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FORWARDER OPERATIONS IN AUSTRALIA

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Figure 1 : Kockums 85-35 Forwarder in Outrow Thinnings

ABSTRACT

Short term work studies of two forwarders working in clearfell and thinning operations in Australia were undertaken. One study suggested that productivity in fifth row outrow Radiata thinnings of 0.25 m³ tree size on moderate terrain exceeded 20 m³/per productive machine hour (PMH). This represents a significant productivity increase from early models of forwarders in thinning operations, and is assumed to be a result of both technological advances in forwarders, and improvements in operator experience. The second study, in Radiata clearfelling of approximately 2.0 m³ tree size indicated that the forwarder's productivity sorting, extracting and loading sawlogs on truck exceeded 50 tonnes per PMH.

INTRODUCTION

If New Zealand is to efficiently harvest the large volumes of wood available in the next decade, advances in the mechanisation of forest harvesting are one option. Alternatives to current tree length operations include :

- mechanised processing in the bush and log length extraction by forwarder;
- forwarder extraction in manual cutting operations.

Using forwarders, sawlogs and pulpwood can be sorted, extracted and loaded on truck without the need for landings or separate loaders. The cost of construction of log landings can be eliminated and the environmental effects of drainage from roads and landings minimised.

Other advantages of forwarders include :

- Clean wood input to the mill. This is particularly important to a thermo-mechanical mill (Humphreys, 1980). Clean wood reduces wear on chipper knives and refiners and minimises shut downs for boiler maintenance (T Beath, pers comm).

- Ability to segregate different log products either in the bush or at roadside.

- Reduced tree damage. Damage to crop trees may be reduced in comparison with tree length extraction.

- Ergonomics. Forwarder design is generally far in advance to that of log skidders. All features are oriented towards superior operator comfort.

- System Flexibility. The more flexible loading system from roadside results in reduced haul distances, and high extraction productivity. Trucks can be loaded either direct from the forwarder or from roadside stacks.

This Report examines two case studies of forwarders working in both Radiata pine clearfell and thinning operations in Australia.

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PREVIOUS AUSTRALIA STUDIES

A series of studies of forwarders in thinnings extracting both 2.4 m and 5.4 m lengths indicated productivity of about 14 m^3 per productive machine hour (PMH), (Kerruish and Shepherd, 1982).

Another study investigated the influence of stand variables on productivity of mechanised pine thinning operations (Ferguson 1986). In this study, forwarder productivity ranged from 15.5-19.3 tonnes per PMH depending on contractor (0.25 tonne stem size).

Scandinavian studies of forwarder extraction were not directly relevant due to the larger stem size, and larger models of forwarders in the operations studied in this Report.

STUDY No. 1: THE KOCKUMS 85–35 FORWARDER IN RADIATA THINNINGS

Study Area : The first study was of A.N.M. contractor Jim Crozier's thinning operation on moderate to steep country in Carabost Forest, 70 km south of Tumut, NSW. The operation was delayed first thinnings of Radiata pine, planted in 1963 (tree size approximately 0.25 tonne). A fifth row outrow system was used (Figure 1).

Crozier's system consisted of a Timbco 2518 feller buncher, a Kockums 85-41 Logma delimber, a Valmet 902 harvester and two six-wheel Kockums forwarders (models 85-33 and 85-35). This operation was producing 1520 tonne of pulpwood to roadside per week (300 tonnes per day). The required wood length was 3.6-5.8 m in random lengths. Truck loading was on separate contract.

The Timbco feller buncher felled the outrow, thinned the two adjacent rows on each side and bunched the wood for processing either by Logma delimber or by the Valmet 902. At over 30 tonne per PMH the Timbco was much more productive than the other machines in the system.

The forwarder studied in this operation was a three and a half year old Kockums 85-35 extracting on moderate terrain.

Table 1 : Work Cycle of the Kockums 85-35 Forwarder (n = 10)

Element	*Mean per Cycle (min)*	*% of Total Cycle*
Travel Empty	*3.18*	*11.9*
Load	*13.16*	*49.3*
Move (while loading)	*1.36*	*5.1*
Travel Loaded	*2.54*	*9.5*
Position	*0.16*	*0.6*
Unload (to roadside)	*6.28*	*23.6*
Total Cycle (net of delays)	*26.68*	*100.0*
Empty Distance (m)	*188*	
Loaded Distance (m)	*146*	
No of Pieces Loaded	*112*	
Volume per load (tonnes)	*9.0*	

The Kockums 85-35 is in the large forwarder class. It has a load capacity of 15 tonne, and is powered by a 132 kW Scania diesel engine with Clark torque converter and power shift transmission.

Study Results : At the time of the study, ground conditions were dry, the soil was hard packed loam and slope ranged from 0-19° . (The maximum slope set by A.N.M. for thinnings operations was 20° . The outrows had been cut directly up the slope to reduce the effect of sideslope. As noted by Ferguson (1986) relatively moderate slopes (10-14°) have little impact on forwarder productivity (where soil conditions are firm). In general, slopes over 15° are probably much more critical to performance, although problems can arise on slopes of 12° in wet weather.

The operator was highly skilled with approximately five years experience in forwarder operation. Results of the production study are given in Table 1.

Average extracted log size (5.4m length) was measured at 0.08 m^3 . Forwarder pulpwood loads were calculated at 9.0 tonnes.

Given a total cycle time of 27 minutes and an average payload of 9.0 tonnes, forwar-der productivity over haul distances averaging approximately 170 m was calculated at 20 tonnes per PMH. Scheduled machine hours (SMH) were from 7 am to 4 pm. Assuming approximately 7.5 PMH per day, daily productivity is estimated at 150 tonnes extracted to roadside.

