

CLEARFELLING YOUNG *PINUS RADIATA*

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SYNOPSIS

The early clearfelling of a 17-year-old stand of Pinus radiata during 1971 allowed the collection of detailed work measurement and mensuration data for analysis and provisional costing of the operation. A 1.2 ha plot on flat terrain was established in the stand, and trees were measured to calculate the available standing volume to a 10 cm top. Trees were subsequently remeasured on the skid to show recovered volume.

Measurements showed a negligible loss of volume from felling breakage in this class of stand (17 years, tree height 28.3 m, 331 stems/ha, 300.9 m³/ha) on flat terrain, probably less than 1.7 m³/ha. The total volume loss of potentially merchantable material, in the bush and on the skid, amounted to less than 106 m³/ha.

A contract five-man gang, using a C5 Treefarmer as the prime logging unit, carried out the logging operation. Conventional work study techniques were employed to record the work content over a 3-day production run. Production was at the rate of 118.3 m³ per day, at a man-hour production level of 3.6 m³. Based on this level of production, a detailed costing exercise indicates a direct cost on the ride comparable with the cost of clearfelling mature radiata pine stands in the Bay of Plenty region. The ratio of capital to labour in this particular logging unit was 1 to 1.38, which is considered a good balance for this class of operation.

INTRODUCTION

Detailed documentation of a clearfelling operation in a 17-year-old radiata pine stand (see Appendix 1) should allow some tentative conclusions to be drawn on the likely costs of clearfelling for pulpwood, as an alternative to a production thinning at a similar age. In this study the work content involved in the felling, transport, and manufacture of the volume present on a 1.2 ha plot were recorded. The data relate to actual performance without adjustment. The project falls into three main sections: assessment, work measurement, and costing.

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ASSESSMENT

The plot was established in the compartment by survey with compass and chain, and carefully defined. Comprehensive measurement before and after felling were aimed at providing accurate volumetric data for the work measurement exercise, and subsequent costing of the operation. Every tree in the plot was measured for dbh (ob) and numbered for later identification (Appendix 1). Forty-eight trees were measured for height to cover the range of diameters present, and in addition a further 18 trees were felled and sectionally measured. These data were used to calculate the available standing volume to a 10 cm top.

During the felling operation the point at which stem break occurs was checked to find out how much utilizable volume is lost from this source. The average diameter at this point was recorded at 10.9 cm (ib) and as the minimum utilizable diameter is 10 cm (ib) the loss is negligible — probably less than 1.7 m³/ha.

On arrival at the skids the numbered trees were measured to give the recovered volume. Diameter over bark and bark thickness were measured at the large end, small end, and middle of the logs, "logs" being 0 to 6 m, 6 to 12 m, 12 to 24 m up the stem. From these data log volumes were calculated.

Volume loss from docking on the skids amounted to 0.9 m³/ha plus a further 9.0 m³/ha left in the stand, arising partly from a decision by the fallers to classify some trees as dead and therefore not utilizable. These trees had been classed as alive by the measurement team and they were therefore included as part of the utilizable volume. However, the measured waste from these sources amounted to only 9.9 m³/ha (Mackintosh and Park, 1971).

The volume loss from malformation was only 5% of the volume of equivalent normal stems. This high recovery is a reflection of a pulping end use. Logs that contain defects that make them unsuitable for sawlogs are mainly quite acceptable for the pulping process.

WORK MEASUREMENT

An experienced officer equipped with a stopwatch recorded the activities of each member of the logging gang.

The five-man logging crew was made up of two faller/trimmers, one tractor driver/fleeter, and two skid workers. One of the faller/trimmers was the prime contractor who also carried out general supervision and field repairs. The logging crew under study is considered above average. The mean tree size in the stand was 0.9 m³ to a 10 cm top. On the basis of hours of productive work, the crew produced at the rate of 3.6 m³/man-hour.

(a) *Felling and Trimming*

Felling and trimming were done by two men using Husqvarna 180S power saws. The fallers assisted in the "breaking-out" operation after an adequate supply of tree lengths had been felled and prepared. During the study the two-man bush crew felled and prepared 336.2 m³ at a man-hour production rate of 8.5 m³.

The development of an economical approach to trimming radiata pine with anti-vibration power saws has reduced the amount of time required for this labour-intensive aspect of the operation, with a resultant increase in productivity and a reduction in cost.

A high degree of proficiency in power saw trimming was displayed by both workers. Bush trimming time amounted to 2.51 minutes/m³ and trimming quality was considered satisfactory by a senior controlling officer.

Trees had been pruned to various heights throughout the stand, ranging from 1.8 m to 9.8 m. A sample of trimming times was segregated on the basis of pruned height, to show differences in trimming time per pruning lift and per cubic metre. The results are shown in Table 1. The data have been smoothed and refer to normal-formed stems only. Data for the 0 to 1.8 m and 0 to 2.4 m pruning lifts have been combined.

