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COLLECTION AND TRANSPORTATION OF LOGGING RESIDUES

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Figure 1 - Cat 311 excavator sorting and stacking waste wood from a skid surround

ABSTRACT

Three systems for collecting and transporting short sections of stem wood waste created during log making were studied. The systems are described and the production rates and costs are reported. Recovery of this material is most efficient when the systems are integrated with the conventional logging operations.

INTRODUCTION

Waste wood surrounding logging landings, created during log making, is made up of two distinct types of material. The first is branches, the second is solid stem wood. The stem wood is made up of slovens, heads and sections of mid stem material cut-out during the value recovery driven log making.

Traditionally, these sections of stem residue have been pushed to the skid edge along with the branch material and left as waste, to rot or be burned.

The large piles ("bird's nests") of this material which occur around hauler landings at the top of steep slopes are of particular concern, as they can become unstable. In some instances, compliance with the Resource Management Act requires that these be removed or reduced in size. Burning of these bird's nests is possible and is practised in some areas as it is the cheapest option. However, this is not without risk as they can become unstable whilst on fire and, in some cases, can smoulder for several days. The smoke clouds created also tend to draw adverse public comment.

The volumes of material in the landing surrounds are substantial. On a national basis they are in the order of:

stem waste - 465,000 m³ per annum
branch waste - 574,000 m³ per annum
(Hall, 1994, MOF, 1994)

Increasing demand for chip material, the drive for higher value recovery and the reduced pulp volumes available from tended stands, has resulted in a rise in chip log prices. This, combined with increasing environmental concern, has enabled some harvesting systems which were previously not economically viable, to extract and transport this material to a utilisation point.

Three systems for collection of stem waste wood from logging landings were studied.

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METHODS

Three systems for collecting and transporting short sections of stem waste to a point of use were studied. All the operations were studied using time study techniques and the volumes of material produced were measured by either log measurement or weighbridge figures. Costings were derived using the LIRO format (Riddle, 1994).

The material had to meet a dimension specification of greater than one metre in length and greater than 10 centimetres small-end diameter, free of branches. Due to the way the material was transported, it is referred to in this report as bin wood.

RESULTS

NOTE - In the three systems described, the purchase price of the wood is **not** included in the costs

System 1 - *Sorting and stacking of wood from skid surrounds by excavator*

An 11 tonne excavator fitted with a fixed head grapple (Figure 1) was used to sort the bin wood out of the debris piles around both ground-based and hauler landings. This material was stacked for collection by bin trucks. In some cases, the wood was taken directly from the heap and stacked. In other cases, it was double handled, that is picked out of the debris heap and swung on to the skid, then stacked later.

This operation was studied for 6.5 productive machine hours (PMH) over two days. During this time, the excavator retrieved and stacked 444 pieces with an average piece size of 0.206m³, giving an estimated total production during the study of 91.9m³. This equates to 14m³ per PMH. Based on a working day of 7.25 PMH from an eight hour working day and a daily cost of the operation of $760 (including excavator, labour, transport and overheads), this operation could be expected to produce 102m³ per day at a cost of $7.45 per m³.

The production rate of the system will be affected by the average piece size of the available material. In the other studies the material being removed had a piece size of 0.14 to 0.16m³. Using a figure of 0.15m³, the production rate would drop to around 10m³ per hour and the cost would rise to $10.50 per m³. In this study, the log dimensions were:

Average length - 2.56m (96% between 1.5 and 4.0m)
Average LED - 33.8 cm (88% between 20 and 45 cm)
Average Volume - 0.206m³ (83 % between 0.1 and 0.35 m³)

The transport of this wood from Kaingaroa Forest to Mount Maunganui was by "paired" bin trucks. One of the pair was fitted with a self-loading crane. This units configuration was a 6 x 4 truck with the crane mounted on it towing a 3-axle bin semi-trailer. The second truck was an 8 x 4 truck with a bin and a 4-axle bin trailer. The bins were all tip unload. The trucks worked together, with the self-loader loading both trucks. The self-loader had a maximum payload of 19 tonnes and the 8 x 4 truck trailer had a maximum payload of 24 tonnes.

Trucking costs over a 150 km average lead distance, with both trucks working double shifts:

Self-loading bin truck - $0.20 per tonne kilometre
Bin truck and trailer - $0.16 per tonne kilometre

The wood produced from this system can be delivered to the chipping site at a cost of approximately $35.00 per m³.

System 2 - *Wood extracted from skid surrounds and heaped for removal by an off-highway 6-wheel drive self-loading dump truck*

A Moxy off-highway (6-wheel drive) truck fitted with a tipping bin and a crane with a grapple for self-loading was used to collect the bin wood material from two different sources. The first involved sorting logs from skid surrounds, and the second involved extraction from heaps of wood placed on the skid by the logging crew for collection by the Moxy.

