HARVESTING TECHNICAL NOTE

HTN05-08
2013

Improved Grapple Control – The Alpine Grapple

Summary

Better grapple/carriage control can improve the productivity of the extraction phase of cable logging. A prototype Alpine Grapple Carriage was studied working in a Bay of Plenty hill country cable logging operation using a TSY6335 swing yarder. Extraction was downhill, and trees of average 2.1 m^3 tree size were pulled by the head. Time study data were collected and analysed to compare grapple time with manual breaking out (choker setting). Extraction productivity of the Alpine Grapple in these conditions exceeded that of manual choker setting in unbunched trees at haul distances of up to 250 m. When trees were bunched (and an excavator was present to feed the grapple), the Alpine grapple was more productive at haul distances less than 175 m. At 150 m haul distance, bunching for the grapple resulted in a 5% lower hauling and bunching cost than bunching for chokers. Compared to grappling from unbunched trees, productivity increased 25% through bunching and using an excavator to feed the trees to the grapple. It should however, be noted that that the operating conditions of this study, namely downhill yarding to roadside over relatively short haul distances, is not a typical scenario for many New Zealand operations and therefore estimates were higher than might normally be expected.

Tony Evanson, Scion

Introduction

One project initiated by Future Forests Research Ltd (FFR) in 2010 involved the development of an improved grapple/carriage control system (Task 2.2). This project had the aim of improving productivity of the extraction phase of cable logging and reducing both the cost of operation and worker exposure to hazards.

Using a grapple carriage, instead of manual hooking tree stems using strops (chokers) to the cable rigging, the hauler cycle time elements of “grapple” or “hook”, “break out” and “inhaul” could be reduced.

Because of short loading (or “grapple”) time, grapple yarding of trees is a desirable means of extracting both single tree stems and bunched wood. It also eliminates the “breaker-outs” exposure to hazards.

One such grapple carriage is the Alpine Grapple designed by a South African company called Alpine Shovel Yarders Inc. The grapple was designed and patented to operate on two drum haulers in a running skyline (or “scab skyline”) configuration as well as being operated on three drum haulers in a slack line configuration (using a standing skyline).

The carriage consists of a hydraulic pump and an accumulator, a valve block and two remote controlled clamps, one for the main rope and one for the tail rope/skyline.

The carriage weighs approximately 560 kg. It had been matched with a Johnson 80” grapple weighing around 700kg for an overall weight of 1260 kg.

Hydraulic power for the grapple rotation, and clamping on main and tail rope was supplied by a hydraulic pump charged by an accumulator, working on a sheave on both inhaul and outhaul

The prototype had been retrofitted with a grapple camera system manufactured by Trinder Engineering as part of a separate FFR project (Task 2.1 Hauler Vision System). For this trial the benefits of the grapple camera system in terms of improving the operator’s vision for the grappling function were measured.

Figure 1: The prototype Alpine Grapple Carriage

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The electronic remote controls and the camera are powered by a 12V battery. In operation, the carriage is hauled out (grapple clamped open) using the tail rope. The carriage is held in position by activating the haulback clamp. The carriage is then lowered to the tree to be hauled and the grapple closed through hauling in on the main rope. The main rope can also be clamped but this feature is not required when the main rope is under load.

The recommended retail price of the Alpine Grapple carriage is expected to be around $60,000 dependent on the exchange rate or around $75,000 including the camera system.

This report describes the results of the first of a series of trials of the Alpine Grapple in the North Island, where it was operating in a Thunderbird 6355 swing yarder operation for a period of some weeks. Some of the subsequent, shorter duration trials showed that sometimes operators required more time to familiarise themselves with the controls, and expected productivity levels were not achieved.

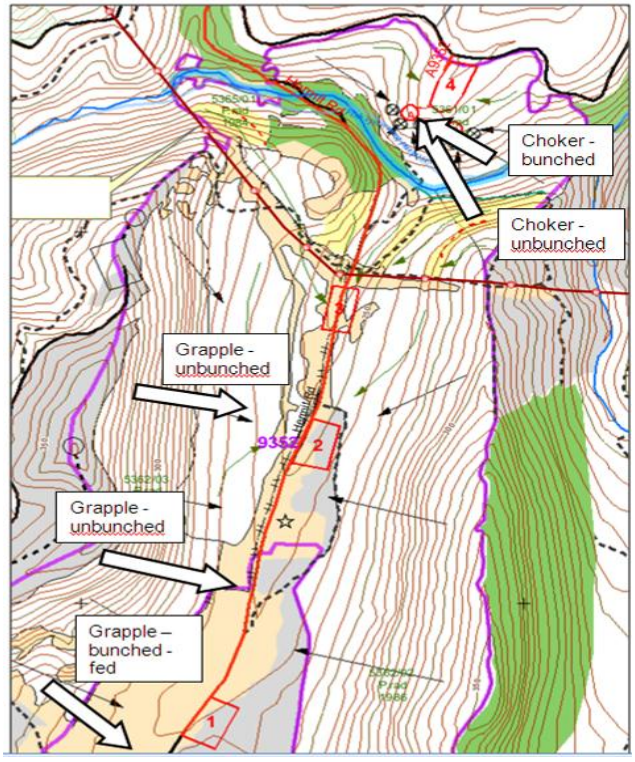

Figure 2: Block description and haul directions

System and Study Area

The first trial site for the Alpine Grapple was at FPNZ Logging Ltd's operation at Manawahe Forest in the Bay of Plenty. The contractor was Ian Harvey, contracting to PF Olsen Ltd.