The data show that increasing pruning height leads to a reduction in trimming time.

TABLE 1: THE EFFECT OF PRUNING ON TRIMMING TIME

<i>Pruned Height (m)</i>	<i>Trimming Time (min/m³)</i>	<i>Average Tree Volume (m³)</i>
0	3.29	—
1.8-2.4	2.90	0.8 (26)
3.7	2.50	1.1 (2)
6.1	2.14	0.9 (8)
9.8	1.71	0.9 (44)

Figures in parentheses = no. of trees in the sample.

(b) *Skid Operation*

Two men were employed on the skids, each with a mean work load of 4.80 minutes/haul (combined 9.60 minutes) and a mean wait time of 1.96 minutes/haul.

Total work time on the skids was made up of assisting the tractor, measuring, cutting into log lengths, final trimming, skid cleaning, and maintenance of equipment. No particular pattern of work responsibilities emerged during the study; each sub-operation was readily interchanged between the two men. This possibly accounted for the rapid throughput of all the operations at the skid site.

Both men measured logs (1.85 minutes/haul), using a wind-up tape. An aerosol paint dispenser was used for marking the log lengths for subsequent cross cutting. It was also the

responsibility of the skid workers to select the logs suitable for the export market from the tree lengths making up the haul.

Tree lengths and logs received a final trim by one or both the skid workers, amounting to 0.93 minutes/m³. This figure added to the trimming times in Table 1 gives the total trimming time/m³. Skid trimming time was possibly inflated because of the interference caused by making detailed measurements on the tree lengths immediately they were dropped from behind the tractor.

(c) Tractor Operations

During the 3 days of study the tractor, a C5 Treefarmer direct drive, produced 355.1 m³ of wood to the skids and pushed into stacks an average daily amount of 118.3 m³. The average haul size over 129 hauls was 2.7 m³ with a combination of two, three, and four strops. Haul sizes when three strops were in use (strops were ring-mounted on the main rope) ranged from 1.5 to 3.6 m³, a reflection of the diameter and tree size distribution (Appendix 1). The dbh (ob) ranged from 13 to 53 cm with a mean of 36 cm. The machine in size, and level of capital investment, was well matched to the tree size in the plot, and this is reflected in the cost of the operation.

The breaking-out element is about 40 to 50% of the total tractor cycle over a mean haul distance of 80 m. The tractor driver, breaking-out, unassisted, took 3.05 minutes/haul (2.7 m³) using three strops; with an assistant the time was 2.08 minutes/haul for 2.7 m³ with three strops, a reduction of 0.97 minutes/haul. A saving of one minute per haul would justify the employment of a man for breaking-out. However, the effect of employing an assistant is reduced because the strops are attached to the tractor main rope.

The short haul distance (80 m) must have contributed to the high production rates achieved. However, multiple regression analysis indicates that rubber-tyred skidders are not as affected by distance as by other elements in the total turn time, such as breaking-out and stacking logs on the skids; therefore, production rates would not decrease much with some increase in haul distance, provided other factors in the logging operation are held constant.

COSTING

The clearfelling operation has been subjected to a detailed costing analysis (Appendix 2). Three daily production levels were used, an optimistic level of 118.4, an average level of 104.8, and a pessimistic level of 90.6 m³/day. The average and pessimistic levels of production are subjective but cover the likely range of production over an extended production period. They equate to man-hour production levels of 3.1 and 2.7 m³/man-hour, respectively. The costing of the three production levels shows a direct cost per m³ on ride com-

parable to the cost of clearfelling many mature radiata pine stands (unpublished data).

To test the influence of increased machine size on the cost structure, the data were recalculated, increasing capital by 16%, which led to a total unit cost increase of 7%. However, an increase of 20% in the cost of labour, through the employment of one extra gang member, led to an overall unit cost increase of 11%, reflecting the effect of the capital/labour ratio of 1 to 1.38 in the actual operation.

CONCLUSIONS

Manpower on the skids could be reduced by introducing a belt-mounted, spring-loaded measuring tape. This type of equipment allows the operator to measure and mark the log on the first pass down the tree length, trimming and cutting to length on the return trip. An extensive trial is certainly warranted.

Complete pre-stropping of the load by a breaker-out would further reduce breaking-out time (from synthesis, to 1.01 minutes/occasion); the system would require additional strops but would be beneficial in allowing the number of stems/haul to be varied, depending on their size, to give a large and consistent haul size.

Young radiata pine crops with the general characteristics of the stand under study can be clearfelled and stacked on the ride at a unit cost comparable to that of many mature radiata pine clearfelling operations. Such stands can yield not only materail suitable for pulpwood but also a percentage of logs suitable for the lucrative export market.

