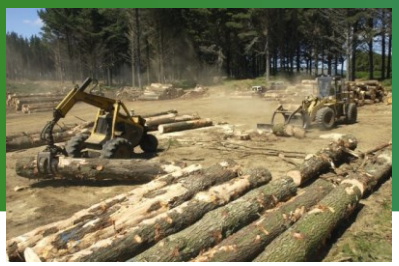

HARVESTING TECHNICAL NOTE

HTN07-02
2014

Logging after dark with an Alpine Grapple Carriage fitted with lights

Summary

Mechanising the extraction phase of cable harvesting through the use of grapple systems has been identified as one way to improve safety and ensure breakerouts can be removed from the hazard zone. With the introduction of improved grapple carriages such as the Falcon Forestry Claw and Alpine Grapple Carriage, and other ancillary equipment, grapples are now easier to use. Mechanised processing with the aim of removing skid workers from hazardous congested landings is also becoming more popular in cable logging. Processors are highly productive and in many cable operations are under-utilised. The opportunity to operate the hauler for longer hours, while keeping most of the operation on single shift, was investigated to determine if overall system profitability was improved. Benefits of cable logging at night were identified firstly by carrying out a desktop analysis and then a short time study-based evaluation of a Harvestline operation using an Alpine Grapple Carriage fitted with lights. The desktop analysis showed that the break-even production level for night harvesting would be at least 45% of the day shift production, depending on the additional machinery required to clear the chute or process logs. Assuming night shift production levels of 70% of day shift production, the improvement in profitability of the whole operation could be between 16-35%, depending on the additional machinery required.

Spencer Hill, Scion

INTRODUCTION

Grapple systems were identified as an obvious way to improve safety and ensure workers can be removed from the danger zone during breaking out. From an earlier survey of cable yarders in 2012, only 17 out of 213 carriages, or 8%, were grapples (all simple mechanical grapples) [1]. That number has increased to an estimated 16% of cable logging operations with the introduction of hydraulically controlled grapple carriages such as the Falcon Forestry Claw, and the Alpine Grapple Carriage. Other equipment such as improved hauler controls, remote control camera systems, and lights on grapples have also contributed to making grapples easier to use and a more attractive proposition to contractors.

As the number of cable operations using grapple systems continues to grow, options for extending hauler shift times open up, as these operations are not limited to daylight hours. Much of the international literature on multi-shift harvesting operations suggests that overall productivity falls with multi-shift operations [2]. The question then is, "What might drive a move toward longer shifts for haulers?"

Recent results from the FFR Benchmarking database of New Zealand cable operations [3] show that cable operations in New Zealand average approximately 200 tonnes per day. The North American style haulers typically used in these operations are however capable of much higher daily production if the harvesting conditions are favourable. Benchmarking results also show that mechanised processing, where skid workers are removed from hazardous congested landings, has also become more common, with over 50% of cable operations using mechanical processors.

From an environmental ("licence to operate") point of view, there is pressure to reduce the size of landings, and this will compound the congestion problem, adding to safety hazards of manual operations. Mechanical processors are however capable of processing in excess of 350 tonnes per day, and therefore in many cable operations the processor is underutilised. Operating haulers for longer hours, while keeping most of the operation on single shift, could improve overall system profitability.

One innovative logging contractor in Nelson who has been harvesting at night using his Falcon Forestry Claw systems for some time, reports

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only a slight drop off in night time production compared to day time production [4]. The contractor uses "after dark" harvesting to manage the wood flow from his operation to ensure production targets are met on a weekly basis.

This study investigated the opportunity for night time cable harvesting using a grapple equipped with lights and explored the possible benefits for contractor and forest owner profitability. The study also highlights the potential barriers to extending hauler operating hours.

METHOD

This study approach comprised firstly a desktop analysis to determine if overall system profitability was improved with cable logging at night, and then a short time study-based evaluation of a Harvestline operation using an Alpine Grapple Carriage fitted with lights.

Desktop Analysis

A standard Excel spread sheet analysis of costs and productivity was done to investigate a longer hauler shift operation. A simple model was developed to test the hypothesis that extending the hauler operating time would improve profitability. Three scenarios were compared to a standard day time operation:

1. Extending the operating time of the hauler, assuming there is no problem with landing the tree stems at the hauler. The daily cost of this operation included extra hauler time, two extra staff, an extra work vehicle and the additional overheads required to manage a larger operation.

2. Extending the operating time of the hauler and the processor, assuming the processor has no problem clearing the landing chute and has enough space to store cut logs at night. The daily cost of this operation included extra hauler time, additional processor time, three extra staff, an extra work vehicle and the additional overheads required to manage a larger operation.

3. Extending the operating time of the hauler and an excavator loader, assuming the excavator loader will clear the landing chute and stack trees ready for processing during the following day shift. The daily cost of this operation included extra hauler time, additional excavator time, three extra staff, an extra work vehicle and the additional overheads required to manage a larger operation.

