ISSN 0111-4743

LOGGING INDUSTRY RESEARCH ASSOCIATION

NEW ZEALAND

TECHNICAL RELEASE

Vol. 12 No. 2 1990

CLEARFELLING "YOUNG CROP" PINUS RADIATA PRODUCTION STUDY RESULTS

Peter Hall and Cedric J. Terlesk, Harvest Planning Group, Forest Research Institute, Rotorua

ABSTRACT

A production study of a low stocked, tended "young crop" P. radiata stand showed that a conventional ground-based tree length motor manual system could produce 270 m^3/day over an average haul distance of 285m. Piece size to 10 cm SED was recorded as 2.8 m^3.

INTRODUCTION

Figure 1 - Landing Activity Young Crop P. radiata in Rotoehu Forest

Many of the past radiata pine production studies have been undertaken in either "old crop" stands or partially tended, highly stock transition crop stands. The clearfelling of Compartment 110 in Rotoehu Forest presented an opportunity to obtain production data from a relatively low stocked stand that had received intensive silvicultural treatment - i.e. three pruning lifts, a waste and a production thinning (Table 1). The production levels achieved over the study period will provide an indicator of the production levels possible in other "young crop" stands of similar silvicultural background and piece size when using a conventional ground-based tree length logging system.

Table 1 - Stand History

	Nominal Treatment (spha)	Residual Stocking (spha)
1962 Established		
1967 Low Pruned	667	
1970 Medium Pruned	395	
1971 High Pruned	300	
1972 Waste Thinned to	-	370
1980 Production Thinned to	-	210
1989 Clearfelled	-	0

ACKNOWLEDGEMENTS

The authors acknowledge the co-operation of the Adams Logging crew and N.Z. Timberlands Limited, Bay of Plenty during the study.

PRE-STUDY MEASUREMENTS

The area to be studied was marked out from the rest of the stand. Sectional measurements were taken from 30 stems over the diameter range to derive a tree volume table. Measurements taken were the diameter at the butt, breast height, stem mid-point and the small end. Diameters were also recorded every three metres above breast height together with two bark thicknesses. The sectional measurements of the 30 trees gave an average merchantable volume of 2.82 m^3. A regression of mid-point diameter (MD) squared times length (L) against volume had an r-squared value of 0.9424, and this was used to calculate the log and haul volumes for the skidder study :

$$Volume\ (m^3) = 0.7882 \times (MD^2 \times L) + 0.0105$$

BRANCH CHARACTERISTICS

Branch measurements were taken to assess branching characteristics, with a view to possible mechanisation of delimbing. Branch data were collected for the entire stem up to a small end diameter of 10 cm. The height locations of all the whorls on the stem were recorded, as were the sizes and number of branches in each whorl. On the lower part of the stem where branches had been dead for some years and had largely rotted away, the stubs were recorded as decayed whorls and they were not measured - this condition could lead to problems in pruned log recognition.

	Mean	*Standard Deviation*
Trimmed length (m)	*23.71*	*4.6*
No. of Whorls	*44.6*	*9.3*
No. of Branches	*181.67*	*54.7*
No. of Branches/Whorl	*4.27*	*0.5*
No. of Branches/m	*7.7*	

Figure 2 shows distributions of branch diameter and branch cross-sectional area for the thirty trees measured.

