T-WINCH 10.2: A versatile traction-assist solution

Summary

Harvesting small forest blocks which have difficult access and steep slopes can be extremely challenging and cost prohibitive. In some cases growers risk receiving little or no return for their forest investment. Finding a suitable, cost-effective harvesting system in these situations can be taxing for forest owners and harvesting contractors alike.

Woodlot crews often use less expensive, older or second-hand machines to try and reduce daily costs as the nature of woodlot harvesting often means that machinery is not fully utilised. Productivity is relatively low, with fewer tonnes harvested per day than by similar crews based in large, commercial forests.

Incorporating specialist machinery like winch- or traction-assist machines to increase productivity and safety can result in very high overheads, pushing harvest costs up and reducing returns to the forest owner. Slightly cheaper, versatile machines can have a positive impact in these situations.

Forme Consulting Group Ltd completed observations and research on a T-WINCH 10.2 machine used by Northland contractor Peter Davies-Colley, as part of a woodlot harvesting system used in small Northland forests. The system also incorporates reconfigured MAN fertiliser trucks as forwarders, which reduces capital expenditure on roading.

Our research confirms that effective incorporation of the T-WINCH 10.2 into a mechanised small-scale harvesting system can assist in addressing several of the challenges faced when harvesting woodlots on steep slopes. The T-WINCH 10.2 has relatively low capital cost. It provides extra traction and safety, and has expected low repairs and maintenance outgoings. Minimal ground impact and low fuel consumption contribute to positive benefits in an increasingly carbon constrained environment.

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

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Introduction

The use of winch-assist machines has increased markedly in forest harvesting over the past five years in New Zealand and overseas. Winch-assist technology gives harvesting contractors the ability to safely harvest trees in fully mechanised operations on ground previously suitable only for cable hauler operations combined with manual felling. Winch-assist machines have also resulted in an increase in the area of viable terrain for fully mechanised felling operations, both for ground-based and hauler crews.

Operating safely is the primary concern around felling machines working on steep slopes. Early systems used a wire rope attached to the felling machine, which provided an added level of safety for the machine as it traversed up and down the slope. As this technique gained, the benefits of having machines attached to a winch of some description became apparent, and ideas around 'traction-assist' technology began to develop.'

Traction assist provides both better safety and improved productivity of machines on the felling slope.

One traction-assist machine is the T-WINCH 10.2, manufactured by Austrian company EcoForst and distributed throughout New Zealand and Australia by FORCO.

Woodlot harvesting in New Zealand

The forest planting boom in the 1990s resulted in many small forest woodlots which are now becoming ready for harvest. Many of these woodlots were planted on broken or steep country, often in the back blocks of a farm. Building roads to many of these

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blocks cannot now be justified; often it is difficult to create a landing large enough for a cable hauler in small blocks as well. Innovative systems to harvest such small, remote block efficiently and safely are needed if growers are to receive decent returns on their investment in forestry.

A review of the literature reveals numerous publications about winch assist machinery in New Zealand and worldwide. Authors have delved into rope tensions, allowable safe working loads, productivity and utilisation rates of machines. In certain winch-assist situations, machine utilisation can be as little as 50% (Leslie & Koszman, 2019). Generally the literature focuses on felling machines: limited studies have been completed on traction-assist extraction, where the winch machine may be hooked up and working the whole time to provide traction assistance.

Traction assist can result in lower soil disturbance and reduced traction loss. A machine loses traction when the gravitational force pulling the machine down is greater than the traction force. The benefit of a winch-assist or traction-assist machine is to increase the traction force therefore increasing the slope limit on which a machine is able to operate (Pedofsky & Visser, 2019). Often, only a small amount of additional assistance force is required to overcome the force of gravity and avoid traction loss.

High capital costs of conventional harvesting equipment, lack of economies of scale, long distances to markets, and lack of relevant experience amongst harvest planners and harvesting contractors are some of the challenges facing woodlot owners. An added challenge on farms is maintaining day-to-day farming operations while harvesting is on-going and ensuring the woodlot is left in an acceptable environmental state. Utilising traction assist effectively appears to reduce machine rutting and tracking and allows for shovelling on steep slopes, reducing the amount of skid tracks being cut into slopes. This can greatly reduce the total amount of earthworks required, and topsoil disturbance, in harvesting a woodlot.