The block had an average tree size of 2.1 m^3 and a stocking of 250 stems per hectare (sph). Trees were manually felled, downhill in the steeper sections, and across slope in other areas. Where the terrain suited, trees were bunched by an excavator for either Alpine Grapple or radio-controlled choker extraction. A Thunderbird TSY6355 swing yarder was used to extract the trees, which were delimbed by static delimber and manually processed.

Data were collected from the following scenarios:

- Grappling from unbunched stems.
- Grappling from bunched stems with an excavator presenting or feeding trees to the grapple.
- Manual breaking out unbunched stems using electronic-release chokers.
- Manual breaking out using electronic-release chokers from bunches of stems that had been bunched using an excavator laying out trees for each cycle.

Figure 3: Downhill yarding with the Alpine Grapple

In this tree size (2.1 m^3) the 80" Johnson Grapple was suitable for head-first extraction downhill. Trees closer to the mobile tail hold position were extracted using chokers, with the assistance of a spotter.

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Results

A total of 201 observations were made and the time data were collected over a three week period. The number of bunched cycles was limited by the area suitable for bunching. Table 1 describes the study data collected for both grapple extraction and choker extraction for unbunched and bunched wood.

Table 1: Grapple and Choker Study Data

System	Unbunched Grapple	Unbunched Choker	Bunched Choker	Bunched Grapple-Fed
No. Obs.	101	50	25	25
Haul Direction	Downhill	Uphill Downhill	Uphill	Flat, Downhill
Extraction	Head first	Butt first	Butt first	Head first
Estimated average piece size (m3)	1.55	1.42	1.99	1.88
Average haul distance (m)	151	150 (est)	64	90

Summary of Grapple vs. Choker: Unbunched Trees

Table 2 gives the study results for the comparison of grapple extraction and choker extraction for unbunched wood.

Table 2: Study Results - Unbunched Trees

	Grapple (head pull, downhill)	**Choker** (butt pull, down/uphill)
Average Grapple/Hook On time (sec)	28.5	133.1
Average Butts/haul	0.88	1.2
Average small pieces/haul	0.39	1.26
Estimated average haul size (m3/cycle)	1.87	2.24
Calculated hourly production	52.75	39.2
$/m^3 Haul cost (150-m haul distance)	$5.28	$8.46

To account for the different piece sizes in the different study areas (Table 1), a weighted average butt volume of 1.55 m^3 and an average top piece of 0.3 m^3 were used. This enabled a comparison of the productivity of the different systems. Standard equipment costs were used and daily cost data were sourced from Informe[1].

In unbunched wood, the use of manual breaking out resulted in a 20% larger estimated average haul size due to the larger number of butts and small pieces extracted. However due to the much longer hook on time the average calculated hourly productivity was lower than that when grappling unbunched trees.

Despite the lower average haul size, using the grapple was more productive at 150-m haul distance than using chokers. This resulted in 37% lower haul costs in $/m^3 when grappling.

Summary of Grapple vs. Choker: Bunched Trees

Table 3 gives the study results for the comparison of grapple extraction and choker extraction in bunched wood.

A comparison between grapple and hook on times in bunched wood shows that the average times were less than half for the grapple than for manual breaking out.

Using chokers, despite the average haul volumes being almost 40% larger than that for grapple extraction, the time lost in hooking on resulted in calculated hourly productivity only 7% higher than grappling bunched wood.

At a standardised 150-m haul distance, grapple extraction of bunched wood resulted in a slightly lower bunch and haul cost (by 5%).

Compared to extracting unbunched trees, productivity increased 100% through presenting bunched trees to the grapple with an excavator even though the grappling time was similar. This is due to the higher estimated average haul size in bunched wood (+50%).

Bunching wood for choker extraction showed an even larger increase in hourly production (+180%). The additional haul size volume more than covered the cost of the excavator bunching the trees.

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Table 3. Study Results - Bunched Stems

	Grapple/fed (head pull, flat/downhill)	**Choker**(butt pull, uphill)
Average Grapple/Hook On time (sec)	25.58	55.28
Average Butts/haul	1.76	2.44
Average small pieces/haul	0.48	0.72
Estimated average haul size (m3/cycle)	2.87	4.0
Calculated hourly production (150m haul distance)	105.24	112.6
$/m3 Bunch and Haul cost	$3.96	$4.17

Manual hook on times using chokers were substantially different for bunched wood than for unbunched trees (Figure 4).