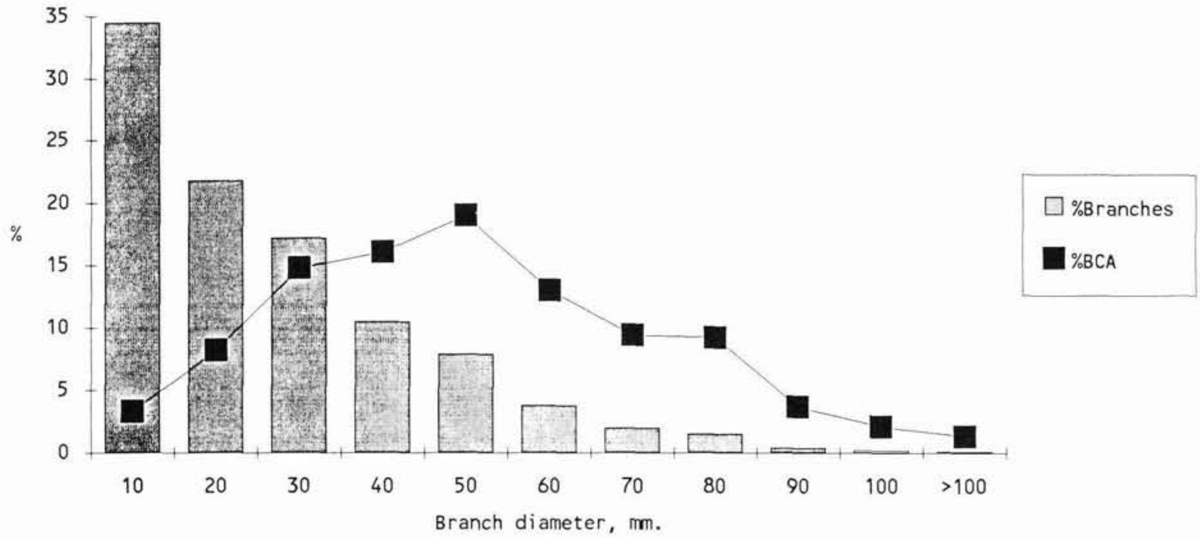

Figure 2 - Distribution of Branch Size and Branch Cross-sectional Area (BCA)

The graph clearly shows a high number (columns) of small branches and a decreasing number of large branches. The cross-sectional area (line) of branches to be removed shows that the very small branches make little contribution to the area of wood to cut, whilst the bulk of the cross-sectional area is in mid-sized branches. It is these mid-sized (50-60mm) and larger branches that can significantly reduce the output of mechanical delimbers.

Linear regression analysis indicated a simple relationship between DBH and total branch cross-sectional area. It was found that 68% of the variation of total branch cross-sectional area could be related to DBH. If the number of whorls was included as well as DBH, 75% of the variability could be explained. There is a positive relationship between DBH and both total branch cross-sectional area and number of whorls, i.e. as DBH increases the cross-sectional area of branches increases.

With lower stocked open grown stands becoming more common, loggers can expect to have a large trimming component in their future work.

STAND DATA CLEARFELL

The area studied was of a relatively small size with clearly defined boundaries. A series of temporary 0.04ha plots were established prior to clearfelling to gather the data set out below:

Mean DBH (cm)	-	*47.6*
Mean Height (m)	-	*39.9*
Stocking	-	*210 spha*
Merchantable Volume	-	*2.8 m^3/stem*
		588.0 m^3/ha

MARVL ASSESSMENT

It was estimated from the preharvest inventory that the following log grades and volumes/ha were available in the stand :

Grade	*Percentage*	*Volume (m^3/ha)*
P 1	*23*	*135*
S 1	*19*	*112*
S 2	*32*	*188*
L 1	*10*	*58*
Pulp	*16*	*94*

The influence of the previous silvicultural treatment on the grade percentages can be seen in the high number of small branched logs potentially available. The relatively high stocking to age 18 years, when a production thinning reduced the stocking to a nominal 210 spha, suppressed branch growth and diameter. The ability to manipulate branch growth through stocking should receive more research input.

AREA DESCRIPTION

The topography was rolling to steep with wide flat-bottomed gullies and wide-topped ridges, with short (50-70m), steep (approximately 22°) slopes.

The skidder tracks were located in the gully bottoms and averaged 4.5° downhill hauling. The skidder operated almost exclusively from the gully bottom, doing very little climbing up the ridge slopes.

LOGGING SYSTEM

The system studied was :

1 Caterpillar 926E rubber-tyred loader and operator

1 Caterpillar 518 rubber-tyred skidder and operator

2 skid workers

2 falling and trimming

1 prime working contractor

The skidder was equipped with a winch and four chain strops.

PRODUCTION - FELLING

Two loggers felled and trimmed at the stump, the skidder alternating between them. A day's time study of the most experienced faller (4 years' felling) provided the information in Table 2. Felling direction was downhill into the gullies. Breakage levels were normal for this type of operation. The skill level and motivation of the faller was high.

Table 2 - Cycle Time for Felling

Element	Time (mins/m^3*)	Time/ tree* (mins)	% of total bush time
Fell	0.54	1.52	26.0%
Trim	1.30	3.68	62.4%
Walk to fell	0.13	.37	6.0%
Clear around tree/gear shifts	0.12	.33	5.6%
	2.09	5.90	100.0%

The observed time of 2.09 minutes/m^3 (5.9 mins/tree) excludes times recorded for access, refuelling and sharpening the saw. These items have been allowed for in productivity calculations by using percentage allowances. Total cycle time averaged 8.23 minutes per tree (Table 3). Table 2 shows the extent of the time consumption in the trimming operation and highlights the need to reduce this input. The calculated felling production per man based on a standard 480 minute working day is 58 trees or 165 m^3 per day.

Linear regression analysis was used to determine the efffect of diameter breast height, trimmed length and number of whorls on trimming time. Very little relationship was found to exist - less than 30% of the variability in trimming time could be accounted for by these variables.

