HARVESTING TECHNICAL NOTE

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MAN Bush Trucks: A forwarding solution for small forest growers

Summary

Harvesting small forest blocks located in areas with difficult access can be difficult for all concerned and the physical and economic constraints sometimes result in growers receiving marginal or no return for their investment in growing their forest. Finding a suitable, cost-effective harvesting system in these situations can be both challenging and confusing for forest owners and harvesting contractors alike.

Small, low-cost trucks used for log transport provide a viable alternative to commonly used systems that struggle to achieve acceptable production and cost levels in small forest harvesting. Reconfigured MAN fertiliser spreaders are one brand of farm truck that provide options for transporting logs from a processing site, in or adjacent to a forest stand, to a load-out point near a road constructed to a logging truck standard. Using a truck forwarding system avoids the need for construction of a fully engineered road to the forest.

Studies have been completed on MAN trucks used by a Northland contractor as part of a unique harvesting system in a small Northland forest. This report is the second in a series produced by Forme Consulting Group Ltd.

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INTRODUCTION

Forwarding systems for transporting logs from the bush to a load-out site have not been widely used recently in New Zealand forest harvesting. Where they have been deployed, custom-manufactured forwarders have been the preferred forwarding option. Alternatives, including locally adapted truck and tractor options, are less popular. Where these alternative systems have been developed and adopted their application remains sporadic and a system of choice only where more conventional systems have proved to be unworkable and uneconomic.

A review of literature provides numerous insights into forwarder and bush truck extraction equipment and system development over the years. Those that have been successful have tended to work well in niche operating and forest site-specific conditions, and usually motivated by innovative contractors looking for lower cost alternatives to 'off the dealer floor' machinery and equipment.

The forest planting boom in the 1990s has resulted in a preponderance of small forest woodlots which are now becoming ready for harvest. Many of these stands are not well located in relation to access to public roads and markets. This means innovative decision making and tight operational control is essential at harvest if growers are to receive decent returns on their investment in forestry.

High capital cost 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.

A small innovative woodlot harvesting system in Northland is using MAN fertiliser trucks which have been converted to log carriers. Contract owner, Peter Davies-Colley, has been developing the concept for long-distance hauling of processed logs to a load-out site generally located next to the nearest public road. Use of the trucks negates the need to build expensive engineered roads to gain access to forest stands, which are often only accessible via difficult or unformed farm accessways.

Trucks currently in use have been acquired second-hand, the bulk fertiliser bin is removed and a locally fabricated log deck together with roll-over protection (ROPS)-compliant headboard and cab protection is added.

The preferred model is the MAN TGM 18.280 4x4 which features 213KW of power, 18 tonne Gross Vehicle Mass, high torque, and exceptional ground clearance, designed specifically for off-road performance.

Studies were undertaken and supporting information collected over three days in early October 2020 in a range of weather conditions to gain an understanding of the capabilities of this equipment combination.

Davies-Colley's harvest system

The system employed during the study consisted of three Hyundai 250LC/290LC excavator machines equipped with felling head, processor and grapple operating the bush, shovelling, processing, and loading functions at the forest stand.

The reconfigured MAN trucks, referred to as 'bush trucks', transported the processed logs over an extraction distance of almost 500 metres to the load-out site adjacent to a public road. A Cat 538 excavator loader was deployed at the load-out site to unload the trucks as well as undertake tasks associated with log sorting, stacking, and loading road trucks.

Figure 1: MAN bush truck about to be loaded.

The crew consists of the owner who operates, loads, and unloads the trucks at the roadside load-out site, and 2-3 operators who work interchangeably on bush operations and driving the bush trucks. For most of the study period one operator controlled the truck extraction cycle by relay i.e., as one truck was transporting logs to the roadside the other which he had previously driven back to the bush site was being loaded. This system allowed plenty of flexibility to manage wood flow by interchanging operators to minimise delays caused by log accumulation at any point in the system.

The nature of farm woodlot operations often means it is rarely possible to use all equipment to its maximum capacity. However, the Davies-Colley system can continue to operate with two, three or four operators, thereby providing the opportunity to manage manpower availability within employment and safety requirements.

