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A COMPARISON OF A GRAPPLE AND A CABLE SKIDDER ON EASY TERRAIN

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Figure 1 - Cat 528 skidder with an Esco 47 grapple working in Tahorakuri Forest

ABSTRACT

This report describes the results from a trial with a grapple skidder and a cable skidder extracting clearfelled radiata pine on flat terrain.

The performance of each Caterpillar 528 skidder was monitored for two days in adjoining blocks. Haul distances ranged from 25 m to 350 m.

In a piece size of 2.1 m^3 over a haul distance of 150 m, grapple skidder productivity averaged 57 m^3 per productive machine hour, compared with 66 m^3/pmh for the cable skidder.

Grapple size limited the average drag volume of the grapple skidder to 4.4 m^3, compared with 8.2 m^3 for the cable skidder. At this distance (150 m), cycle time for the grapple skidder was only 62% of that for the cable skidder, a result of reduced load and unload times.

When grapple size limits skidder payload, piece size is the major factor in determining its productivity. Grapple skidders of this type can out-perform cable skidders over a wide range of distances once piece size exceeds 3 m^3.

INTRODUCTION

Grapple skidders were first introduced to New Zealand about twenty years ago (Hurst, 1986). They have mainly worked throughout the central North Island in a range of species, piece size and terrain. Early experience showed they were highly productive machines in the right situation, but that they had a number of limitations (LIRA, 1982).

Early grapples often suffered from component failures, due to poor quality hydraulic fittings. This type of problem has largely been overcome. With daily greasing and visual examination for cracks and general damage, downtime can be reduced to the replacement of an occasional burst hydraulic hose.

In the logging industry today, an ongoing problem with some operations is that grapple skidders continue to be mismatched to piece size and terrain. This is often due to improper machine selection and poor planning. It must be realised that these are specialist extraction machines, capable of high production given moderate terrain, firm ground conditions, and piece size matched to the machine size.

Grapple skidders make up only 4% to 5% of all skidders in New Zealand. Papers from LIRA's 1986 "Ground-Based Logging" seminar discussed the productivity of grapple skidders and their advantages and disadvantages in general terms (Higgins, 1986; Rasmussen, 1986). Seminar discussions indicated that little had been documented on grapple skidders and that further research was required. In late 1986, an industry meeting decided that although the Johnson rope grapple[1] was available overseas, the New Zealand industry should first study the hydraulic grapples operating in this country.

The objective of this study was to compare the performance of a grapple and a cable skidder working in the same conditions.

[1] The Johnson grapple is attached to the skidder mainrope and not fixed to the machine. It therefore combines the advantages of mechanical grappling of the logs, without the disadvantage of the skidder being fixed to the drag in adverse pulling situations.

ACKNOWLEDGEMENT

LIRA thanks NZFP Forests Limited and contractors, Lance Duncan and Blue Parkes, for their co-operation during this trial.

STUDY SITE

The study was conducted on flat terrain in NZFP Forests Limited Tahorakuri Forest during late April and early May, 1987.

The stand was 40 year old radiata pine that had been waste thinned in 1963 and 1966 and production thinned for veneer logs in 1982. This resulted in uneven spacing between crop trees and a wide variation in tree size. The stand details were :

Stocking	- 211 stems/ha
Mean tree dbh	- 52.5 cm
Mean merchantable tree size	- 3.0 m^3

The conditions of flat terrain and relatively large piece size were ideal for high production skidder extraction.

LOGGING EQUIPMENT AND PROCEDURE

Both machines were Caterpillar 528 skidders. One was fitted with an Esco 47 (100") grapple and the other with 22 mm mainrope and six strops. Each skidder operation was studied separately.

Each contractor felled a one hectare strip measuring approximately 28 x 350 metres and hauled the wood to an adjacent skid measuring 75 x 56 m (0.42 ha).

The grapple skidder operator normally started accumulating his load by picking up the tree furthest from the skid and then driving forward to the next piece.

The cable skidder operator often bladed the logs in the bush prior to hook up. On average, the breakerout pulled the mainrope about five metres per occasion and the skidder operator assisted with hook up.

STUDY METHOD

A total of 125 cycles were recorded for the grapple skidder and 86 cycles for the cable skidder.