PRODUCTION SKIDDER

Skidder productivity calculations, based on a 480 minute working day and a 285m average haul distance, shows that the skidder was capable of completing 41.7 hauls a day. The average haul volume recorded in the study was 6.582 m^3.

Production Potential

= *41 hauls/day x 6.582 m^3/haul*

= *270.1 m^3/day*

The actual volume recorded during the study was 263.5 m^3.

The skidder operation was studied for one working day (40 cycles) under wet conditions.

The average haul distance in the study was longer than is usually found on flat terrain with regular planting boundaries e.g. Kaingaroa Forest. Adopting an average haul distance of 150m, the daily production could theoretically rise as high as 355 m^3/day. This level of production would, however, cause interference on the landing which would require extra workers there and would require the loader to work up to twelve hours per day exclusive of travel time.

Table 3 - Felling Productivity based on a 480 Minute Working Day

Observed time (fell and trim)		5.9 mins/tree	
Add allowances		Access	2.1%
		Refuel	5.0%
		Sharpen	8.0%
		Total	15.1% = 0.89 mins
	=	6.79 mins/tree	
Add rest allowance		15.5%; 1.05 mins/tree	
	=	7.84 mins/tree	
Add contingencies allowance		5%; 0.39 mins/tree	
	=	8.23 mins/tree	
Therefore in a 480 minute working day the faller would produce 58 felled and trimmed trees.			
Volume produced	=	58 x 2.82 m^3/tree	
	=	163.5 m^3/day	

Table 4 - Skidder Cycle Time

Observed time		9.09 mins/haul
Process allowance (5.2%)	+	0.473 mins
	=	9.563 mins
Rest allowance (15.5%)	+	1.482 mins
	=	11.045 mins
Contingency allowance (5.0% of observed)	+	0.454 mins
	=	11.5 mins/haul

Skidder productivity based on a 480 minute working day. Recorded interference and other legitimate lost production times were isolated, removed and replaced by percentage allowances.

DAILY SYSTEM COSTS

A daily cost of $2,035 and a unit cost of $7.54 per m^3 was calculated using the FRI costing format (Walker, pers.comm.). Details are shown in Table 5.

Table 5 - Daily System Costs

			$
Caterpillar loader 926E			478.31
Caterpillar skidder 518 (winch)			462.49
Power saws 5 @ $24.57 (4 operational, 1 spare)			122.85
Crew Transport (120 km/day)			36.58
		Sub total (1)	1100.23
Machine Operators (2 @ $120)			240.00
Fallers/skidworkers (4 @ $112.10)			448.40
Prime contractor			150.00
		Sub total (2)	1938.63*
Plus 5% ancillary equipment			96.93
		Total	$2035.56
Cost/m^3 @ 270 m^3/day	$\frac{2035.56}{270}$	=	$ 7.54*

* Return on Capital not included in calculation

DISCUSSION

The area studied was chosen because the low stocking (210 spha) and crop characteristics are indicative of the type of crop that will be logged in "young" crop stands.

Open grown trees tend to have larger DBH's than their more highly stocked counterparts. The relationship of DBH to total branch cross-sectional area indicates that young crop stands will have a large amount of branch material to be removed. In this case, trimming occupied over 60% of the faller's time.

The wet conditions, difficult terrain, low stocking and long average haul distance did not appear to affect the productivity of the gang as the 263.6 m^3/day extracted was higher than their targeted production.

An annual production figure for this highly-skilled and motivated crew is estimated to be 55-60,000 m^3. Greater production may be possible with a shorter haul distance, however the caveats mentioned earlier apply. In addition, the cost of increased roading on the more difficult terrain has to be balanced against the expected reduction in logging costs.

SUMMARY OF RESULTS

- During the study the gang extracted 263m^3.
- Given an average haul distance of 150m instead of 285m, a higher production level should be possible.
- The average extracted piece size was 2.82 m^3.
- The average haul size was 6.58 m^3.
- Skidder productivity was 1.78 mins /m^3.
- The faller was capable of producing 165 m^3/day, felled and trimmed
- Felling productivity was 2.94 mins /m^3.
- Trimming occupied 62% of the faller's time.
- The average total branch cross-sectional area was 1466 cm^2.
- The average number of branches/tree to be removed was 182.

This Technical Release is the work of the authors and is not the result of LIRA project work. LIRA publishes it in the interests of wider dissemination of knowledge in the industry. LIRA takes no responsibility for the accuracy of figures nor does it necessarily support or disagree with the opinions and conclusions shown.

For further information, contact:
N.Z. LOGGING INDUSTRY RESEARCH ASSOC. INC.
P.O. Box 147,
ROTORUA, NEW ZEALAND.
Fax: (073) 462-886 Telephone (073) 487-168