The forest stand at the study site consisted of 4ha of 1992/93 plantings of *Pinus radiata* pruned to 6.3m and thinned to 250 stems per hectare (sph).

The stand was located approximately 500 metres from the log accumulation and load-out site at the front of the farm property. Typically, forest stands might be located up to 5km from where road trucks can be loaded, and the routes may consist of a mixture of surfaces and therefore travel speeds are highly variable. Travel speeds of up to 80km/hr are achievable on smooth surfaces. (contractor pers. comment).

Figure 2: Operation layout: bush processing and loading (bottom right) and roadside load-out site (top left).

Study approach

Time studies were carried out on the bush truck cycle only. Elements, consisting of return haul unloaded, load, hauling loaded, and unload, were recorded. The focus was on operational time with delays, although recorded, excluded from any data analysis. Associated actions e.g., securing and releasing load securing strops, have been incorporated in load and unload times.

The extraction haul route was demanding as soils were wet and virtually the whole route was unpaved. Minimal formation work was undertaken to flatten and provide a stable running carriageway and aside from a small length of track entering and leaving the roadside load-out area, no metal was used over the length of the extraction route.

Some heavy rain showers early on during the study period made the tracks impassable; however, the soil-types and windy conditions enabled quick drying. This was assisted by initial passes following rain showers effectively squeezing surface water from the running surface and contributing to quick drying. Wide profile

tyres used on the trucks reduce deep wheel rutting, although over time through multiple passes wheel ruts became deep which affected ground clearance and truck stability. On one occasion during the study period, it was necessary to remove rutted soil material, particularly over lower, poorer draining sections of the track.

For study purposes the extraction route was segregated by broad slope categories, in this case, +/- 5 degrees and +/- 10 degrees.

The prime objective of the time studies was to understand truck travel times and speeds and evaluate any significant observations over varying surface and slope conditions. This would enable construction of a set of high-level time standards to predict truck performance over a range of conditions.

While it was not possible to measure each load weight, some sample weights were calculated through weighing by road truck and trailer weighing scales.

Time studies were supplemented by UAV videography that captured full cycle truck running time over the length of the extraction route.

Production data presentation

Data presented in **Table 1** follows a work study approach. The data represent activity at the studied site and are therefore specific to that site. Calculated cycle times relate to the route explicit to the study site.

Table 1: Basic data presentation

	Dist (m)	Slope (0)	Min/cycle	Min/10m
Load			7.95	
S1 Loaded	140	+12	1.58	0.11
S2 Loaded	130	+/-5	1.43	0.11
S3 Loaded	140	+7	1.09	0.08
S4 Loaded	70	-7	0.84	0.12
Unload			3.16	
S4 Unloaded	70	+7	0.70	0.01
S3 Unloaded	140	-7	0.82	0.06
S2 Unloaded	130	+/-5	0.91	0.07
S1 Unloaded	140	-12	1.18	0.08
Total			**19.66**	

Note: S1, S2 etc relate to sections of the extraction route.

Data is presented to demonstrate a simple methodology for calculating estimated production once basic cycle times are known. Machine travel times are further presented as time/10m standards that that can be applied to other route scenarios.

Table 2 provides a mechanism for additional machine and operator specific allowances. For this we have adopted a historical work study figure of 31.8%. This accounts for extra time, usually non-productive, that includes rest, contingency, and process (e.g. refuel, maintenance, preparation, etc) allowances. Daily production estimates have been provided for three load size scenarios that represent high, average, and low truck capacity depending on log size (length & diameter).

Table 2: Daily production estimates.

Basic Time (from Table 1)		19.66
Allowances	plus 31.8%	25.91
Cycles/day	480 min day	18.5
Tonnes/day	6 tonne payload	111.0
Tonnes/day	8 tonne payload	148.0
Tonnes/day	10 tonne payload	185.0

Slope performance variance

Data were further analysed to detect any meaningful variances due to changing slope. Approximately 180 observations over varying slope changes and loaded/unloaded status of the trucks did not discern any notable differences in travel speeds during the study period, except of course those between loaded and empty.

