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THE HAHN HARVESTER IN CLEARFELL

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Figure 1: The Hahn Harvester

ABSTRACT

Short term work studies of three applications of the Hahn harvester were carried out in Kaingaroa, Kinleith and Kaweka Forests. The piece sizes across the three studies were similar and averaged 1.42m^3.

The delimber worked in two "hot deck" operations. The first was in conjunction with a rubber-tyred front end loader and a Bell Logger, the second in conjunction with a knuckleboom loader. The third study was in a roadlining operation involving processing trees from a stack "cold decked" to a landing prior to the study.

The studies showed that the Hahn harvester could successfully delimb and cut to length second crop radiata pine. The results of the respective studies indicated that productivities of 52.2m^3/productive machine hour (PMH), 40.0m^3/PMH and 42.8m^3/PMH could be achieved.

INTRODUCTION

The Hahn harvester is a processor capable of delimbing and processing trees with a maximum large end diameter of 65cm. It is designed and manufactured by Hahn Machinery Inc, Illinois, USA. Since its development in 1975, 109 units have been produced of which 20 are the latest "F" series. These are in wide use throughout both North America and Canada. The machine was introduced to New Zealand for trials and to be exhibited at the FI1990 in-forest demonstrations.

As the industry begins to harvest the second crop stands, the amount of delimbing and the importance placed on achieving optimal value from each tree will increase significantly. Performing these tasks mechanically will help improve the efficiency of the operation, improve the work environment and reduce the risk of personal injury.

Previous attempts to mechanise delimbing in New Zealand have generally been successful, however these machines are best suited to small piece sized operations (Gleason, 1984; Raymond, 1988 and 1989). To date there has not been a mobile delimber in New Zealand capable of successfully removing branches from trees of second crop size.

The advantages of the Hahn over most other delimbers is that it supports the tree on a bed when delimbing rather than suspending it from a boom. The energy used by other delimbers to support the tree is transferred to the delimbing head of the Hahn.

The Forest Engineering Institute of Canada (FERIC) have carried out evaluations of the Hahn working in a number of applications including central yard processing and a comparison of a "hot deck" landing operation to a continuous roadside operation. In the central yard application productivities of 104.5m^3/PMH (Peterson 1986a) and 42.5m^3/PMH (Powell 1981) were achieved with machine utilisation of 50.5% and 84% for the respective studies. The comparison of the two landings showed that the roadside landing was 27% more expensive (Peterson, 1986b).

The objective of the New Zealand studies was to evaluate the Hahn in second crop operations. Two "hot deck" operations (standard clearfelling) and one "cold deck" operation (roadlining) were selected for study.

ACKNOWLEDGEMENTS

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THE MACHINE

The delimber studied was the Hahn harvester HTL 300/F tree length processor. The manufacturer's specifications are summarised in Table 1. While the machine is designed for dual operators, it can be operated by one man situated in the main operating cab.

Whole trees are placed into the delimbing carriage with the self-loader. They can be aligned with the delimbing bed using either the dead heel on the loader boom or the heel which is located under the loader turntable. The large knives are able to grip the tree while the carriage is driven to the far end of the delimber by two heavy duty chains. Two hydraulically operated clamps hold the tree during delimbing. The delimbing head has five knives, four moveable and one stationary (Figure 2). The two larger knives are designed to delimb the upper sides and the top of the stem, while the two smaller knives open to delimb the lower sides. Branches on the underside of the stem are removed by the fixed knife at the bottom.

Table 1: Machine Specifications

Basic weight	*24090kg*
Dimensions:	
Height	*3.78m*
Width	*3.04m*
Length	*14.02m*
Loader:	
Hydraulic motor swing	
Lift capacity	*6.81t @ 1.5m* *1.50t @ 6.1m*
Delimber:	
Force	*7.72t @ 3.1m/s*
Carriage travel	*10.4m*
Knife opening	*65cm*
Travel speed	*12km/hr*
Tyre size:	
Steering	*17.5 x 25*
Drive	*1100R-24.5*
Cost:	
With all options included *$NZ 505,000 @ 23/5/1990*	

Electronic sensors, located at the output end of the Hahn, trigger the length measuring device so that accurate cutting to length can be achieved. Two kicker arms are located immediately in front of the sensors and are used to remove logs from the bed to either side of the Hahn.