Harvesting System Observed

Observations of a T-WINCH 10.2 being utilised by harvesting contractor Peter Davies-Colley in a small woodlot harvesting operation east of Whangarei were made over three days in late May 2022, in a range of weather conditions. The aim was to gain an understanding of the capabilities of the T-WINCH 10.2 in a woodlot harvesting system.

The operation involved a felling machine, two excavator loaders and three of Peter's own MAN forwarding trucks. This system used both shovelling and forwarding extraction to reduce the amount of bulk earthworks required to harvest the block, reducing environmental risk and capital investment for the landowner.

The T-WINCH 10.2 was used by both the felling machine and shovelling excavator. It can be attached to a standard excavator undercarriage, and the felling machine had been modified by adding a drawbar to allow for increased manoeuvrability when tethered, a common modification to excavator-based machines using tethers.

Fig 1: T-WINCH 10.2 and felling machine.

The T-WINCH 10.2 is designed to assist machines working on a slope while in motion. The machine performing operations on the felling face still moves under its own power and should remain stable as the T-WINCH 10.2 is not designed to 'hold' the machine on the hill, contrary to other designs with much larger winch machines and rope diameters. Nevertheless, the added security of an anchored tether machine aiding stability and traction, allows machines and operators to travel to, and work on, steeper slopes where they would be unlikely to manoeuvre safely or efficiently without the assistance of the tether.

T - WINCH 10.2 Specifications

The T-WINCH comes in two models, the 10.2 and the larger 30.2, which has been designed to 'hold' machines on the hill with increased rope diameter, pulling force, and line speed for heavy duty high production winch-assist applications. The smaller T-WINCH 10.2 traction-assist machine is potentially more economically feasible for smaller logging crews while providing a high level of versatility that suits small woodlot harvesting.

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Table 1: T-WINCH 10.2 key specifications.

KEY SPECIFICATIONS - T-WINCH 10.2	
DIMENSIONS	
Length	4290 mm
Width	2250 mm
Height	2120 mm
Weight	10,000 kg
ENGINE	
Diesel Engine	FPT N45 Tier4
Max power output	125kW / 170 HP
Fuel tank capacity	210 L
WINCH	
Max pulling force	100 kN (10-11T)
Max pulling speed	4 kph
Rope diameter	20 mm
Rope length	500 m
Rope Breaking Strain	356 kN (~36T)

The T-WINCH 10.2 has an auto-tensioning winch system which provides a constant force at the pre-set tension level (0.5T increments from 1.5T up to 10T max pulling force). By monitoring the tension multiple times per second, the T-WINCH spools out or winds in rope to remain at the desired amount of tractive assistance.

Machine costing

Forestry equipment costing is heavily reliant on individual and specific operator preferences and circumstances and costing methodologies can provide a wide range of outcomes. Indicative daily costs of operating the T-WINCH 10.2 were estimated using the machine costing methodology "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 updated in 1994 by LIRO and later in 2009 by FFR and the Blackburne Group, Chartered Accountants.

The machine costing used in this study provides (i) a daily cost range based on full utilisation of the machine, i.e. 6.1 productive machine hours per day, and (ii) a 50% utilised machine at 3.0 productive hours per day.

The fundamental inputs and outputs are identified in Table1. See Appendix 1 for full details.

