LOGGING INDUSTRY RESEARCH ORGANISATION
NEW ZEALAND

ISSN 0111-6711

REPORT

Vol. 17 No. 9 1992

TWO GRAPPLE SKIDDERS FOR NEW CROP RADIATA

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Figure 1 - Franklin 170 PTM-31A Grapple Skidder and Valmet Ranger F67 Grapple Skidder

ABSTRACT

A study was undertaken to investigate the productivity of the Franklin 170 PTM-31A and Valmet Ranger F67 grapple skidders working on flat terrain in Kaingaroa Forest. Both machines were operated by the same person and worked under the same stand and terrain conditions. Motor-manually felled and trimmed trees were extracted to a landing for further processing.

The Franklin skidder produced 63m^3 per productive machine hour (PMH) over an average haul distance of 178m. The average drag size was 6.5m^3 comprising 2.5 full stems and 0.6 short pieces per cycle. The Valmet Ranger achieved 59m^3/PMH over an average haul distance of 124m. During this study the average drag size was 6.1m^3 comprising 2.5 full stems and 0.5 short pieces per cycle.

INTRODUCTION

In New Zealand, cable skidders rather than grapple skidders have remained the preferred machine for extracting felled trees from the felling face to the landing. Their versatility and ability to work steeper and more difficult areas have been the main reasons for this even though in the past there have been cost savings of up to 10% when using grapple skidders on flat country (Higgins, 1986).

High productivity through using grapple skidders and the factors affecting their production have been well documented in both New Zealand and North America (Moore, 1987; Robinson, 1987; Rummer, 1988; Tufts et al., 1988, 1989). Canadian skidder sales are now four to one in favour of grapple skidders (Poole, 1989). In the Southern states of the U.S.A., it has been suggested that the use of grapple skidders paved the way for low cost mechanised systems (Cubbage et al., 1988). Franklin skidders, well known in the United States, are less common in Canada and almost unheard of in New Zealand, while Valmet Ranger skidders have an established reputation in all three countries.

With the recent arrival of several grapple skidders into New Zealand there has been increased interest from industry in using grapple skidders as the prime extraction machine. That interest initiated this investigation of the productive capability of a Franklin 170 PTM-31A grapple skidder and a Valmet Ranger F67 grapple skidder.

ACKNOWLEDGEMENTS

LIRO acknowledges the co-operation of the staff of Forestry Corporation of New Zealand Limited, CBS Engineering Limited, Titan Plant Services Limited, and John Milnes and his logging crew for their assistance with this study.

THE MACHINES

	Valmet Ranger F67	*Franklin 170 PTM-31A*
Engine	*Cummins 118kW (159hp)*	*Detroit 120kW (160hp)*
Operating Weight	*12030kg*	*11900kg*
Ground Clearance	*546mm*	*510mm*
Winch Linepull (Bare drum)	*15086kg*	*12272kg*
Machine Height to Top of Exhaust	*3254mm*	*3175mm*
Machine Width	*3048mm*	*2895mm*
Machine Length (Blade down grapple arch up)	*6796mm*	*6400mm*

Table 1: Machine Specifications of a Franklin PTM-31A and Valmet Ranger F67

The operator's cab of the Franklin is fully enclosed by lockable doors, mesh guarding and safety glass in the front. The cab has two small windows either side of the control panel allowing sight of the blade and front wheels.

The Franklin's grapple arch when fully extended has a reach of 2.4m from the centre line of the rear axle. The grapple has a 290° rotation, a maximum opening of 2.3m and a 0.8m^2 capacity. For added flexibility the grapple can be removed quickly to allow effective use of the winch and fairlead.

The Valmet Ranger F67 has a maximum grapple opening of 2.7m and features a parallelogram arch and boom providing, when fully extended, a reach of 2.8m from the centre line of the rear axle. The grapple head has continuous 360° rotation. The grapple closing pressure is maintained by an accumulator system in the grapple close circuit. The grapple arch is also equipped with a fairlead for cable skidding.

Operator's Comments

The operator, although familiar with cable skidder operation, had limited experience on grapple machines. The Franklin's grapple arch is operated with a single control whereas the parallelogram grapple arch of the Valmet has two controls and requires greater operator experience to be operated efficiently.

The operator considered the Valmet had more comfortable seating, a better view to the front and rear of the machine, and better layout of controls than the Franklin. The disadvantages with the Valmet were, in his view, a tendency for logs to slip out of the grapple during travel loaded, and slower grapple activation.

