ISSN 0111-6711

LOGGING INDUSTRY RESEARCH ASSOCIATION NEW ZEALAND

REPORT

Vol. 16 No. 8 1991

D4H TRACTOR AND TOWED ARCH IN RADIATA CLEARFELL

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Figure 1 - D4H Tractor with Towed Arch

ABSTRACT

A study to investigate the productivity of a D4H high drive tractor and towed arch working in a radiata clearfell operation was undertaken in Kinleith Forest. The stand was characterised by large piece sized wood ($2.7m^3$) and a 5^o favourable slope. The average haul distance was 191m and the average volume per drag was $10.4m^3$. With an average cycle time of approximately 14.7 minutes, the overall productivity of the system was $42.4m^3$/productive machine hour (PMH).

INTRODUCTION

Tractors incorporating elevated drive sprockets first appeared in 1921. They were, however, an innovation ahead of their time and were not commercially successful. Caterpillar Inc. developed the concept further during the 1960s and the first high drive tractor appeared in 1978. The high drive design is reputed to isolate final drives, steering clutches and brakes from ground-induced impact and shock loads.

This Report summarises a study to investigate the productivity of a D4H high drive

tractor with a towed arch working in a clearfell operation in Kinleith Forest.

ACKNOWLEDGEMENTS

LIRA acknowledges the co-operation of NZFP Forests Limited and logging contractor, Rex Vincent and his crew for their assistance with this study.

THE MACHINE

Table 1 - Machine Specifications

Engine (Cat 3204 turbo-charged diesel)	*74kW/99hp*
Operating weight	*10105 kg*
Travel speed :	
1st Gear	*3.5 km/hr*
2nd Gear	*6.2 km/hr*
3rd Gear	*10.2 km/hr*
Ground clearance	*376mm*

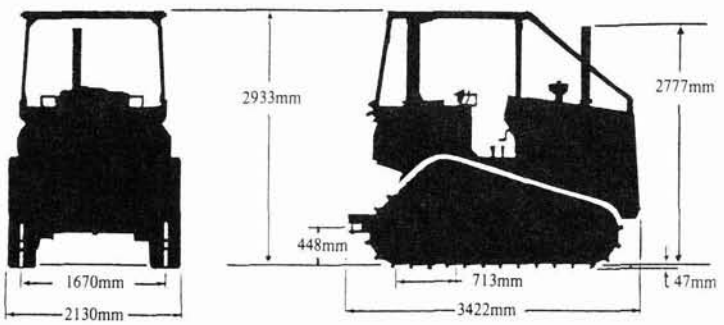

Figure 2 - Machine Dimensions

The D4H high drive tractor was purchased new by the contractor in October, 1989. At the time of the study the machine had completed 2700 hours working in radiata clearfell.

The owner stated that he had problems with the tractor's winch. When the winch was engaged from free spool, the gears occasionally had difficulty in meshing. Eventually the gears were worn to a stage where meshing would not occur and require replacing. Favourable comments included the machine's good climbing ability and its stability when traversing slopes.

STUDY AREA

The study was undertaken in an area of 1.4 hectares in Kinleith Forest. The block was long, narrow and adjacent to a site where a D4H custom skidder had previously been studied (Hill, 1991).

Table 2 - Stand Details

Stocking	*(s/ha)*	*420*
Piece size	*(m^3)*	*2.7*
Stand age	*(years)*	*27*
Slope (favourable)		*5°*

STUDY METHOD

The total duration of the study was 30 hours during which 116 cycles were completed producing 1209m^3. A continuous time study method was used to collect data from 102 cycles.

Log volume calculations from a sample of 55 stems were used to obtain a relationship between large end diameter and tree volume (r^2 = 0.89). The relationship was used to calculate individual cycle volumes.

RESULTS AND DISCUSSION

The average productive cycle time was approximately 14.7 minutes and the average drag volume was 10.4m^3, equating to a productivity of 42.4m^3/PMH (Table 3).

During normal operation, the tractor operator hooks on his own trees. In this trial, a beakerout was used and he indicated to the operator when the trees required pushing together or lifting.