Table 2: Indicative cost inputs and outputs for T-WINCH 10.2

MACHINE COSTING 1			
Machine - Function		**Winch**	**Winch**
Type		T-WINCH	T-WINCH
Power (kw)		125	125
Year purchased		2022	2022
Machine Life	Workdays per year	230	230
	Productive Hours per day	3	6.1
	Hours per year	690	1403
	Hours to be owned?	10000	10000
	Machine Life (yrs)	**14.5**	**7.1**
Fixed costs			
Capital Cost	Current price	$445,000	$445,000
	Resale value (as a % of cost)	75%	75%
	Depreciation ($/Workday)	**$ 33.38**	**$ 67.86**
	Interest ($/Workday)	**$ 119.84**	**$ 121.05**
	Insurance ($/Workday)	**$ 51.29**	**$ 51.81**
Total Fixed Costs ($/Workday)		**$ 204.51**	**$ 240.72**
Running costs			
	Fuel Cost	**$ 48.75**	**$ 99.13**
	Oil Costs	**$ 12.19**	**$ 24.78**
	Repairs and Maintenance	**$ 16.69**	**$ 33.93**
	Rigging	**$20.44**	**$41.56**
Total Running Costs ($/Workday)		**$98.07**	**$199.40**
Total Machine Rate ($/Workday)		**$302.57**	**$440.12**
Total Machine Rate Per Hour		**$ 100.86**	**$ 72.15**

Production Benefits

- Fuel consumption of the T-WINCH 10.2 is low compared to similar winch-based machines, averaging only 5 – 6L per hour. This figure was verified by monitoring fuel tank levels over the three days of observations.
- Fuel consumption by tethered machines is reduced due to traction assist on slopes. While hard to quantify, the visual indicators of decreased slipping or traction loss while manoeuvring around the slope were obvious to the observers.
- The T-WINCH is a small machine with a small footprint. This allows unique placement options (Fig 2) such as mid-slope roading and small landings.
- Fast line speed for tracking up and down the slope quickly, as well as appropriate line speed for wheeled machines.
- Remote controlled machine – does not require second operator to use the machine or the machine can be shared between multiple skilled operators throughout a working day.
- Increased productivity and range when shovelling on slopes as excavators can walk up and down slopes at similar speeds to traversing flat ground.

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Fig 2: Unique placement options available for versatile skid size or layouts

- Increased safety when working on slopes. While the T-WINCH does not hold the machine on the slope in place, the tractive effort provided by the rope allows a more stable placement and manoeuvring of the machine, ultimately leading to increased operator safety and reduced fatigue.
- Automated rope tensioning - the T-WINCH measures tension multiple times a second to ensure the rope tension is kept at a constant setting, as set by the operator up to 10T of tension. This allows the machine to reduce the likelihood of shock loading on the rope and allows the operator to focus on the task at hand.
- Decreased track slipping on steep faces due to the traction assist reduces scouring and therefore reduces the likelihood of water channelling and subsequent topsoil erosion caused by heavy rainfall.

Fig 3: Ground disturbance after multiple passes of excavator attached to T-Winch

Versatility

One of the clear benefits of a T-WINCH 10.2 is its versatility to fit into a multitude of different operations, especially related to woodlot harvesting. Some of the observed versatility benefits are as follows:

- Extremely manoeuvrable due to the small footprint of the machine. This allows it to easily traverse existing narrow farm tracks or ridges.
- T-WINCH 10.2 can winch itself into difficult to access areas.
- Rope can be manhandled up and down slopes due to lower weight than conventional winch ropes.
- T-WINCH 10.2 can use its blade to flatten a small area for secure winching.
- T-WINCH 10.2 can be transported on an 8-wheeled transporter due to compact size and weight, or even transported on a forwarder within forest (Fig 4).

Fig 4: T-WINCH 10.1 transported within the bunk of a forwarder

- T -WINCH 10.2 can be used with an EcoForst block (a type of pulley) to allow for 90-degree changes in rope direction. Having a good understanding of rope dynamics and loading within ropes is important.
- Two 10.2 T-WINCHES can operate together, synchronised via one remote control to provide 20 tonnes of pulling power through a two-rope system for larger jobs (Fig. 5). The total purchase cost of two 10.2 T-WINCHES is similar to that of a single larger machine. Having two machines provides versatility, as the machines can be operated independently or together as a synchronised system.

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Fig 5: Two synchronised T-WINCH 10.1 machines providing 20T of pulling force.

- Easy to switch T-WINCH between two or more machines, there is no integration required between the T-WINCH and the tethered machine. Only the remote control needs to be swapped between machines (Fig 6).

Fig 6: Two examples of the T-WINCH remote control attached within the cab of a tethered machine. This can be achieved using different mounting systems which can easily be removed and swapped between machines. The photos above are two examples of different places to mount the remote control, depending on how frequently it needs to be monitored or used.