In all three scenarios one extra staff member was required for safety reasons and for moving the mobile tail hold, which may or may not be an acceptable practice at night, and would be site dependent.

Productivity Study of a Hauler Harvesting at Night

A short time study of a Harvestline hauler using an Alpine Grapple Carriage fitted with the DC Repairs camera system and lights was undertaken to ascertain the difference in production between operating during the day and extracting trees at night.

The trial site, shown in Figure 1, was in a moderately steep forest with very small piece size (0.5 tonne per tree). The trees in the extraction line had been bunched prior to extraction so that the butts of the trees were clearly identifiable.

Figure 1: An aerial view of the trial site. The redline depicts the extraction corridor.

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The extraction line consisted of a small gully falling directly away from the hauler then climbing to an area opposite the hauler where the slope flattened (Figure 2). The productivity assessment was carried out on the area where the slope flattened out on the back face. The haul distance during the study started 140 m from the hauler, and data collection stopped when the haul distance reached 180 m from the hauler. This represented the mid-span area of the extraction corridor, and there was a definite lack of deflection at this point. The lack of deflection did not impede production. A total of 43 cycles were measured, of which 20 cycles were recorded at night.

Figure 2: Extraction corridor of trial site

The night logging was carried out on an exceptionally dark night with no moonlight. Operator vision was totally reliant on the external lights of the grapple carriage and, to a lesser extent, the infra-red low light capability of the camera. Weather during the trial was clear and cold with a slight southerly breeze.

RESULTS

Desktop Analysis

Daily operating costs for each machine were calculated and used to formulate a daily cost for the daytime operation and for each of the three scenarios (Table 1). A conservative drop in night time production to 70% of the day time production was assumed for the analysis. This fall in production was based on the slight drop in night time production observed by the Nelson contractor who occasionally operates at night with the Falcon Forestry Claw grapple[4].

The analysis showed that, assuming night time production was 70% of day time production, a more profitable operation could be expected. Depending on the configuration selected or required, the increase in profit ranged from 16% to 35%.

Table 1: Cost and productivity comparison assuming production of night shift is 70% of day shift

	Daily Cost ($)	Indicative Production (tonnes/day)	Profitability as % of cost
Normal Day Shift	$7,440	150	-
Normal Day Shift + Extra Hauler Shift	$9,310	255	+35%
Normal Day Shift + Extra Hauler + Processor shift	$10,895	255	+16%
Normal Day Shift + Extra Hauler + Excavator shift	$10,590	255	+19%

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The additional production needed to cover the extra costs of night time operations was also calculated and is shown in Table 2. Depending on the configuration required, 25%-46% extra production over and above the day shift production would be needed for night harvesting to be viable.

Productivity Study

The short night time trial was undertaken to verify what actual reduction in night time production could be expected. Hauler cycle times were recorded. Haul volume was predicted from an estimate of tree size extracted each cycle. Data were also collected on grapple extraction of unbunched trees and bunched trees during some cycles of the night time logging trial.

The delay-free hourly productivity was then calculated. Results are summarised in Table 3. The proportion of time spent on each task for day and night time grapple logging is shown in Figure 3.

In bunched wood night time cycles (5.58 minutes per cycle) were shorter than day time cycles (5.87 minutes per cycle). The longer day time cycles were attributed to the operator slowing the outhaul speed and avoiding excessive tension in the mainline that caused the mainline to slip through the brake and close the grapple. The productivity of the night shift was similar to that of the day shift. The difference in delay-free production between the night and day shift during this specific study was negligible if the cycle time was adjusted for the mainline brake issue.

Table 2: Additional production required for the night shift operation to cover costs

	Daily Cost ($)	Increase in production to cover costs
Normal Day Shift	**$7,440**	-
Normal Day Shift + Extra Hauler Shift	**$9,310**	**+25%**
Normal Day Shift + Extra Hauler + Processor Shift	**$10,895**	**+46%**
Normal Day Shift + Extra Hauler + Excavator Shift	**$10,590**	**+42%**

Table 3: Cycle time and estimates of hourly productivity

	Cycle time with 95% confidence limits	Estimated production per delay-free hour with 95% confidence limits	Cycle volume with 95% confidence limits
Night Shift Bunched	5.58 ± 0.34	12.8 ± 2.5	1.18 ± 0.23
Day Shift Bunched	5.87 ± 0.34	12.1 ± 2.9	1.19 ± 0.29
Day Shift Unbunched	5.43 ± 0.33	12.6 ± 2.9	1.11 ± 0.24
Day Shift Bunched and Fed	5.21 ± 0.35	25.0 ± 3.9	2.20 ± 0.39