Table 3 - D4H Work Cycle (n = 102)

Element	Per Cycle (mins) Mean	95% Confidence Limits (±)	occurence	Per Occasion (mins) Mean	95% Confidence Limits (±)
Fleeting	0.49	0.20	34	1.46	0.46
Travel Empty	2.36	0.16	102	2.36	0.16
Position	1.52	0.18	102	1.52	0.18
Hook on	3.40	0.20	102	3.40	0.20
Winch	1.33	0.22	100	1.36	0.22
Travel loaded	3.77	0.31	102	3.77	0.31
Unhook	1.20	0.11	102	1.20	0.11
Turn on skid	0.59	0.10	79	0.76	0.10
Productive Cycle Time	14.66	0.78			
Delays:					
Operational	0.60	0.73	19	3.2	3.97
Personal	2.20	1.60	10	22.5	11.00
Mechanical	0.14	1.14	1	11.2	-
Total Delays:	2.94	1.58			
Total Cycle Time	17.60	2.05			

Trees / cycle	3.75	0.19
Slope (favourable)	5.00	0.00
Drag volume (m^3)	10.4	0.49
Distance empty (m)	205	16.8
Distance loaded (m)	191	16.6

The best predictor of the productive cycle time was the travel empty distance. The productive cycle can be estimated using Equation (1) :

Equation (1) :

Productive cycle time (mins) =

$$\frac{(3.679 \times \text{Travel Empty Distance (m)} + 705.21)}{100}$$

$r^2 = 0.62$

Equation (2) :

Production (m^3/PMH) =

$$\frac{60}{\text{Productive cycle time (mins)}} \times \text{drag volume } (m^3)$$

Equation (2) has been used to predict production rates given a variation in haul distance and drag volume (Figure 3). A trend showed that as travel loaded distance increased, the drag volume also in-

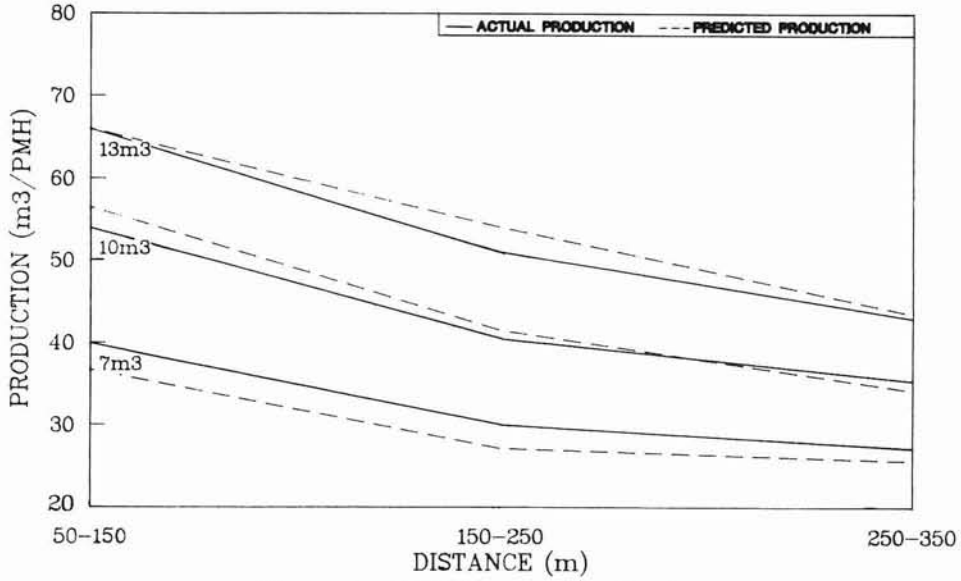

Figure 3 - D4H Tractor Production

creased. Payloads of less than $7m^3$ were only pulled up to haul distances of 200m. Likewise drag volumes greater than $13m^3$ were pulled only where haul distances exceeded 150m. The maximum payload pulled during the study was $15.7m^3$. Generally, the highest productivities were achieved with the largest payloads for all distances. It was noticed that payloads greater than $14m^3$ were difficult to breakout. The weight of the machine and its tractive performance were the limiting factors when breaking out heavy loads.

COST ANALYSIS

Using LIRA's costing format (Wells, 1981), an estimate of the daily cost of the operation was established assuming a 6 man crew (2 skiddies, 1 faller, 2 machine operators and 1 breakerout).

Table 4 - Daily Cost

		Cost ($)
D4H tractor		*385*
Fiat Ellis 645		*350*
1 work vehicle ($0.7/km)		*70*
6 men (including saws)		*1050*
Operating supplies		*60*
Total	*$*	*1915*

CONCLUSION

The study showed that the D4H tractor and towed arch was capable of producing $42.4m^3$/PMH given an average piece size of $2.7m^3$, an average haul distance of 191m and a favourable ground slope.

REFERENCES

Hill, S.M. (1991) : "The D4H Custom Skidder", LIRA Report, Vol. 16 No. 3

Wells, G. (1981) : "Costing Handbook for Logging Contractors, LIRA Handbook.

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 of the operation.

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