The machine trialled in New Zealand had the colour coding option but not the diameter scanner. Although the Hahn is self-propelled, a detachable arched trailer hitch enables the machine to be towed when shifting the machine for greater distances than moves within compartments.

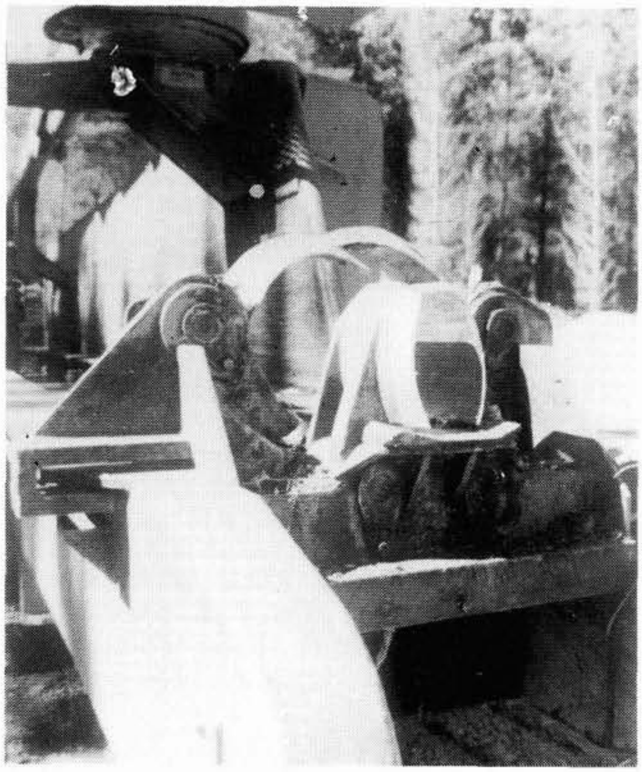

Figure 2: The Hahn Harvester showing the delimbing head and knives

STUDY DESCRIPTIONS

Stand details for each study are given in Table 2.

Study 1 - Kaingaroa Forest, Transition Crop Clearfell

Motor manually felled trees were extracted to a landing using a Caterpillar 528 skidder. A rubber-tyred front-end loader and a Bell Logger fleeted the processed logs to stacks around the perimeter of the landing.

Study 2 - Kinleith Forest, Second Crop Clearfell

Motor-manually felled trees were extracted using a Komatsu D65 tractor and a Clark Ranger 666 skidder to a small skid site occupied by the Hahn and a Sumitomo 2800 knuckleboom loader. The operation utilised approximately half the area of the skid site normally suited to the rubber tyred loaders. The trees were dropped on alternative sides of the Hahn and pushed into a pile ready for processing.

Table 2 : Stand Details

	Study 1	*Study 2*	*Study 3*
Stand Age (yrs)	*35*	*29*	*27*
Stocking (spha)	*540*	*279*	*341*
Volume per piece (m^3)	*1.47*	*1.35*	*1.45*
Branching habit	*light*	*heavy*	*heavy*

Study 3 - Kaweka Forest, Roadline Salvage

Motor-manually felled trees were extracted using a Caterpillar 518 skidder and stacked in a large "cold deck" prior to the study. In addition to the stockpile, a further 80 trees were extracted by the skidder which were processed on arrival. The small number of log sorts was fleeted to stacks around the perimeter of the landing by a rubber-tyred front-end loader.

STUDY METHOD

Detailed studies of the operations were undertaken over a 2 to 3 day period for each study site during which 312, 473 and 225 processing cycles were recorded respectively. The work cycle times were related to measured tree parameters such as large end diameter, tree form and the number of logs produced from each stem. This enabled the influence of individual tree characteristics on machine productivity to be determined. Table 3 lists the elements and element definitions.

RESULTS AND DISCUSSION

The measured cycle times and productivities of the Hahn are summarised in Table 4.

The processing time per tree was relatively consistent across the three studies. A regression of tree form versus processing time indicated that there was no relationship between the two variables.

It was noticed that heavily swept or malformed trees increased the processing time considerably. Over the three studies, 70% of the variation in the processing time was accounted for by tree size and the number of logs produced from each stem. The processing time also increased if the tree slipped in the clamps as a result of continuation of delimbing after a log length had been measured. Stem slippage was usually the result of malformations or limbs greater than 9cm in diameter.

