LOGGING INDUSTRY RESEARCH ASSOCIATION NEW ZEALAND

ISSN 0111-6711

REPORT

Vol. 13 No. 26 1988

THINNING WITH SMALL CRAWLER TRACTORS

(RESULTS FROM A SURVEY OF OPERATORS)

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ABSTRACT

This Report summarises the results of a survey of seventeen operators of small crawler tractors in three localities in the North Island. It includes information on the model, age, rigging, track life, fuel consumption, pay-load, cycle times, productivity and gang structure.

INTRODUCTION

Crawler tractors were introduced into logging operations in the 1930's and were used for thinning and clearfelling in plantations and natural forests. The introduction of rubber-tyred skidders in the 1960s and their subsequent development has restricted the use of crawler tractors to steep terrain and to soils that are unsuitable for rubber-tyred skidders in wet weather.

Figure 1 : Small crawler tractor with conventional trailing arch

ACKNOWLEDGEMENTS

LIRA acknowledges the assistance provided by the staff and operators of Carter Oji Kokusaku Pan Pacific Limited, Tasman Forestry Limited and NZFP Forests Limited.

SURVEY METHOD

A detailed questionnaire was prepared and interviews with operators commenced in February, 1988. Further survey work was curtailed by the arrival of Cyclone Bola in March.

A total of seventeen operators in the central North Island and in Hawkes Bay were surveyed. Information was recorded on:

- machine performance
- production
- gang structure
- techniques
- stand and terrain

RESULTS

Make and Models of Machines

Caterpillar and Komatsu brands dominate the small crawler tractor market. Brand loyalty was strong - most operators replaced their previous machine with a newer model from the same manufacturer. Trade-in prices were often a contributing factor. The models of machine related largely to the current model in the 48-56 kW (65 to 75 hp) range at the time of purchase. The Komatsu D31A was superseded by the D37E in 1987. The Caterpillar D3B range was extended with the addition of the D3 Custom 75, later called the D4B and now available as the D4C.

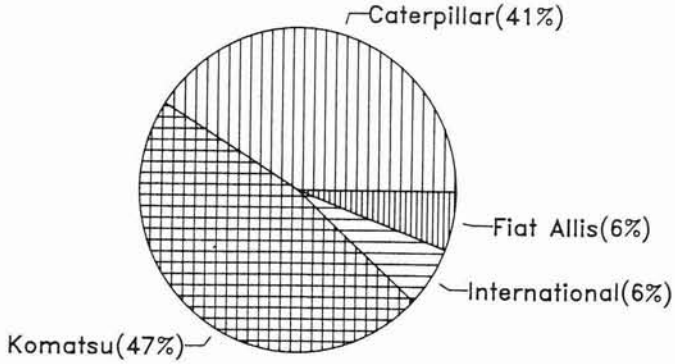

Figure 2 (a) : Makes of Small Crawler Tractors

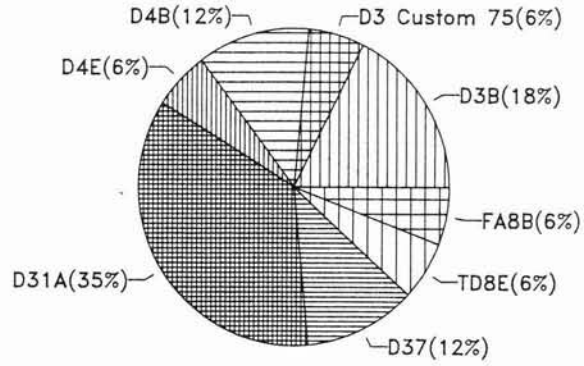

Figure 2 (b) : Models of Small Crawler Tractors

Brands and models are shown in Figure 2.

Age of Machine

The age distribution (Figure 3) shows two distinct age groups of machine. This suggests that most operators replace their small tractors between 5000 and 7000 hours. Since this survey was carried out, several of these older machines have been replaced. Few problems with repairs and maintenance were reported on the younger (under 6000 hours) machines.

