Small Scale Forest Grower Options: Fully Mechanised Waste Thinning

Summary

Finding experienced manual thin-to-waste crews for a timely forest thinning operation is becoming increasingly difficult. The forest industry is trending away from manual work wherever possible in the drive to improve worker safety and well-being. Increased mechanisation combined with the decline in available manual thinners is leading to more fully mechanised thin-to-waste operations in both large and small forests.

Forme Consulting Group Ltd recently observed a mechanised thin-to-waste operation in Kaingaroa Forest. While the study was undertaken in a large corporate forest estate, the terrain and tree crop of the stand being thinned was similar to that often found in small-scale forests and woodlots, with small, sharp incised gullies and awkward drop offs.

The data collected during the study along with current industry machine and crew costings enabled us to calculate an estimated $/ha mechanised thin-to-waste cost that can be compared to industry benchmarked manual thin-to-waste costs. Based on observations during this study, estimated costs ranged from $1,220 – $1,370/ha for a man and machine to mechanically thin a block. This compares with the $1,000 – $1,400/ha range internally benchmarked for a manual thin-to-waste crew.

The use of smaller ‘zero swing’ machines in mechanised thinning operations results in minimal ground disturbance in the right soil / weather conditions and little damage to residual trees. Our conclusion is that with the right combination of machine, operator and forest conditions, mechanised thin-to-waste operations are cost-effective and operationally viable, and should be considered by small forest and woodlot owners.

This report is the sixth in a series produced by Forme Consulting Group Ltd.

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Introduction

Over the past ten years or so, forest harvesting in New Zealand has become increasingly mechanised. This has primarily been to improve worker safety. Increased mechanisation has generally reduced the number of workers in a crew, and like other primary industries, forestry is also suffering from a widespread labour shortage.

One outcome of having smaller crews and pressure on the workforce in general is that it is becoming harder to find experienced and motivated labour for manual waste thinning operations. Small forest owners in particular are finding it increasingly difficult to obtain suitably qualified and experienced contractors to thin their forests to an appropriate final crop stocking.

Mechanical waste thinning provides an opportunity to combat the highlighted labour shortage. Mechanised operations not only increase the safety of workers, but also improve their working environment.

To understand the opportunity for mechanised waste thinning for small forest owners, a mechanised waste thinning operation in Kaingaroa Forest, managed by Kaingaroa Timberlands Ltd, was observed for a few days. This operation was selected due to the certainty of work programme for a time and motion study, alongside the fact the operation was being undertaken in an area of Kaingaroa not dissimilar to that often found in woodlots, with small sharp incised gullies and awkward drop offs to navigate. This area is purposely waste thinned by Kaingaroa Timberlands because of the unsuitable conditions for effective production thinning which happens elsewhere in Kaingaroa Forest.

Woodlot harvesting in New Zealand

The forest planting boom in the 1990s has resulted in a preponderance of small forests and woodlots which have recently been harvested or are due for harvest in the next few years. Many of these forests have or will be replanted due to their location, Emissions Trading Scheme obligations or with the view of increasing returns for the second rotation. Alongside this, Government regulations proposing permanent and rotational forests that are incorporating the improved economics of carbon forestry will require appropriate management and will at the very least require a waste thin for forest health and crop condition purposes. All these forests will need to be thinned but with a diminishing skilled labour pool and more stringent health and safety requirements, potentially pushing the available options further towards mechanised waste thinning operations.

Thinning System

Observations were undertaken and supporting information collected over three days in late November 2022 in a range of weather conditions to gain an understanding of the capabilities of a mechanised waste thinning operation in Kaingaroa Forest in the Central North Island.

The machines were owned and operated by Tombleson Logging, owned by Nick Tombleson.

The operation involved three CAT 315F excavators fitted with Ensign or 350 Wood Cracker Heads, which are a fixed rotating shearing head. The machines were zero-swing models to increase manoeuvrability through the tight spaces and avoid damage to remaining crop stems.

Fig 1: Cat 315F excavator.

Fig 1: Ensign fixed shearing head

The crew consists of three operators and a fourth manual faller who fells difficult to access or small

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sections. The manual faller also completed QC plots to assess stocking in the thinned areas.

Forest Information

Operations were located on the eastern edges of Kaingaroa Forest, near the Whirinaki ranges.