Table 3 : Elements and Element Definitions

PRODUCTIVE:	
Processing tree	*Time to delimb and cut to length one tree*
Loading Hahn	*Time to place tree in delimbing head knives*
TOTAL PROCESSING TIME = PROCESSING TREE + LOADING HAHN	
NON-PRODUCTIVE:	
Waiting for wood	*Time waiting for skidder to bring trees*
Operational delay	*Delay due to build up of slash, processed end becoming cluttered and Hahn moving to new site.*
Other	*System delays, waiting for skiddy and waiting for loader*

Table 4 : Summary of Cycle Times and Productivities (minutes and % of cycle)

	Study 1 Kaingaroa mean	%	Study 2 Kinleith mean	%	Study 3 Kaweka mean	%
PRODUCTIVE:						
Processing tree	1.29	76.8	1.34	64.7	1.39	68.2
Loading Hahn	0.14	8.3	0.19	9.7	0.17	8.2
Sub total	1.43	85.1	1.53	74.4	1.56	76.4
NON-PRODUCTIVE:						
Waiting for wood	0.10	5.9	0.33	16.0	0.00	0.00
Operational delays	0.07	4.2	0.09	4.4	0.45	22.0
Other	0.08	4.8	0.11	6.2	0.03	1.6
Sub total	0.25	14.9	0.53	25.6	0.48	23.6
Total	1.68	100	2.06	100	2.04	100
NON-TIME ELEMENTS:						
Logs per tree	3.0		2.3		2.9	
Trees/PMH	35.7		29.1		29.4	
Logs/PMH	106.0		67.36		84.4	
m^3/PMH	52.5		39.3		42.7	
Number of cycles	312		473		225	

The time taken to load the Hahn was similar for all three studies, between 8% and 9% of the total cycle time. Actual loading times, however, were highly variable and were influenced by tree size. As loading times were a relatively small component of the total cycle time, the inexperience of the loader operator was not considered to have a significant affect on loading times.

A brief evaluation of the Hahn with one operator was carried out during the Kaingaroa study. With one operator, loading time increased by 320% and total processing time increased up to 25%.

Although the Hahn is capable of handling trees with large end diameters up to 65cm, trees over 60cm were difficult to load without damaging them in the knives. Loading times were longer overall. The larger trees, due to their weight, often jammed the delimbing carriage. To free the carriage, the head of the trees required lifting with the Hahn's loader.

The "waiting for wood" delay was the most crucial of the non-productive delays and must be eliminated to achieve greater utilisation of the Hahn. In the Kaingaroa study, the Hahn was waiting for wood 6% of the observed time as the result of the skidding distances. Planning for shorter average haul distances and/or supplementing the wood supply with another machine are likely solutions to this problem.

During the Kinleith study the Hahn was waiting for wood 16% of the total observed time. Once the trees had been pulled to the landing they were pushed into piles. The loader had difficulty in loading the Hahn from these piles as the heads became entangled and were difficult to separate.

In the Kaweka trial there were no delays waiting for wood as the Hahn was operating from a "cold deck" stockpile. The very heavy branching characteristics resulted in large slash piles. A major proportion of the 22% operational delays were attributed to shifting the Hahn so that slash could be bladed away with the skidder. In "cold decking" the neatness of the stack is critical. The "cold deck" in the Kaweka Forest trial was well presented and the Hahn loader had no problem loading from this stack.

Figure 3 : Nodal flushing and bark tear

The harvester is capable of high quality delimbing with the ability to cut nodal swellings flush and thus improve the presentation and the value of the logs produced (Figure 3). While it is possible to delimb from head to butt, log value loss can occur as there is a tendency to tear the stem. Since the logs are measured from the head, part of the premium butt log is often lost as a result of strict log length specifications. The machine should be used only for butt first delimbing.

PRODUCTIVITY AND COST

Table 5 shows the cost per cubic metre to process wood using the Hahn. The predicted values have been derived by eliminating the "waiting for wood" delay in the Kaingaroa and Kinleith studies and reducing the time taken to remove slash in the Kaweka study from 0.45 minutes per tree to 0.1 minutes per tree. This arbitrary reduction in the delays caused by slash removal has been based on the system used in Kinleith Forest. In this study, the slash piles were removed by another machine while the Hahn was operating.