Continuous time study was carried out over a period of approximately 10 productive machine hours for each operation. Due to the short term nature of the study, personal delays were not included in the results. There was no mechanical downtime during the study. Therefore all production figures relate to utilised time (productive machine hours).

Data was collected on a portable Husky Hunter Data Logger. Distances were marked along each strip to enable individual haul distances to be measured. Drag volumes were measured at the skid, and the number of pieces per drag and their volume was reconciled with each machine cycle.

THE TRIAL

On the first day of the grapple trial, the skidder worked in heavy rain for 4.8 hours. Although there was no rain on the second day, ground conditions had become slippery and slightly reduced travel speeds. Analysis of the data indicated these differences were not significant however.

Both days of the cable skidder trial were fine and ground conditions were firm. The motivation of the breakerout and the ability of the skidder operator favourably influenced skidder productivity. The skidder was regularly loaded close to its optimum payload. When this was exceeded, the skidder lost traction and it was necessary to stop and winch. This usually occurred once the load size exceeded 9 m^3 to 10 m^3.

The size of the grapple on the skidder limited its load size to two large pieces per drag. For most of the time, the skidder was operating at well below its optimum payload. Payloads up to 8 m^3 did not adversely affect its travel loaded times on the flat terrain.

DATA ANALYSIS

Analysis of the data was complicated by the need to standardise three factors. The first was the difference in average piece size between the two blocks (2.5 m^3 for grapple, 2.1 m^3 for cable), partly a function of the higher proportion of shorts extracted by the cable skidder. To provide an equitable comparison of skidder productivity, an average piece size of 2.1 m^3 was used. This had the effect of reducing the grapple skidder payload to an average of 4.4 m^3.

The second factor was fleeting time on the landing. The grapple skidder spent minimal time fleeting logs as there was a loader on the landing. An average fleet time per cycle was used for both skidders.

Figure 2 - The Esco grapple holding two logs

The third factor was a substantial difference (34%) in travel empty speeds between the two machines. The cable skidder operator drove more slowly and carefully back to the bush. To standardise the results, the same regression was used to calculate travel empty times. This was obtained by averaging the two regressions for travel empty times for the two skidders.

RESULTS

A comparison of the results is shown in Table 1.

Using the same set of data, and adjusting the travel times for different distances, a comparison of productivity versus distance for the two skidders was made (Figure 3).

The high productivity of the grapple skidder over shorter distances is related to the time saved in loading and unloading. Its productivity was limited by its drag size of 4.4 m^3, a function of grapple size. In a piece size of less than 2 m^3, there would be limited benefits from using a grapple skidder with this size of grapple.

In a large piece size, the grapple skidder would be much more productive. The effect of a range of piece sizes on skidder productivity is shown in Figure 4.

This shows the dramatic effects of piece size on grapple skidder productivity, when grapple size is the limiting factor.

An indication of cable skidder productivity is shown in this figure, where it is assumed that payload is unaffected by piece size. As piece size reduces, additional pieces would be hooked on to maintain the payload. As the cable skidder data showed no relationship between the number of pieces and the times for hooking and unhooking, the only variable elements were travel times. On this basis, a skidder with this size of grapple should be capable of out-producing a cable skidder over distances up to 150 m once piece size exceeds 2.5 m^3. Once piece size exceeds 3 m^3, it is capable of out-producing it over distances up to 350 m.

TABLE 1 : COMPARISON OF SKIDDER WORK CYCLE AND PRODUCTIVITY

ELEMENT	GRAPPLE SKIDDER		CABLE SKIDDER	
	NO. OF OBSERVATIONS	MEAN TIME PER CYCLE (min.)	NO. OF OBSERVATIONS	MEAN TIME PER CYCLE (min.)
Travel Empty	123	1.01	86	1.01
Blade logs	43	.14	53	.36
Position	113	.25	81	.31
Load	125	.85		
Hook on			86	1.91
Breakout			86	.54
Stop and winch			14	.06
Travel loaded	123	1.60	86	1.87
Unhook			85	.64
Fleet	90	.79	82	.79
Total Cycle Time		4.64		7.49
Piece Size (m3)		2.1		2.1
Pieces per cycle		2.1		3.9
Volume per cycle (m3)		4.4		8.2
Haul Distance (m)		150		150
Productivity (m3/pmh)		57		66