The forest stand was established in 2011 with *P. radiata* seedlings at approximately 833 stems per hectare (sph). Recent inventory plots recorded a current stocking of 741 sph after an initial manual waste thinning occurring a few years prior. This mechanised operation was targeting residual stocking of 450 sph (range: 400 – 475 sph),and aiming for a rectangular spacing of 4.7 metres between trees.

Fig 2: Working from a forest access track.

Study Approach

Time studies were carried out on two of the three thinning machines, capturing the different work elements involved. Operational time was analysed as well as delays, which were categorised and used in the data analysis where appropriate.

The weather was very wet and soil conditions soft but well-draining, characteristic of Kaingaroa pumice land. Machine slippage was observed on some slopes; however in general this was a combination of avoiding tree damage and utilising existing cleared tracks to traverse, rather than machinery limitations. In general, the single-pass nature of the felling machines' activities meant that they were not affected by ground conditions. The clear production benefit of a machine over a man on the ground was evident when observing the time taken to travel between trees as hindrance from e.g. felled trees or branches was not a factor in the machinery's movement. The machine could therefore travel faster from tree to tree than any manual thinner.

Data Presentation

Four elements were captured during the study: Felling, Positioning, Clearing, Delays (Operational, Mechanical, and Other). Table 1 shows a summary of the total study time across the two machines and the total working time used for data analysis.

Table 1: Study times summary

	Time (mins)
Felling	558.6
Positioning	228.4
Clearing (Stem Management)	29.3
Delay, Operational	132.4
Delay, Mechanical	296.8
Delay, Other	29.3
Total Time	**1,274.9**
Total Working Time	**816.3**

Operational, mechanical, and other delays were observed during the study, with two mechanical delays observed. One of these mechanical delays was a blown machine hose that resulted in a delay of over four hours (249.5 minutes). Although this delay was recorded as part of the total measured study data, it was removed from the total study time, due to the delay making up 19.5% of the total recorded study time and therefore distorting total recorded study time.

All other delays contributed 20% of the study time (209 mins) resulting in a utilisation (calculation of working day less delays) of 79.6% (382.1 mins, assuming a normal working day of 480 mins).

To quantify the productivity of the study and compare mechanical waste thinning to traditional chainsaw waste thinning, a hectares per day per man and machine value was determined. Total working time per tree, total trees culled in the study, thinning prescription and working day less delays were used to calculate the hectare per day per man-and-machine rate of 0.866 ha.

Table 2: Data analysis summary

Total working time (mins)	816
Total trees culled in study	1,238
Mins per tree	0.451
Total working time per tree	0.659
Normal working day (mins)	480
Working day less delays (mins)	382.1
Culled trees per ha	291
ha per day per man & machine	**0.866**

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Machine Costing

Indicative daily costs of operating the excavator with shearing head were estimated using commonly used machine costing methodology. Costing of forestry equipment is heavily reliant on individual and specific operator preferences and circumstances and therefore resultant methodologies can provide a variety of quantum outcomes. Rather than rely on any one methodology or introduce any perception of bias we have adopted two common forestry equipment costing approaches: Firstly, "Business Management for Logging, 3rd edition 2020", Future Forests Research (FFR).

This is a later version of the costing handbook for loggers first produced by the NZ Logging Industry Research Association (LIRA) in 1981 and subsequently reviewed and updated in 1994 by LIRO and later in 2009 by FFR and the Blackburne Group, Chartered Accountants.

Secondly, "Informe Harvesting 2023", Forme Consulting Group Ltd, displaying daily rate estimates, based on an independent survey of harvesting equipment, vehicles, labour, and overheads.

This publication, widely subscribed to by industry participants, is based on a comprehensive costing methodology developed for managing harvesting operations during the last 20 years of the NZ Forest Service.

The fundamental inputs and outputs have been identified for each of the methodologies in the following tables, along with the relative merits and differences of each methodology.

Table 3: Key cost inputs – machinery

Key Cost Inputs	
Purchase price (Machine & Shearing Head)	$ 342,000
Power (kW)	80
Standard hours	1,400
Variable hours	1,400
Life (hrs)	8,280
Cost set of tracks	-
Fuel	$ 2.02
Interest/Risk	10%
Insurance	2.7%

Table 4: Indicative daily machinery costs

	Informe	BMOL
Depreciation	$ 196.86	$ 196.85
Interest/risk	$ 126.22	$ 98.38
Insurance	$ 45.73	$ 26.23
R & M	$ 232.07	$ 147.64
Fuel	$ 150.79	$ 180.51
Oil	$ 18.95	$ 27.08
Tracks	$ -	$ -
Overheads	$ 53.70	$ -
Total/hour	**$ 138.37**	**$ 113.59**
Total/day	**$ 824.33**	**$ 679.69**

Note: Individual cost components vary between the differing approaches to costing e.g. BMOL is based on 75% borrowed capital, whilst Informe is 70%, differing fuel consumption formula, no overhead component in BMOL etc.