Constraints

Few constraints were observed, apart from the T-WINCH 10.2's lower allowable rope tension loads compared with other winch machines on the market. The T-WINCH 10.2 is marketed as a traction-assist machine rather than a winch-assist machine and the main constraints may come down to the tendency for operators to misuse the equipment, overloading the rope in ways it is not designed for (cutting into trees, over stumps or double purchasing etc).

Conclusions

The T-WINCH 10.2 provides logging contractors with a cheaper and smaller alternative to larger winch-assist machines available within New Zealand. The relatively low purchase price makes it a potentially viable addition for lower production logging crews often employed to harvest small woodlots.

The increased productivity, safety and environmental outcomes of decreased track slippage and skidding by large track-based machines on the felling face were evident when observing the operation in Northland. The inclusion of a T-WINCH 10.2 allowed for careful planning, felling and extraction of trees on steep slopes which otherwise would not have been safely accessible by conventional ground-based logging machines.

The need for traction-assist and winch-assist machinery has increased markedly as both ground-based and hauler crews become increasingly mechanised. Small-scale harvesting contractors need versatile and cost-effective harvesting machinery. The T-Winch 10.2's relatively low up-front cost, resultant increased productivity, and potential for cost savings elsewhere in the operation, make it a very good option for small-scale crews: large-scale crews may also find a cost-effective role for this machine in some circumstances.

References

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Acknowledgements

Support and funding for this project was provided by New Zealand Forest Growers Research Limited and the New Zealand Forest Growers Levy Trust.

The ready assistance and co-operation of Peter Davies-Colley and his harvesting team is gratefully acknowledged.

Supporting specifications, information and photos provided by Ian Wilton, Managing Director of FORCO.

Note: This study focused on the T-WINCH 10.2. An earlier model, T-WINCH 10.1, also features in some of the images. The 10.3 model is due to be released shortly.

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Appendix 1: Full Machine Costing Printout

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Machine - Function		**Winch**	**Winch**
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Power (kw)		125	125
Year purchased		2022	2022
Machine Life	Workdays per year	230	230
	Productive Hours per day	3	6.1
	Hours per year	690	1403
	Hours to be owned?	10000	10000
	Machine Life (yrs)	**14.5**	**7.1**
Fixed costs			
Capital Cost	Current price	$445,000	$445,000
	Resale value (as a % of cost)	75%	75%
	Current used price (after hours to be owned)	$333,750	$333,750
	Tyre/Tracks life (hrs) *	10,000	10,000
	New tyre/tracks price	$0	$0
	Annual depreciation	$7,676	$15,608
	Depreciation ($/Workday)	**$ 33.38**	**$ 67.86**
Interest	Proportion of ACI as loan	70%	70%
	Proportion of ACI as owners equity	30%	30%
	Loan interest rate	8.00%	8.00%
	Owners interest rate	4.70%	4.70%
	Weighted interest rate	7.01%	7.01%
	Average capital invested	$393,213	$397,179
	Interest ($/Workday)	**$ 119.84**	**$ 121.05**
Insurance	Insurance Rate as a Percentage of ACI	3.0%	3.0%
	Insurance ($/Workday)	**$ 51.29**	**$ 51.81**
Total Fixed Costs ($/Workday)		**$ 204.51**	**$ 240.72**
Running costs			
Fuel	Fuel price ($ per litre)	$ 2.60	$ 2.60
	Fuel Usage	0.05	0.05
	Fuel Cost	**$ 48.75**	**$ 99.13**
Oil	Oil as a % of Fuel	25%	25%
	Oil Costs	**$ 12.19**	**$ 24.78**
R+M	R + M as a % of depreciation	50%	50%
	Repairs and Maintenance	**$ 16.69**	**$ 33.93**
	Tyres/Tracks	**$ -**	**$ -**
	Rigging	**$20.44**	**$41.56**
Total Running Costs ($/Workday)		**$98.07**	**$199.40**
Total Machine Rate ($/Workday)		**$302.57**	**$440.12**
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