PMH). This is corroborated by Australian experience with stroke delimbers (O. Raymond, 1986).

As discussed previously, daily utilisation averaged 7.1 hours per day, hence gross productivity is calculated as :

54 trees/PMH x 7.1 PMH/day x 0.40 m^3
(average tree size = 153 m^3/day

at 0.9 m^3/tonne :

Production = 170 tonne/day

The LIRA costing format (Wells, 1981) gives a total daily machine rate of $680.00 and a delimbing cost of $4.70 per tonne.

Operating in a system with; two manual fallers, one Bell logger, a grapple skidder and a loader, the costs of the delimber operation can be compared with the conventional operation. This is equivalent to a comparison between the cost of six cutters, and that of two cutters and the delimber. Two operators would substitute between the loader and the delimber.

Delimber System

1 Harricana	$ 680
6 men @ $120	720
2 chainsaws @ $23	46
1 Bell Logger	210
1 Cat 518 skidder	410
1 520B Loader	315
Total Daily Cost	$ 2,381

at 170 tonne/day
= $14.00/tonne

Manual System

9 men @ $120	$ 1,080
6 chainsaws @ $23	138
1 Bell Logger	210
1 Cat 518 skidder	410
1 520B Loader	315
Total Daily Cost	$ 2,153

at 143 tonne (target)
= $15.05/tonne

It is felt that the use of the fleeting loader could be eliminated from the mechanised system. This would reduce the daily cost by $315 ($1.85/tonne). This is dependent on the development of an efficient work method whereby slash is removed by the skidder without adversely affecting extraction productivity, and the delimber can satisfactorily fleet short pulpwood.

Overseas experience, however, should teach us that mechanised operations may not always be cheaper than manual methods (especially in the long term), (O'Reilly, 1980). The benefits of mechanising the delimbing phase include increasing man-day productivity and reducing dependence on the fluctuating labour supply (Folkema, 1979).

CONCLUSIONS

This study has shown that the Harricana delimber is capable of delimbing radiata pine thinnings but attention to work organisation is important. The Harricana is capable of operating over a range of working conditions and tree sizes to delimb, sort and stack wood to a standard acceptable to two major processing plants.

For two relatively inexperienced operators, production rates averaged over the full day period ranged from 42 to 67 trees per hour. There was wide variation both between operators working in the same conditions and with the same operator in different stands.

The major tree characteristics influencing delimber productivity in m^3/PMH were the degree of malformation and the tree size. Processing small diameter, short trees and those with multiple leaders, significantly reduced the productivity of the delimber. It is estimated that stands of 0.35 m^3 piece size or greater best suits the stroke delimber operation. The size and number of branches on processed trees did not appear to limit the performance of the delimber.

Acceptable machine availability was achieved throughout the period of the trial. High daily production is dependent on maximising machine availability and utilisation through preventative maintenance, and through working overlapping operator shifts to minimise personal delays.

Operational delays such as travel between skids and positioning at stacks must be minimised through careful attention to the organisation of the work method. Mechanical delays involving hydraulics should also be minimised through the provision of good mechanical backup. This will ensure the successful introduction of these machines into the New Zealand logging industry over the next few years.

LIRA NOTE

Since its introduction to New Zealand in February, 1987, the delimber and base unit had undergone considerable modification. This trial describes equipment and systems that are still in a state of development. LIRA will continue to monitor and report on further developments with the Harricana stroke delimber.

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 estimate and do not necessarily represent the actual costs for this operation.

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