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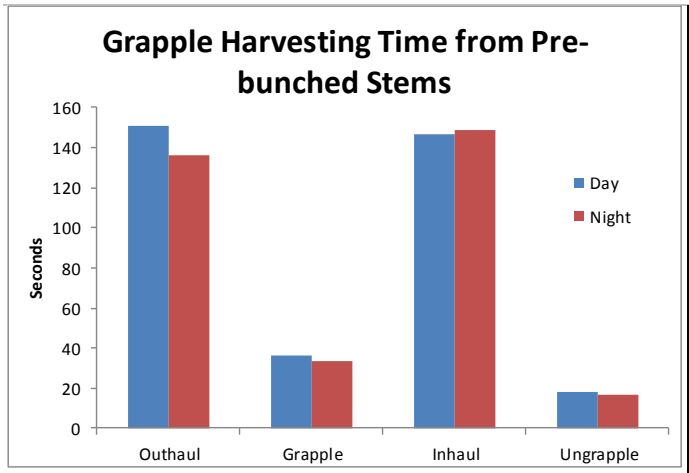

Figure 3: Proportion of time taken for each element of the cycle for night logging

The Harvestline line speed at the time of the trial was 1.81 m/s during outhaul and 1.75 m/s during inhaul, and together accounted for 87% of the time. Task time was very similar for night and day and this is likely a result of good vision due to good lights, and extracting pre-bunched stems. Cycle volume had no impact on inhaul speed. Slow line speed had a huge effect on production in this study.

These data showed a very similar volume was produced from unbunched trees compared with the trials where the trees had been pre-bunched. This result was attributable to the larger average tree size (0.88 tonne) in the unbunched area versus the bunched area (0.6 tonne).

However, the productivity doubled when the excavator prepared a bunch for the grapple each cycle ("day shift bunched and fed") as the optimal payload could be achieved each cycle.

As a result of this time study the drop in volume estimate for night time logging to 70% of the day time volume was considered a fair and reasonable predictor of the benefit of night time logging.

Barriers to Extending Working Hours

The requirement to pull broken heads, particularly if no pre-bunching is possible, does limit the effectiveness of grapple harvesting, and in some cases may make grapple harvesting uneconomic. The policy regarding recovery of small pieces should be set for each logging site to ensure the cost of production does not outweigh the benefit of recovering this material.

The capability to move the wood away is often a barrier to longer shift operations. Truck scheduling would also need careful planning to accommodate increased production.

Making manual line changes at night would be unacceptable from a safety point of view, therefore using a mobile tail hold machine would be a necessity for night time line shifts. Even with a mobile tail hold, the risk of mishaps would be higher at night and would require good lighting and careful safety management.

For night operation, hauler reliability would need to be high. Breakdowns during a night shift would be difficult to fix and would affect the start of the day shift.

The trial was conducted on a cold, pitch black night and the setting was very claustrophobic and unpleasant. The lack of people on site would take some getting used to. Night harvesting would require at least two staff to work together which would make the work a little more enjoyable.

Resistance to after dark harvesting could be expected, and any change may take some time to be accepted within the crew.

CONCLUSIONS

Using a grapple fitted with lights and a camera system creates an opportunity for cable harvesting after dark. A standard modelling approach showed night harvesting had the potential to be more profitable. A short duration production study evaluating a Harvestline operation using an Alpine Grapple fitted with lights and camera showed that night logging should comfortably produce at least 70% of the day shift's production and that gains in profitability between 16% and 35% could be

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expected (assuming the hauler rate is the same as that of the day shift).

The ability to increase daily production through night harvesting would help manage short term increases in volume requirements.

Data were also collected from a small number of cycles where an excavator prepared bunches and fed the grapple each cycle. Compared to the production measured from grappling unbunched stems, the production doubled for each cycle where stems were pre-bunched, due to the optimum haul volume being achieved for each cycle. As expected, this resulted in a much higher gain in profitability than extending the hours of the hauler into the night time.

Optimising the volume for each cycle through careful pre-bunching is critical to high production and improved profitability. Pre-bunching stems into optimal payload bunches that can be easily grappled and extracted, without the need for an additional excavator to assist the grapple, would result in higher productivity grappling for both day and night shifts.

If pre-bunching is not possible, night harvesting with grapples is a very real option to improve production and profitability. Night harvesting with grapples could also provide one solution to the requirement to increase hauler capacity in the future.

Unfortunately, like all new ideas, there are likely to be barriers to uptake, including but not limited to:

- Any rope shifting required at night could be viewed as higher risk and would need to be managed appropriately.
- Mechanical reliability of the haulers could be an issue with breakdowns at night more difficult to fix.
- Additional volume from hauler operations could result in transport logistic issues.
- The requirement to pull broken heads, particularly if no pre-bunching is possible, limits the effectiveness of grapple harvesting.
- Crew culture issues may result in night time cable harvesting taking some time to become an accepted practice.

RECOMMENDATIONS

Operational improvements should focus on new supply chain systems that simplify what is required from hauler operations to allow contractors to focus on higher production in a safer manner. Harvesting at night is one way to reduce the cost of steep country harvesting, but the potential barriers to uptake must be addressed first.

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