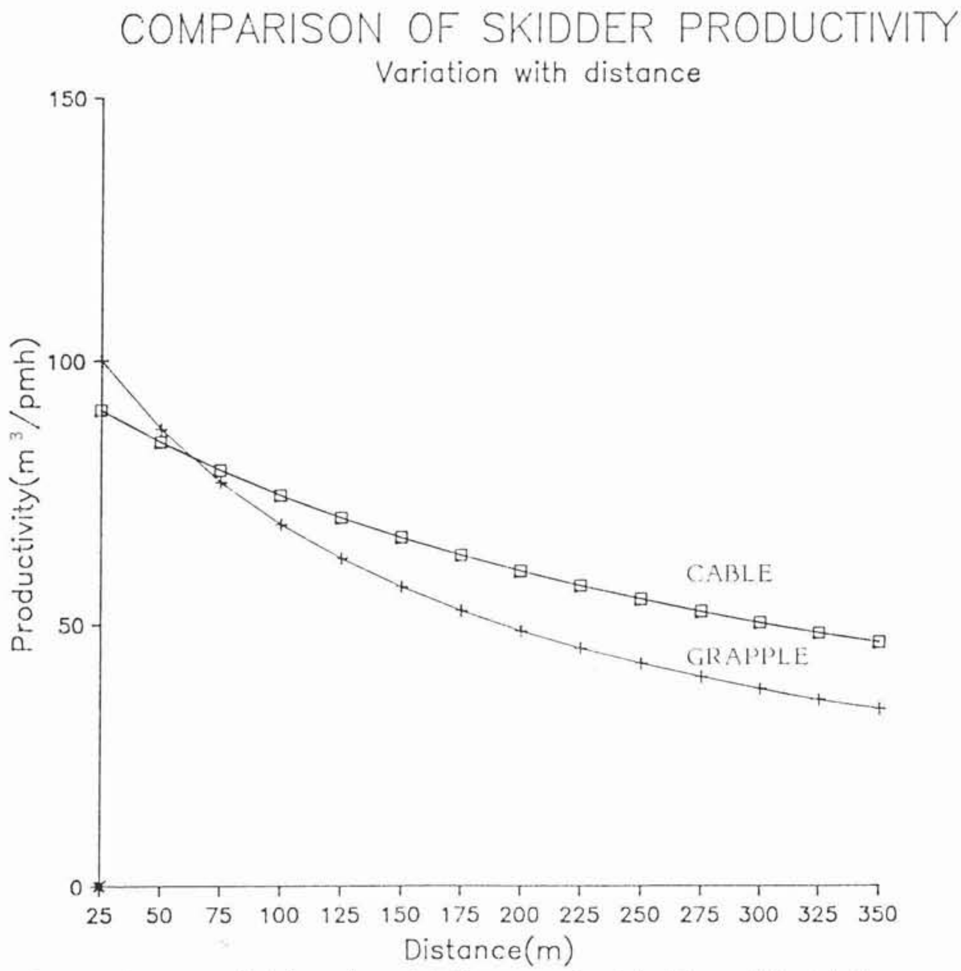

Figure 3 - Variation in skidder productivity with distance

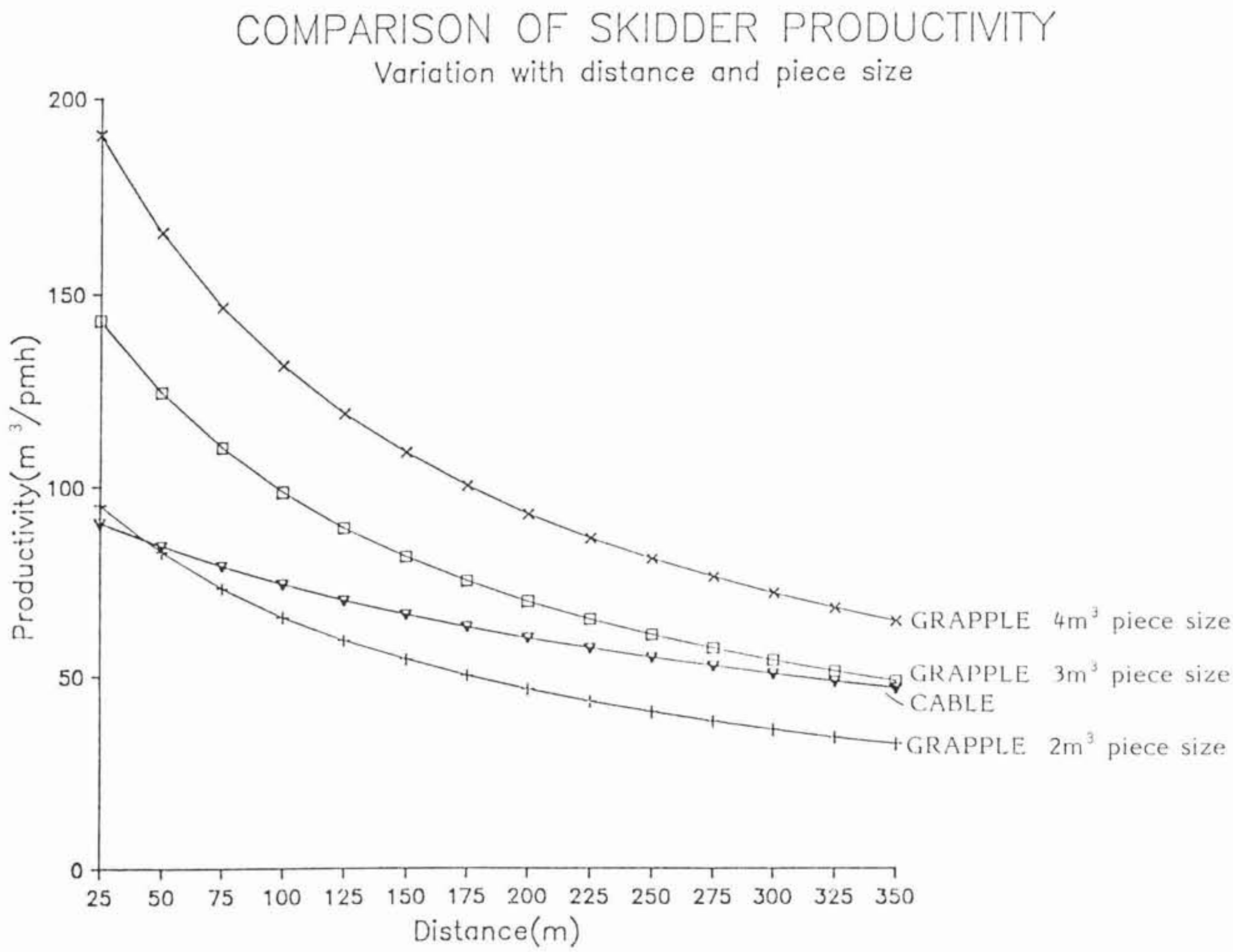

Figure 4 - Variation in skidder productivity with distance and piece size

COSTING

Costing of the two skidders is confined to a comparison between the cost of an Esco 47 grapple, and that of a breakerout (since the winch is retained on the grapple skidder). This comparison, using LIRA's costing format (Wells, 1981) is given in Table 2.

The grapple was costed over five years, with a resale value of $30,000. The labour cost was based on Logger I rate and included ACC and currently paid allowances.

Grapple components are generally reliable nowadays, and their availability is equivalent to other standard logging machine components. A well maintained grapple should have a life of at least ten years.

As shown in Table 2, the daily cost of the grapple is considerably less than the cost of a breakerout.

TABLE 2 : COSTING COMPARISON

Grapple	Breakerout
Purchase Price - $41,000 Interest - 25% Insurance - 2.5% of capital Repairs and Maintenance - 40% of depreciation	
= $56 per day	= $130 per day

CONCLUSIONS

Grapple skidders are capable of very high levels of production when operated on easy terrain in suitable piece size. For a grapple of the size used in this trial, a piece size of 2.5 - 3 m^3 or larger would allow a grapple skidder to out-produce a cable skidder. In smaller piece size, a larger grapple would be needed to allow a larger drag size to be carried.

There are also substantial cost savings through the replacement of the breakerout. Where sufficient areas of easy terrain are available, grapple skidders offer opportunities to increase crew and skidder productivity and reduce production costs.

Note : The high productivity of both skidders in that trial is a result of very favourable terrain and relatively uniform piece size. Productivity is expressed as m^3 per productive machine hour (PMH). Skidders typically achieve only 6 to 7 PMH in an 8-hour day due to mechanical downtime and production delays.

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

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