Non-Standard Features

Crawler tractors for logging are available with improved guarding, a roll-over-protection canopy and a winch-mounted fairlead. Modifications made by individual operators include:

- plates welded on the blade ends to assist in fleeting logs
- a plate welded on top of the blade to protect the blade-tilt cylinder and increase blade height, reducing the likelihood of logs rolling over the blade during fleeting
- fitting a double-skinned radiator guard, covering the blade angle cylinder ports and hoses, building up the track-shoe growsers, fitting a bracket to protect the exhaust pipe, fitting a cross brace to the engine cover between the front canopy mounts, and extending and strengthening the under-carriage guarding.

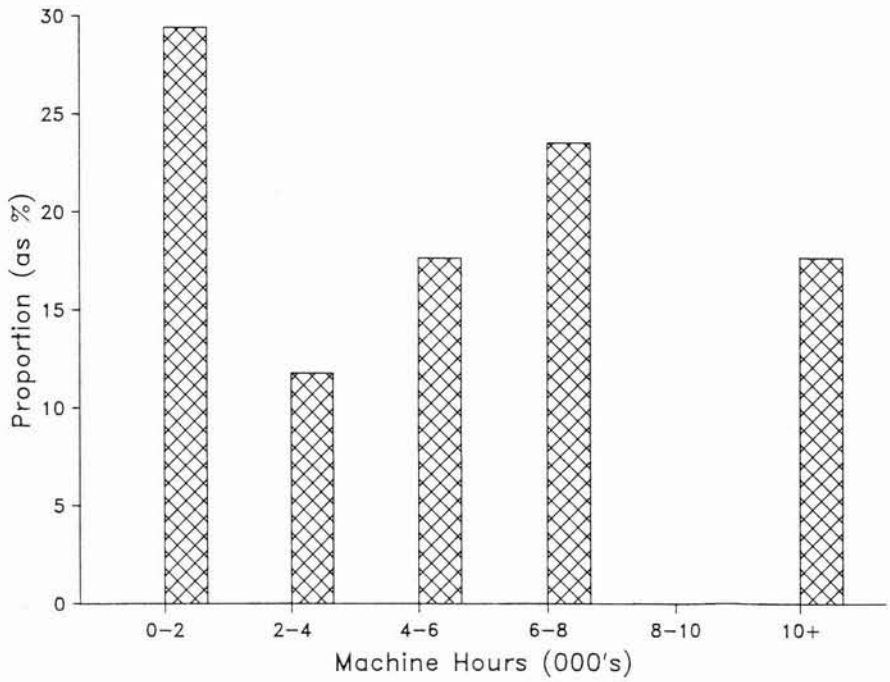

Figure 3 : Age Distribution of Small Crawler Tractors

These modifications are well described in a LIRA Technical Release (Evans, 1984) and are shown in Figure 4.

Figure 4 : Crawler tractor with modifications for logging

Arches

Integral arches were used by six of the seventeen operators and these have varied considerably in design. Seven operators used trailing arches where there was sufficient room to allow the machine to be turned. These are more common in uphill extraction or long-distance pulling on flat or easy country. Operators pulling uphill without fairleads or arches had smaller payloads and considerably shorter rope life.

There have been two developments of interest in the area of transportable trailing arches. One approach used a single-wheeled trailing arch, which could be raised easily and lowered. This Smart Arch is shown in Figure 5 and has been described in two LIRA publications (Prebble, 1986; Pritchard, 1986).

The other development involved developing a drawbar with a universal joint hooked to a conventional type of arch. This can be raised or lowered by using the winch rope. The arch is held firmly by mounts against the back of the cab (Figure 6).