Most of the Franklin's controls were operated with the right hand, making smooth operation difficult in some circumstances. In the operator's opinion, the Franklin's larger tyres provided better traction in the wet. The Franklin often reared in the front when breaking out loads. Filling the front wheels with water would have helped alleviate this problem.

OPERATION DESCRIPTION

The grapple skidders were studied in Compartment 1057 of Kaingaroa Forest. The area was flat and considered ideal for grapple skidder applications but heavy rain prior to the study had made ground conditions very soft. A number of felling faces had been opened to reduce interference between the felling and extraction phase of the operation. The trees had been directionally felled to improve grappling times and trimmed to enhance payloads.

During the Franklin and Valmet study, load accumulation was carried out using the grapple. Trees were grappled and moved to other trees where further grappling would take place until a full load had been achieved. Short pieces were often bladed to other short pieces or full length trees before grappling commenced.

Stand details are given in Table 2.

Area (ha)	*60*
Stocking (stems/ha)	*326*
Stand Age (years)	*36*
Merchantable Stem Size(m^3)	*2.4*
Extracted Piece Size (m^3)	*2.33*

Table 2 - Stand details

STUDY DESCRIPTION

Log volume calculations of a sample of 90 stems were used to obtain a relationship between large end diameter to tree volume. A good correlation was obtained between these two parameters (r^2=0.90). This relationship was used to calculate individual drag volumes.

The total duration of the Franklin study was 39.2 hours during which 264 cycles were completed. Detailed timing was carried out on 209 cycles of which 12 cycles had the trees pre-bunched prior to grapple skidder extraction.

The total duration of the Valmet study was 22.8 hours during which 169 cycles were timed in detail. A further 10 cycles of pre-bunched trees were recorded during the Valmet study.

Data on the following non-time elements were also collected to help explain some of the variation in time elements. These included; the distance travelled during breakout, positioning, repositioning and blading, the number of times positioning and repositioning occurred in each cycle, and the number of longs and shorts in each drag. The definition of "Position" is the time required to position or reposition the machine with an empty grapple ready for grappling. Conversely "Reposition" is the time to reposition the machine ready for further grappling, i.e. with a partially filled grapple.

RESULTS AND DISCUSSION

The average productive cycle time for the Franklin was 6.2 minutes from an average haul distance of 178m. Given an average payload of 6.5m^3, productivity for the Franklin averaged 62.8m^3/PMH. The Valmet's average productive cycle time was 6.2 minutes from an average haul distance of 123m. Given an average payload of 6.1m^3, productivity for the Valmet averaged 58.9m^3/PMH (Table 3).

Analysis showed that travelling times for both machines correlated to the distance travelled. Regression equations to predict travel loaded times and travel empty times for the Franklin and Valmet are given below:

Franklin

(1) Travel loaded time (mins)= (0.00595 x travel loaded distance (m) + 0.71833) (r^2=0.67)

(2) Travel empty time (mins) = (0.00433 x travel empty distance (m) + 0.40832) (r^2=0.75)

Valmet Ranger

(3) Travel loaded time (mins)= (0.00647 x travel loaded distance (m) + 0.61806) (r^2=0.47)

(4) Travel empty time (mins) = (0.00579 x travel empty distance (m) + 0.19516) (r^2=0.73)

Due to the variability of the drag accumulation elements (position, reposition, blade and grapple) for both machines, reliable models could not be developed for the productive cycle times for either study.

For both studies almost half of the productive cycle time was used to accumulate the drag. Strong correlations between the distances travelled during the position, blading and reposition elements explain most of the variation of these three elements.

To investigate the effect the time spent gathering loads had on production, a small number of cycles, where the trees had been prebunched, were compared to a sample of cycles where the trees were not bunched for a similar haul distance.

For the Franklin, load accumulation time for unbunched cycles accounted for 45.6% of the productive time whereas for the bunched cycles these four elements accounted for only 25.4% of the productive time. Load accumulation time was 40% faster when the trees had been bunched for the Franklin and 43% faster for the Valmet. Although bunched drag volumes were larger, they were not statistically different from unbunched drag sizes collected during this investigation. The improved load accumulation time equates to a 34% increase in hourly productivity or 18m^3/PMH for cycles with bunched trees (at 283m haul distance).