Several points arose from observation of the forwarder work method:

- Where the outrows did not extend directly to roadside, the operator reconnoitered the most effective route through the bush during the travel loaded phase of the cycle.
- No sorting was done during loading. The operator loaded pulp and any sawlogs together then sorted into separate stacks at the roadside (Figure 2).
- The average grapple load of the forwarder was 8 pieces

Figure 2 : Kockums 85-35 Unloading at Roadside

(0.6 tonne). Wood presentation was such that each stack required approximately 2 grapple swings to load on the forwarder.

- Average time per move was 0.12-0.15 minutes (approximately 8 seconds per move). Moving between stacks of processed wood on the outrow comprised only 5% of the forwarder work cycle.
- Maximum slope the forwarder travelled was 19°. Travel empty speed (uphill) was 0.73 m/s. Travel loaded speed (downhill) was 0.84 m/s.

STUDY No. 2: THE OSA 280 FORWARDER IN RADIATA CLEARFELLING

Study Area : Robert Crawford operated a mechanised clearfelling operation in 28 year old Radiata pine on easy terrain in Jeeralang Tree Farm, south of Morwell, Victoria. The operation comprised a Kockums 880 shear feller buncher, a Harricana stroke delimber mounted on a Cat 215 base and an Osa 280 Master forwarder.

The Osa 280 is in the large forwarder class, rated at 18 tonne capacity (Figure 3). It is powered by a 155 kW Volvo turbo diesel with hydrostatic transmission and computer controlled three-speed powershift and power control. Fuel consumption averaged 12.0 litres per hour (120 litres per day).

Figure 3 : Osa 280 Forwarder Loading Sawlogs

Table 2 : Work Cycle of the Osa 280 Forwarder

Element	*Mean per cycle (min)*	*% of Total Cycle*
Travel Empty	*4.80*	*19.0*
Load	*7.66*	*30.3*
Move (while loading)	*1.76*	*7.0*
Travel Loaded	*4.28*	*16.9*
Position	*0.98*	*3.9*
Unload (to truck)	*5.79*	*22.9*
Total cycle (net of delays)	*25.27*	*100.0*
Average Haul Distance (m)	*150*	
Number of Pieces Loaded	*34*	
Volume per load (tonnes)	*21.3*	

Study Results

In this clearfelling operation the forwarder was sorting sawlogs from pulp while loading. Tree size was estimated at approx 2.0 m^3 and forwarder productivity averaged 13 loads per day (310 tonne) with a maximum of 17 loads per day. Truckloads were scaled, giving pulpwood log size of 0.27 tonne per piece, and sawlogs averaging 0.62 tonne per piece. Forwarder payloads averaged 34 pieces for sawlogs (21.3 tonnes). Average log length was 5.5 m.

The forwarder was extracting directly to roadside where there were trucks waiting to be loaded. The work cycle of the forwarder extracting sawlogs over an average haul distance of approximately 150 metres is given in Table 2.

At a total cycle time (excluding delays) of 25 minutes, and an average payload of 21.3 tonnes forwarder productivity extracting sawlogs was calculated at 51 tonnes per PMH. This figure includes loading trucks.
The productivity of the forwarder extracting pulpwood was not measured.

COST AND PRODUCTIVITY

The Osa 280 Master Forwarder extracting and loading in this clearfelling operation was costed using the standard LIRA format (Wells, 1981). Using a capital cost of $553,000 and a resale value of 25% after 5 years, the machine cost was calculated at $1,025.00 per day.

The cost of extracting and loading sawlogs and pulpwood at an average productivity rate of 310 tonnes per day is given in Table 3.

Daily Machine Cost ($)	*$1,025.00*
Daily Labour Cost ($)	*$ 124.00*
Total Daily Cost ($)	*$1,149.00*
Daily Productivity (tonnes)	*310*
Extraction & Loading Cost ($/tonne)	*$ 3.70*

Table 3 : Cost & Productivity of Osa 280 Forwarder

DISCUSSIONS AND CONCLUSIONS

In Radiata thinnings of 0.25 m^3 tree size, the Kockums 85-35 forwarder produced 20 tonnes/ PMH on slopes up to 19°.

The average log size of 0.08 m^3 limited the forwarder payload to 9.0 tonnes per load. It is obvious that productivity would have been higher if payload could be increased without adversely affecting forwarder stability.

A short term study of an Osa 280 forwarder in clearfell Radiata pine of approximately 2.05 m^3 tree size indicated that productivity extracting sawlogs exceeded 50 tonnes/PMH. Although rated capacity was 18 tonnes, the forwarder regularly extracted payloads in excess of 21 tonnes.

Some of the advantages of forwarders have been discussed and are borne out by the indicative productivity measured in these two case studies.

Some disadvantages of forwarders include:

- High capital cost. The Osa 280 Master costs over $500,000.
- Instability on excessive sideslopes. As a general rule, on steep slopes, forwarders are worked directly up or down the slope.
- Inability to extract wood from inaccessible areas. In Australia, trees are often extracted from steep gullies by skidder to more accessible areas for further processing and forwarder extraction.

These two studies have indicated that both forwarders extracting over 150 m average haul distance were capable of high productivity under the conditions of terrain and tree size. Productivity extracting pulpwood from production thinnings was higher than reported in previous studies. This is assumed to be the result of both improved forwarder technology and improvements in operator skill and experience.

Forwarder productivity in Radiata clearfelling over 150 m haul distance is comparable to high production skidder operations. As in Australia, developments in mechanised processing in New Zealand may result in a trend towards forwarder extraction in the future.

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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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