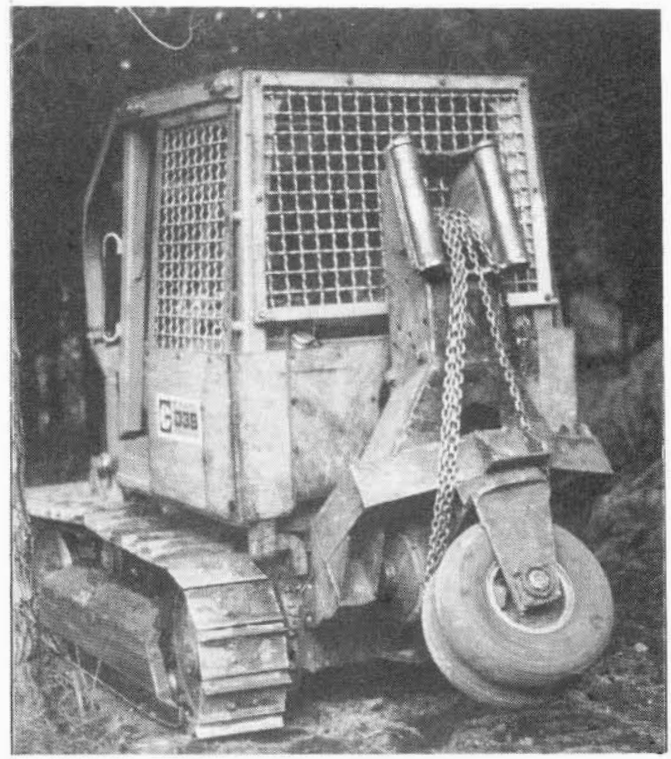

Figure 5 : The Smart Arch

Winches

Standard winches were fitted to all machines. The Komatsu winches have proved trouble-free. The only problem occurred when the rings on the rigging were accidentally pulled on to the winch and hit a bearing on the inside of the winch housing. Caterpillar winches have also proved reliable. The only problems arose with the first batch of Caterpillar 53 winches on the D3B, arising from contaminants left inside the fabricated winch housing.

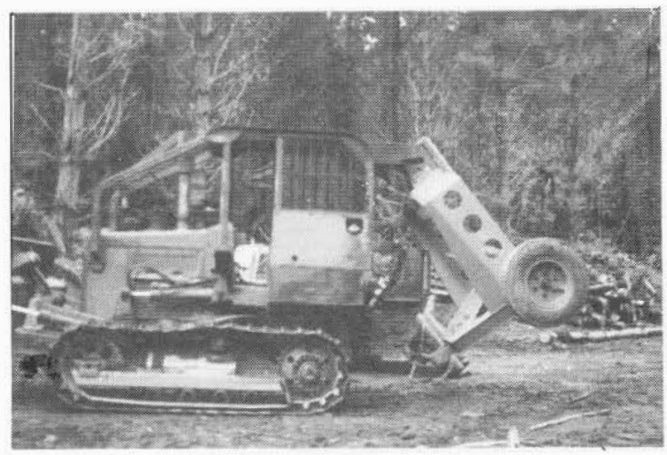

Figure 6 : Transportable Trailing Arch

Rigging

The mainropes were 16 mm (5/8") or 19 mm (3/4") and only one operator used a 22 mm (7/8") rope.

Virtually all mainropes used a 6 x 19 construction (9/9/1 with a steel core).

Mainrope life was consistent with rope size; 16 mm ropes usually lasted 200 to 300 machine hours, the 19 mm rope lasting from 350 to 750 hours and the 22 mm rope 750 to 1500 machine hours. Other experienced operators consider the lower values to be more realistic. The choice of mainrope was influenced both by piece size, the distance and slope over which mainrope had to be pulled, and whether a fairlead or trailing arch was used.

Almost all operators used chain strops, usually 7 mm or 8 mm high tensile steel. Some operators carried one or two larger chain strops to handle bigger logs. The number of logs extracted depended on the piece size required for a 2 to 2.5 tonne payload. With a larger piece size (0.5 to 0.6 tonne), only 3 to 4 strops would be required. For a smaller piece size (0.2 to 0.3 tonne), 6 to 8 strops were common and occasionally up to 10. Some operators would double-strop (two or more logs in a strop) and carried longer strops to do this.