We have therefore aggregated all truck travel as either loaded or unloaded for slopes of between 0° and 12°. Whilst we would expect that more observations would reveal a wider range of travel times/10m dependent on slope, and more so in association with the type of running surface, these were not available on this site. Load size variability (estimated at 6-10 tonnes) was well within the available power and gearing capacity of the trucks to manage. One possible exception is downhill loaded speeds above 10 – 12° where engagement of lower gears and truck braking will become a factor governing travel speed.

Our overall conclusion is that travel speeds are unlikely to have much impact on production capacity of the overall harvesting system.
Basic time standards were developed as shown in **Table 3**.

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Table 3: Time standards for trucks (consolidated)

Element	Min/10m	
Load		7.95
Travel Loaded	0.10	
Travel Unloaded	0.07	
Unload		3.16

Example production calculation using consolidated data.

Table 4 provides an example of a production calculation using a 1200m extraction route consisting of maximum slope (uphill or downhill) of 12°.

Table 4: Example of basic production calculation.

Element	Dist	Slope	min/10m	mins
Load				7.95
Travel loaded	1200	+/- 12	0.103	12.36
Travel unloaded	1200	+/- 12	0.073	8.76
Unload				3.16
Total basic time				32.23
Allowances	31.8%			10.25
Total cycle time				42.48
Cycles/day	480 min			11.30
				Tonnes/day
6 tonne payload				68
8 tonne payload				90
10 tonne payload				113

Note: 1200m travel on poor surface is considered an extreme condition. Where extraction distances increase beyond this, work to smooth the running surface to increase travel speeds would likely be undertaken.

Figure 3: Bush truck returning to forest site unloaded.

Machine costing

Indicative daily costs of operating the MAN bush trucks 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 commonly known forestry equipment costing approaches:

1. "Business Management for Logging, 2nd edition 2009", 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. A further revised version of this publication was released in 2020.

2. "Informe Harvesting 2020" and daily rate estimates, based on an independent survey of harvesting equipment, vehicles, labour, overheads, by Forme Consulting Group Limited.

This publication, widely subscribed to by industry participants, is based on a comprehensive costing methodology originally developed by the NZ Forest Service for the management of harvesting operations during the last 20 years of the NZ Forest Service. This has been updated and refined by Forme Consulting Group over ensuing years.

For the purposes of this study a machine costing is provided that will provide a daily cost range rather than definition and discussion on the relative merits of each methodology.

One significant difference however is the flexibility within the Informe model to differentiate between the number of fixed and variable hours used for machine operation. This is important where variable (operating) hours for a harvesting machine may differ considerably from those fixed hours that require recovery of fixed costs when harvesting systems and scale constrain available working hours. To demonstrate this, the cost summaries provide several iterations.

Table 5: Indicative cost structure

Key Cost Inputs	
Purchase price	$230,000
Residual price (40%)	$92,000
Power (Kw)	210
Standard hours	1400
Life (yrs)	6.16
Cost set of tyres	$9,000
Tyre life (hrs)	5000
Fuel ($/litre)	$1.05
Interest % (Debt)	0.08
Interest % (Equity)	0.03
Risk	0.015

Indicative Annual Costs				
	BMOL	Informe		
Standard hours	1400	1400	1400	1400
Variable hours		1400	1000	800
Depreciation	$24,525	$28,419	$25,983	$24,765
Interest/Risk	$14,365	$8,280	$8,280	$8,280
Insurance	$3,482	$5,504	$5,504	$5,504
R&M	$18,394	$19,880	$17,457	$16,245
Fuel	$7,718	$7,971	$5,694	$4,555
Tyres	$2,520	$3,600	$2,571	$2,057
Overheads		$4,587	$4,427	$4,348
Total	**$72,160**	**$79,508**	**$70,821**	**$66,478**

Note 1: Individual cost components vary dependent on differing approaches to costing e.g., BMOL is based on 75% borrowed capital, Informe 70%, differing fuel consumption formulae, no overhead component (BMOL) etc.

Note 2: Fuel consumption estimated based on measured usage during study.