Given a well motivated, well controlled and directed gang of men, high levels of man-day and machine-day productivity can be achieved. The level of capital investment must, however, be suitable and closely controlled in order to achieve low costs of production.

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REFERENCE

- Mackintosh, J.; Park, J., 1971: Test of assessment of methods in Kaingaroa and Forest Products — *Pinus radiata*. N.Z. For. Serv., For Res. Inst., Econ. Silv. Rep. 47 (unpubl.).

A P P E N D I X 1 STAND AND VOLUMETRIC DATA

Terrain	0.5°
Ground cover	Medium to dense black-berry
Species	<i>P. radiata</i>
Age	17 years
Previous treatment	Thinned and selectively pruned
Basal area/ha	34.0 m ²
Average dbh	36 cm
Diameter range	13 to 53 cm
Height of trees (Ho)	28.3 m
Average tree volume	0.9 m ³
Tree volume range	0.04 to 1.9 m ³
Percentage of stems malformed	35
Malform volume percentage of normal stems	95
Assessed standing volume to a 10.2 cm top/ha	301.4 m ³
Recovered volume/ha	291.6 m ³
Volume loss/ha	9.8 m ³

Diameter (cm)

No. of Stems/ha

10-20	6
21-25	22
26-30	62
31-35	56
36-40	100
41-45	54
46-50	26
51-55	5

A P P E N D I X 2 MACHINERY DETAILS

- | | |
|--------------------------------|-------------------------------|
| 1 Rubber-tyred skidder 97HP | — Logging and felling |
| 2 Anti-vibration power saws | — Felling |
| 1 Medium and 1 light power saw | — Skid work |
| 1 Gang transport and trailer | — Transport and small stores |
| 1 Diesel container | — Bulk supply of tractor fuel |

1 spare saw plus ancillary equipment was kept on site.

Allowing a 10% contingency on principal equipment, to cover ancillary equipment and minor items, the above equipment approximated to \$27 000 of capital cost.

Allowing a 5-year life and 20% residual value, the average capital, based on formula:

$$\frac{(I - R)(N + 1)}{2N} + R$$

where I = original cost; N = number of years life; R = residual value, was approximately \$18 000.

COSTING METHODS

The following criteria were used in developing the cost assessment of this study.

(a) CAPITAL-DERIVED COSTS

Insurance

- (1) Basic premium of \$48.50 on first \$2 000 of insurable value.
- (2) Plus, balance of insurable value at 1.25%.
- (3) Plus, 25% on total of (1) and (2).
- (4) Plus, additional premium of 0.05% on total insurable value.

Depreciation

- (1) *Principal Machines and Ancillary Equipment*
Depreciable content $(I - R)$

Years \times Operative days

- (2) *Power Saws*

Original cost

2 \times Operative days

Interest on Capital

- (1) 25% of capital at 6%, regarded as own funds
- (2) 75% of capital at 8%, regarded as loan funds

Note: The level of capital used for interest will be affected by the conditions of the loan. This exercise used original capital, but more favourable conditions than those envisaged here could allow the use of average capital.

Return on Capital Employed

A standard profit margin, to give a return of 15% on the average capital, has been added to the cost.

In this context this is equivalent to 10% on original capital, before tax.

(b) RUNNING COSTS

These are based on 6.6 operating hours per day (82.5% availability).

Fuel

Skidder: 9.1 litres/hour

Power saws: 50% of the operating day at 1.4 litres/hour

Lubricants

Skidder: 0.2 litres/hour

Power saws: 50% of operating day at 0.9 litres/hour (inclusive of chain oil)

Gang Transport

Fuel and lubricants based on 48 km/day at \$0.030/km (other costs included under respective cost element headings).

Repairs of Principal Machines and Ancillary Equipment

$$\frac{\text{Depreciable content less Cost of 1 set tyres}}{\text{Years} \times \text{Operating days}}$$

Power Saws

$$\frac{\text{Original cost}}{2 \times \text{Operating days}}$$

Tyres

1 set per 2 000 hours for principal machine

Labour

Taken over a standard 8-hour day at an all-inclusive hourly rate.

On the basis of the cost results the capital/labour ratios are 1 to 1.38 exclusive of standard profit.

For three levels of production, the volume distribution over the three basic cost classifications are:

			<i>Distribution</i>			
			(%)	<i>Optimistic</i>	<i>Moderate</i>	<i>Pessimistic</i>
Labour	....	....	54	64.0	56.6	49.0
Capital	....	....	39	46.1	40.0	35.4
Standard profit	....	....	7	8.3	7.4	6.2
Total	....	....	100	118.4 m ³	104.8 m ³	90.6 m ³

The three levels of production represent a 30% range in material and unit cost/m³.