Table 5 : Cost of Processed Wood

	Volume/ shift (7/PMH) hr shift	*Hahn cost $/(m^3)$*
STUDY 1		
Observed	*360*	*3.14*
Predicted	*384*	*2.94*
STUDY 2		
Observed	*274*	*4.13*
Predicted	*326*	*3.47*
STUDY 3		
Observed	*300*	*3.77*
Predicted	*360*	*3.14*

Table 6 : Kaingaroa Trial

Machinery		*Skidder operation $/day*		*Hahn Operation $/day*
Loader (935E)		*437*		*437*
Work vehicle		*39*		*39*
Labour	*(6 men)*	*891*	*(9 men)*	*1,337*
Operating costs (including chainsaws)		*147*		*97*
Skidder (Cat 528)		*524*		*524*
Bell Logger				*198*
Hahn				*801*
		--------------		--------------
Total daily cost		*2,038*		*3,433*
Production/day (m^3)		*275.00*		*385.00*
Cost ($\$/m^3$)		*7.41*		*8.92*

COST ANALYSIS

LIRA's costing format (Wells 1981) has been used to derive the cost comparisons (Table 6, 7 and 8). The costings for the Hahn operations assume that the system productivity is limited by the Hahn.

Table 7 : Kinleith Trial

Machinery		*Skidder operation $/day*		*Hahn Operation $/day*
Loader (LS2800)		*392*		*392*
Work vehicle		*39*		*39*
Labour	*(8 men)*	*1,188*	*(7 men)*	*1,040*
Operating costs (including chainsaws)		*147*		*97*
Tractor (D65)		*566*		*566*
Skidder (666)				*406*
Hahn				*801*
		-------------		-------------
Total daily cost		*2,332*		*3,341*
Production/day (m^3)		*285.00*		*326.00*
Cost ($/$m^3$)		*8.18*		*10.25*

Table 8 : Kaweka Trial

Machinery		*Skidder operation $/day*		*Hahn Operation $/day*
Loader		*387*		*387*
Work vehicle		*39*		*39*
Labour	*(5 men)*	*743*	*(8 men)*	*1,188*
Operating costs (including chainsaws)		*97*		*97*
Skidder (518)		*405*	*(2 x 518)*	*810*
Bell				*198*
Hahn				*801*
		-------------		-------------
Total daily cost		*1,671*		*3,520*
Production/day (m^3)		*120.00*		*360.00*
Cost ($/$m^3$)		*13.93*		*9.78*

CONCLUSION

The three studies showed that the Hahn harvester is capable of delimbing radiata pine typical of second crop. Provided that wood flow problems and operational delays are all but eliminated, good production rates are obtainable. Its strengths as a delimber/processor were really only tested in Kinleith and Kaweka Forests where the trees had a very heavy branching pattern.

For a successful Hahn operation the system must be designed to eliminate any disruption of the wood flow to the machine. Delays of 16% or even 6% waiting for wood could not be tolerated in a production situation. Working the Hahn out of "cold decks" is one solution to the wood supply problem. In the Kaweka trial, the "cold deck" operation was successful and alleviated the problem of wood flow to the Hahn. The anticipated problem of separating the stems from the stock pile never eventuated. Integrated planning would be required for a successful "cold deck" operation.

The main factors influencing machine productivity were; tree size, the number of logs cut from each stem and to a lesser extent the degree of stem malformation. Reducing the number of log sorts would increase productivity. Branch size under 9cm did not appear to limit the performance of the delimber. Large branches often required more than one attempt to remove them.

The Hahn is capable of higher daily production compared to conventional manual systems. Although the costs of the wood processed with the Hahn were higher for studies 1 and 2, a number of advantages accrue to both contractor and management:

1. Improved safety for fallers and skiddies is achieved.

2. The improved working environment and the elimination of manual delimbing results in higher gang morale.

3. Improved log presentation such as the removal of nodal swelling.

4. Increased gang production resulting in the potential to reduce the number of logging crews for an equivalent harvesting volume.

5. The ability of work extended hours or to double shift resulting in increased wood flow flexibility.

In Study 3, the motor manual system was more expensive. Due to the heavy branching pattern of the trees in this forest, manual delimbing can take up to 15 minutes per tree and the advantages of the Hahn as a delimber were clearly demonstrated.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook. They are only an indicative estimate and do not necessarily represent the actual costs for this operation.

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