Note 3: Variable hour costing approach is appropriate for woodlot harvesting. Full day operation (based on 1400 hrs/annum) is usually not attainable due to scale of operation - i.e. fewer operators mean machine is often idle while operator is undertaking other tasks. The operation however still needs to recover fixed costs.

Truck forwarding cost/tonne

Indicative cost per tonne for the studied operation is calculated as follows for differing machine cost scenarios.

Table 6: Indicative cost/tonne

Indicative cost per tonne				
	BMOL	Informe		
Annual cost	$72,160	$79,508	$70,821	$66,478
Variable hours	1400	1400	1000	800
6 tonne payload	$4.52	$4.98	$6.20	$7.28
8 tonne payload	$3.41	$3.76	$4.69	$5.50
10 tonne payload	$2.72	$2.99	$3.73	$4.38

Note: To translate this data to total operation or crew cost other cost components will be added. These will include operator, other harvest system machinery and equipment, remaining personnel and associated costs. For the purposes of this report it is not intended to expand into these areas.

Truck versatility

Using bush trucks for smaller woodlot harvesting operations confers the following benefits:

1. Bush trucks avoid the need to undertake expensive road access construction. Woodlots are often small scale, inconveniently located and in difficult terrain and the trucks provide an effective option to avoid these costs.
2. The trucks' short wheelbase configuration avoids major disruption to farm infrastructure such as to central raceways, gateways, and fences. Good manoeuvrability through such infrastructure avoids dismantling and re-building costs.
3. Choice of tyres and management of tyre pressure adds significantly to truck capability in difficult soil conditions. Tyres used (see Appendix 1) have aggressive tractor tread and lowering psi from 60 to 40 to increase traction is common.
4. Truck speed provides significant advantages over more conventional forwarder systems. Quicker cycle turnaround can compensate for lower load capacity and is a key consideration when balancing system workloads.
5. Relatively low capital cost reduces pressure on the need to keep the trucks operating. Trucks can be parked up at minimal holding cost as operator resource is spread amongst other operational tasks such as processing, loading, shovelling etc.
6. Processing logs at the bush site avoids the transfer of harvesting slash to more visual road-side sites for load-out.
7. As seen in this operation, having two bush trucks available enables the quick transfer of logs from processing to load-out sites using one driver operating the trucks in tandem.
8. Similarly, as is often the case with woodlot locations on a farm or neighbouring farms, truck extraction movements can be scheduled in a de-phased manner separate from other operational tasks.

Some constraints

The short wheelbase and high ground clearance of the trucks does impose some constraints when assessing optimal load size during loading. Our study observed the trucks at a maximum uphill loaded slope of approximately 12°. This is possibly at the upper limit as we noted the loss of logs over the back of the truck

on occasion. Safe operating conditions are achieved by keeping load height at or below the top of the stanchions.

The trucks are highly capable with front and rear stabiliser bars to level suspension on side slopes; however for added driver comfort and security there is a need to maintain extraction tracks on the level to ensure safer levels of stability and mitigate truck rolling. While we did not observe marginal or unsafe operational practices, further development in defining and maintaining safe operating loads may be required.

Figure 4: Extraction track on a $+12^0$ slope.

Conclusions

The use of the MAN bush truck provides a cost effective and physically viable option for the harvesting of small farm woodlots. They could also be useful to complement more highly productive harvesting system set-ups where access either via skidder or forwarder extraction routes or engineered roads is difficult and expensive.

While sustained high production would not be the major reason for employing bush trucks, being mobile and manoeuvrable they can be quickly mobilised to transfer processed logs from distant sites to front gate load-out sites. An example might include the need to position several truck loads for load-out to meet a short notice shortfall in volume for an expected export ship. The Davies-Colley operation has been known to deliver over 500 tonnes in one shift with two trucks.

Using specialised fertiliser spreaders as the basic structure for the bush trucks means that the trucks are suited for farm type operations, particularly ease of access through gateways, farm waterway crossings and open paddock running etc.

The operation of smaller machines such as the bush trucks in farm woodlot type harvesting operations is less intimidating in terms of potential for creating environmental and farm infrastructure damage and is more likely to be readily acceptable by small woodlot owners.

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