TIME ELEMENTS	FRANKLIN 170 PTM 31A MEAN PER CYCLE (mins)	FRANKLIN 170 PTM 31A 95% CONFIDENCE LIMITS	VALMET RANGER F67 MEAN PER CYCLE (mins)	VALMET RANGER F67 95% CONFIDENCE LIMITS
Travel Empty	1.19	0.06	0.87	0.06
Position	0.66	0.07	0.77	0.09
Grapple	0.88	0.07	1.25	0.13
Reposition	0.89	0.09	0.85	0.11
Breakout	0.18	0.08	0.18	0.05
Blade	0.33	0.11	0.66	0.12
Travel Loaded	1.78	0.08	1.40	0.08
Drop and Turn	0.18	0.02	0.21	0.02
Fleet	0.08	0.02	0.03	0.02
PRODUCTIVE TIME	6.17		6.22	
Operational	0.21	0.09	0.15	0.02
Mechanical	2.43	3.39	0.00	0.00
Personal	0.70	0.66	0.56	0.37
DELAY TIME	3.35		0.71	
TOTAL CYCLE TIME	9.52		6.93	
NON-TIME ELEMENTS				
Travel Empty Distance	180	11.5	124	15.9
Travel Loaded Distance	178	11.4	123	8.4
Position Distance	24	2.4	22	3.3
Number of Positions	1.54	0.13	N/A	N/A
Reposition Distance	27	3.3	23	13.1
Number of Repositions	2.25	0.19	N/A	N/A
Breakout Distance	0.3	0.44	0.17	0.6
Blading Distance	7	2.2	16	3.4
Number of Longs	2.50	0.13	2.51	0.17
Number of Shorts	0.61	0.16	0.51	0.15
Drag Volume	6.47	0.24	6.11	0.29
Piece Size	2.37	0.14	2.31	0.16

Table 3 - Franklin 170 PTM-31A and Valmet Ranger F67 work cycle

It appears from the results of the two studies that there was an apparent difference in production rates of the two machines. However, there was also a significant difference in the haul distances of the two studies. Haul distance was standardised prior to comparative analysis of the data collected on the Franklin and the Valmet. For the Franklin study, 122 cycles were selected and from the Valmet study 92 cycles were selected giving an average haul distance of 128m for the two studies. The results of the comparison are outlined in Table 4. "Yes" or "No" denotes whether or not that particular element is significantly different for the two studies.

ELEMENT	*DIFFERENT AT 0.05 SIGNIFICANCE LEVEL*
Travel Empty	*NO*
Position	*YES*
Grapple	*YES*
Reposition	*NO*
Breakout	*NO*
Blade	*YES*
Travel Loaded	*NO*
Drop and Turn	*NO*
Fleet	*YES*
Number of Longs/Cycle	*NO*
Number of Shorts/Cycle	*NO*
Drag Volume (m^3)	*NO*
Production (m^3/PMH)	*YES*

Table 4 - A comparison of the productive element means of the two studies

The productive cycle time of the Valmet was 24% (1.28 mins) longer than that for the Franklin. Almost 90% of the difference in cycle times was attributable to the longer grappling (0.5 mins), positioning (0.2 mins) and blading (0.5 mins) times during the Valmet study. This corresponds to a 24% higher production for the Franklin system. Differences in these times would suggest a possible change in work methods used by the operator for the two machines. The underlying cause of this may be that drag accumulation for the Valmet Ranger was more difficult. For instance, the manufacturers of the dual function parallelogram grapple on the Valmet acknowledge that single function grapple archs like that of the Franklin may be easier to operate, but experienced operators have found a dual function grapple to have many advantages.

CONCLUSIONS

The hourly productivity of a Franklin PTM-31A grapple skidder was found to be 63m^3/PMH with an average drag size of 6.5m^3 and an average haul distance of 178m. The hourly productivity of a Valmet Ranger F67 was found to be 59m^3/PMH with a mean haul size of 6.1m^3 at an average haul distance of 124m.

Load accumulation time was found to constitute almost 50% of the productive cycle time. Analysis of small samples of pre-bunched material suggested increases in grapple skidder productivity of up to 34% may be achieved.

A comparison of the two machines (haul distance standardised to 128m) showed that the Franklin operation was 24% more productive than the Valmet operation. The difference in load accumulation times appeared to be the reason for the difference in production of the two machines.

Research in New Zealand and overseas has established that grapple skidders are highly productive machines in large piece size, or bunched wood in flat terrain conditions. Bunching for grapple skidder extraction of new crop radiata pine shows the potential to increase system productivity.

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