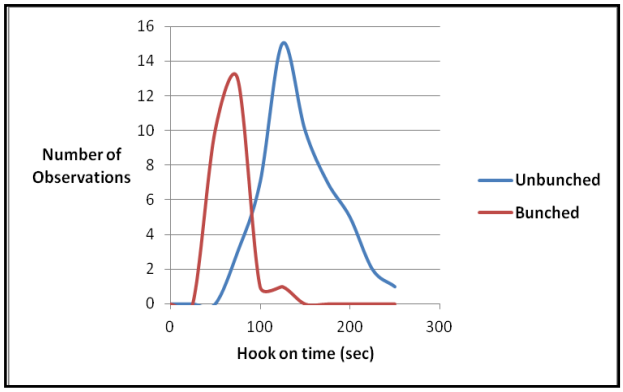

Figure 4: Frequency distribution of hook on times for manual breaking out – bunched and unbunched trees.

The distribution of grapple times appeared similar for bunched and unbunched trees (Figure 5).

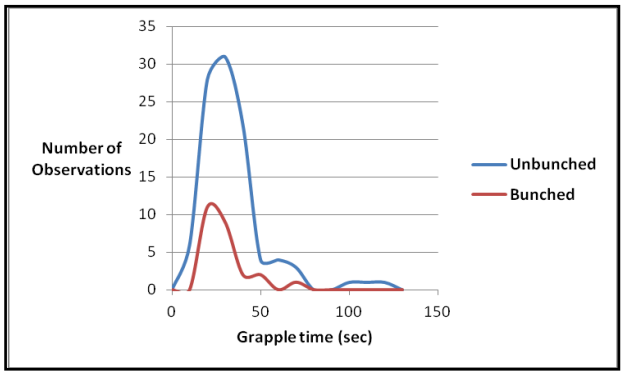

Figure 5: Frequency distribution of grapple times – bunched and unbunched trees.

Effect of Haul Distance on Cost - Grapple vs. Choker Extraction

Figure 6 shows a cost comparison between grappling and hook-on of both bunched and unbunched trees over haul distances between 100 and 250 metres. Standard inhaul and outhaul time elements were used as well as haul sizes from Tables 2 and 3.

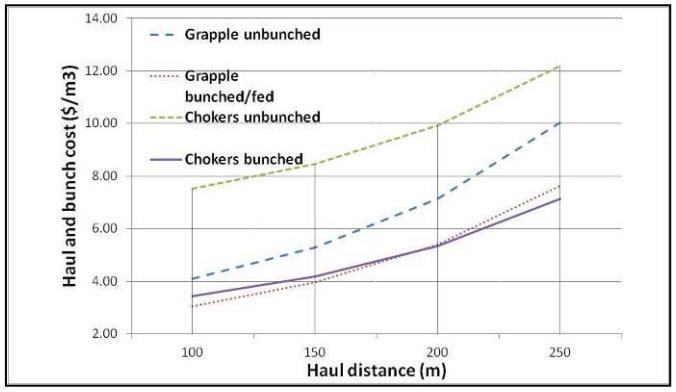

Figure 6: Haul and bunch cost on haul distance for different extraction methods.

The effect of changing from using chokers to a grapple in unbunched trees is significantly apparent. When trees are bunched, the combined bunch and haul cost is reduced even further. For haul distances up to 175 m, grapple extraction is at a slightly lower cost than choker extraction due to faster cycle times of the grapple. At longer haul distances (beyond 200 m) the larger haul volumes of choker extraction result in slightly lower bunch and haul costs than grapple extraction.

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Some caution is expressed with these results as the cycle time data for the bunched wood were obtained from relatively short haul distances (60 to 100 metres).

Conclusions

This study of the Alpine Grapple has found that bunching (and feeding) tree stems increased the productivity (in cubic metres per Productive Machine Hour) of grapple extraction by over 100% (from 52 m^3 /PMH to 105 m^3/PMH).

Productivity of choker extraction following bunching increased by 180%, indicating the advantages of bunching irrespective of extraction method.

These results are consistent with an earlier study in New Zealand[3] which found a large increase in hourly production following bunching for extraction, which is a key to improving hauler productivity.

These study data showed that extraction productivity of the Alpine Grapple in downhill head pull exceeded that of manual breaking out in unbunched trees (butt hauls) at haul distances averaging 150 m. It should however be noted that that the operating conditions of this study, namely downhill yarding to roadside over relatively short haul distances, are not a typical scenario for many NZ operations and therefore estimates may be higher than might normally be expected.

Analysis suggested that when trees were bunched and presented to the grapple with an excavator, the grapple was at a lower cost than choker extraction at haul distances of less than 175 m. Beyond that haul distance, choker extraction may have a slight cost advantage.

It is recommended that the New Zealand forest industry further examine the advantages of grapple extraction in unbunched trees at shorter haul distances using tower haulers.

Secondly, bunching for cable extraction (either using chokers or grapples) where terrain, environmental and safety considerations allow should be widely adopted, as this will lead to improved overall hauler productivity and reduced costs.

Acknowledgements

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References

1. Forme, *Informe harvesting 2010.* No. 1. Forme Consulting Group Limited: (2010).

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