Crew Costing

To complement machinery costing we have constructed a crew costing based on a single man operation. The costing incorporates wages and a vehicle for a one-man crew.

Table 5: Daily single crew cost

	Informe	BMOL
Machine	$ 824.33	$ 679.69
Vehicle (120 km/day)	$ 119.51	$ 118.54
Crew Accessories	$ 81.17	$ 81.17
Labour ($42.48/hr, 8 hrs)	$ 339.84	$ 339.40
Total/day	**$ 1,364.85**	**$ 1,218.80**

Data Analysis

With a productivity rate of 0.866 ha per day per man and machine along with two indicative machine costings, a $/ha rate for the mechanised waste thinning was determined. This $/ha rate is now in a comparable unit format so that the cost of mechanised and manual thin to waste operations can be compared.

Table 6: Indicative machine cost per ha

	Informe	BMOL
ha per day per man & machine	0.866	0.866
Cost per day ($/day)	$ 1,364.85	$ 1,218.80
Cost per ha ($/ha)	**$ 1,576.40**	**$ 1,407.72**

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Benchmark costings show that the cost for manual thinning has increased dramatically over the past few years. An internal benchmark database of costs identifies a generic cost for manual waste thinning in framing stands of $1,000 – $1,400 per hectare. These manual waste thinning rates can be compared to the calculated mechanised waste thinning rates above. However, it is important to identify that waste thinning contract rates are very specific to the prescribed blocks characteristics such as mean tree height, walking hindrance and slope classification.

Mechanised Thin to Waste Options for Small Growers

We noted that residual stand damage was minimal, testament to the care and skill of the crew operators. We see no reason why similar mechanised thinning operations, which are common in other parts of the world and often on much more difficult topography, cannot become a normalised practice in our industry.

Small scale forest growers considering a mechanised thin to waste operation may need to bear the following in mind:

1. Condition and topography. While the equipment used in mechanised waste thinning utilises small highly manoeuvrable machines that leave little damage to the residual crop, stocking is a key consideration for accessibility to cull stems. This includes the consideration of topography where steeper slopes can affect the productivity and ability of the operator to protect the residual stand. However, smaller, more powerful, and sophisticated felling equipment is increasingly available.
2. Lack of local manual thin to waste crews. These crews are becoming harder to find for a variety of reasons, so prompting the need to consider mechanised thin to waste. However, to maximise the productivity and safety of these smaller machines, forest stands need a timely thin to waste operation. Leaving the stand to grow too long can result in increasing costs to thin due to the need for advanced felling skills, or even the inability to thin by machinery altogether if trees grow larger than the machinery capabilities.
3. A potential option to increase the working terrain of the machinery is to pair it with a traction assist machine like a T-WINCH (Small Scale Growers series No.4 (Palmer & Schrider, 2022)). This will allow the thinning machine to safely traverse steeper slopes while still only requiring one operator as the T-WINCH is remote controlled. Introducing more machines to the system will increase the thinning cost, and adjustments to silvicultural practices may be required to run a cable between the machines, however as the available labour pool decreases for manual thinners, forest owners will have to look to new methodologies to continue to meet forest health and quality requirements.

Conclusions

Across the forestry sector workers are being taken off the ground and put into machines. As safety concerns for manual thinners increase, the demand for, and availability of, mechanised thin to waste operators will likely grow.

There is increasing availability of smaller and more sophisticated equipment and the shift in tree harvesting from motor manual to mechanised harvesting is creating opportunities for growers at all scales to consider mechanised thinning and harvesting operations.

Although this study was performed on a large-scale corporate forest, we see no reason why mechanised thin-to-waste operations cannot be adopted by small growers. The $/ha cost of mechanical thin to waste determined in this study is comparable to that of manual thin to waste operations, making it financially viable for small growers under the right conditions while simultaneously creating a safer environment for forest workers.

References

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