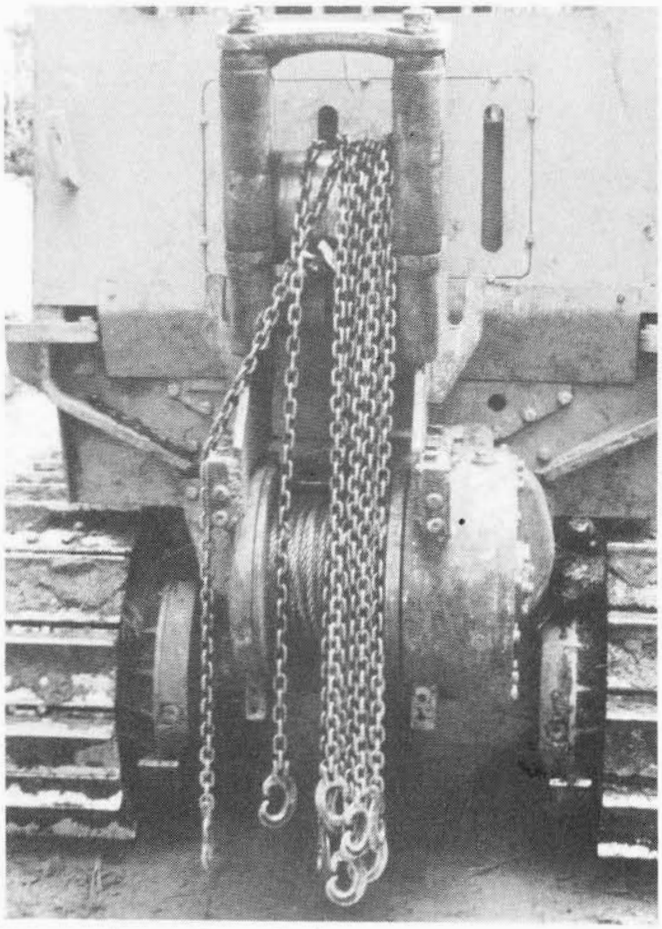

Figure 7 : Chain strops hanging *from an integral arch*

Most operators obtained more than 1500 hours from their chain strops. This was shortened when working with bigger logs or when used with larger machines pulling directly off the winch. The use of hammerlocks to join broken strops extended their life.

Track Life

In the harsh scoria conditions of Tarawera Forest, track life was reported to be between 3000 and 3500 hours. In the fine ash soils of Kinleith Forest, track life was commonly around 400 hours. At Tangoio Forest on sandy loams, track life varied from 4000 to over 5000 hours.

Track life was extended by replacing or turning worn pins and bushes, and replacing or rebuilding the drive sprockets at the same time. Growser life was extended by hard facing.

Fuel Consumption

Operators' estimates of fuel consumption were consistently in the 50 to 60 litres per work day, around 9 litres per productive machine hour. This compares closely with the estimates in the manufacturer's handbook (Caterpillar, 1986) of 7.5 to 11 litres per machine hour for a D3B operating under a medium load factor.

Techniques

Felling

The felling pattern is determined largely by extraction direction. Directional felling is used where possible.

This usually results in head-first extraction for downhill pulling and butt-first extraction for uphill pulling.

Extraction

On easy terrain, the machine travels directly to the landing

over existing tops and branches. For downhill extraction on moderate terrain, the operator will usually travel up the extraction track before turning and backing up. Climbing tracks with slopes up to 24° were recorded during the survey.

On terrain that is too steep for the machine to turn, a climbing track is formed on a suitable gradient to provide access to the top of the block. Where terrain permits, an operator will then travel forwards over the tree-length logs, hooking on the small end as the machine goes downhill. Maximum slope is reported as being around 32° (Travers, 1986).

Uphill extraction on steep terrain requires the formation of tracks to provide access. Some skilled operators prefer to do more tracking and reduce the amount of winching required. Other operators, especially when working on terrain that is more difficult to track, find it more productive to fit a longer winch rope and increase the winching distance.

Piece Size

The average extracted piece size recorded during the survey provided two distinct size classes: .25 to .35 m^3 and .40 to .50 m^3. These were a reflection of stand age and silvicultural treatment. Comparison of the average piece size estimated from stand data compared reasonably well with that obtained by measurement, suggesting that the stand data was reasonably good and that operators were extracting the trees marked for thinning.

During the survey, two small crawler tractors were operating in clearfelling situations; one was pulling Pinus pinaster of 0.8 m^3 piece size and the other pulling a small area of young radiata pine of 1.2 m^3 piece size.

Payload

Individual payloads varied considerably but most fell in the 2.0 to 3.0 tonne range. This was dependent on machine size, whether the operation involved uphill or downhill extraction, they were head- or butt-pulling and whether a trailing arch was used.

Haul Distance

In the central North Island where topography favours down-hill extraction, the average haul distance is planned to be in the 100 to 150 metre range. Individual operators suggested their average haul distances were closer to 200 metres, with a maximum of 300 to 350 metres and occasionally up to 400 metres. This difference is attributed to one being a map distance and the other being a slope distance which included a wander factor (deviation from a straight line to achieve a practical extraction track).

In the steeper terrain of Hawkes Bay, with predominantly uphill pulling to ridge top landings, average haul distances were more commonly in the 200 to 300 metre range.

Maximum haul distance was 400 to 450 metres and occasionally higher to reach the back of stands.

Figure 8 : Small crawler tractor extracting thinnings off steep terrain in Tarawera Forest

Cycle Times

Individual cycle times recorded during the survey varied widely, with haul distance being a major variable. Most operators considered average cycle times would be 15 to 25 minutes, depending on haul distance and whether they were uphill or downhill pulling. On the basis of a 6.5 productive

machine hour day, this would correspond to 16 to 26 drags per day.

Productivity

Daily targets for thinning operators varied from 28 tonnes/day to 50 tonnes/day, depending on average haul distance, uphill or downhill pulling and average log size. Most contractors were able to achieve these targets. As mill demand for thinnings is usually fixed, most contractors are not permitted to exceed their target.

Gang Structure

The most common gang structure was two fallers and one operator in the larger piece size (0.4 to 0.5 m^3) and three fallers and one operator in the smaller piece size stands (.25 to .35 m^3). As the opportunity arose to increase their production, the more innovative contractors added additional machines and employed another operator. These machines included a skidder, a Bell Logger, a rubber-tyred front-end loader and a grapple processor.

One contractor employed three machine operators, seven fallers and one skidworker/faller. The tractor was used to extract off the steep terrain and left the material bunched at the base of the hill for the skidder to collect and extract to the landing. All easy terrain was worked by the skidder. A Bell Logger sorted and stacked on the landing. When time permitted, the Bell Logger extracted from close in and bunched on the easy terrain for the skidder. This better utilised these machines in the mixed setting of easy and steep terrain.

A second contractor used a skidder and a crawler tractor pulling whole trees to a grapple processor. This system is described in a separate LIRA Report (Duggan, 1988).

In some gangs, the machine operator would hook on. The fallers would keep one to two days ahead, reducing the level of interference and the effect of absenteeism on machine production. Other operators required the fallers to assist with hooking on; this produced a better standard of wood presentation, reduced isolation and maintained production pressure.

Work Days

Work days usually involved 7.5 to 8 hours on the job with one to two breaks of thirty minutes. Saturday work is uncommon but owner-operators will often spend Saturday morning on the job carrying out routine maintenance and minor repairs. The gang boss, usually the prime contractor, puts in additional time at night to deal with the day-to-day aspects of managing men.

The prime contractor is becoming more involved in the business aspects of contracting. He now spends time with his accountant, bank manager and machinery supplier.

CONCLUSION

Small crawler tractors have proved to be versatile and reliable machines that provide forest owners with an alternative to cable haulers for thinning steep terrain forests where environmental conditions permit.

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