After this study was completed, the logging crews began stacking all bin wood for collection.

Figure 2 - Bin truck being loaded with waste wood by Moxy off-highway truck fitted with a crane

Once loaded, the Moxy carted the wood to a loading point, where the logs were tipped out in a heap for later loading by the Moxy into the 8 x 4 bin truck and trailer unit. This operation was in Mangatu Forest, and the access for the bin truck was sometimes limited, especially in wet weather. This means that in some cases the wood was carted quite long distances (up to 11km) before being dumped in order to get it to a point where the bin truck could access it. The cart distances ranged from 400m to 11 km, with an average of 1.8 km. The Moxy was also used to load the bin truck (Figure 2).

The material in this operation had dimensions of:

Average length - 2.1 m (90% between 1 and 3.5 m)
Average diameter - 30 cm (86% between 20 and 45 cm)
Average volume - 0.148 m^3 (86% between 0.1 and 0.3 m^3)

The Moxy's average load was 57 logs or 8.4m^3, with a cycle time of 34.1 minutes. Of this, 19 minutes were spent loading.

The daily cost of the operation was estimated at $1190 per eight hour day (including Moxy, labour, overheads and transport) for an hourly cost of $149 per PMH.

The Moxy was required to load the bin truck at least once per day. This took on average 62 minutes. It was also used for other tasks within the forest, such as clearing branch material created by logging operations from river beds, and collecting logs from road lining operations. If the Moxy had been dedicated to collecting and loading out bin wood, it could have loaded one truck (approx 24m^3) and extracted a further 85m^3 at a cost of $13.60 per m^3 on truck.

This material was then transported from Mangatu Forest to Mount Maunganui in the bin truck at a cost of $0.20 per tonne kilometre over a lead of 280 km. The wood was delivered to the chipper site at a cost of approximately $70 per m^3.

The costs for running the 8 x 4 bin truck and trailer are higher in this situation than in System 1 as it only has time to complete one load per shift over a 280 km lead distance, whereas the trucks in System 1 were completing three loads achieving greater vehicle utilisation.

System 3 - *Extracting waste wood from heaps created on skid sites with a 6-wheel drive highway truck with self-loading crane and grapple, with conventional logging bolsters on the truck, and a 3-axle bin trailer*

This unit was used to collect a mixed load of logs and bin wood in Kinleith Forest.

The dimensions of the bin wood material in this study were:

Average length - 2.0 m (94 % between 1 and 3 m)
Average diameter- 29.0 cm (86 % between 20 and 45 cm)
Average volume - 0.140 m^3 (68 % between 0.1 and 0.35 m^3)

The bin wood material was collected from heaps created by the logging crews from both hot and cold-deck operations. The truck loaded itself with pulp logs and bin wood in most cases, although occasionally the logging gang's loader assisted with loading the bin wood. The truck then travelled (off-highway) to the Kinleith log yard, where the logs were unloaded at one site, and the bin wood was tipped out at another. The bin wood was then reloaded into bin trucks at highway loads for transport to Mount Maunganui using the paired trucks described in System 1.

There was a considerable amount of time in each of the truck's load cycles spent driving around the yard from the log drop off point to the bin wood dump, and waiting for logs to be unloaded. This truck may be replaced with a self-loading bin truck and trailer unit. Therefore, the times recorded in this study were used to predict the production rates and costs of the new unit rather than report on the current situation, which is likely to change in the near future.

The new unit would be operating off-highway with a payload of up to 35 tonnes. Working a double shift and using an average payload of 30 tonnes over an average haul distance of 20 kilometres, the unit would be able to produce up to 70,000 m³ per annum at a cost of $5.05 per m³, delivered to the Kinleith log yard.

There are a number of options being considered for the configuration of the trucks collecting bin wood. These include truck only units with rear tipping bins to be loaded by the logging crew's loader and a side tipping bin on a self-loading 8x4 truck with the option of towing a conventional log trailer.

Currently, the wood is then reloaded and taken to Mount Maunganui by truck, a lead of 115 kilometres, at a cost of $18.75 per m³. This gives a cost, delivered to the chipper site, of approximately $24.00 per m³.

An option being considered is taking the wood from Kinleith log yard to Mount Maunganui by rail.

A further option for highway transportation is the use of vehicles with multiple sets of bolsters capable of holding lengths as short as 1.2 metres. The tare weight of these vehicles is expected to be less than the existing tipping bin trucks and, therefore, a greater payload can be carried.

LOADING TIMES

During these studies there were a number of self-loading cranes observed. Time study data for these cranes revealed substantial differences in production for the different cranes (Table 1). Whilst some of this could be attributed to the differing skill levels of operators, some of it was clearly due to the capabilities of the cranes. This would be a consideration in setting up any new self-loading bin truck units.

The Log Lift crane was the fastest, partly due to a skilled operator and partly due to the crane. The slower times recorded for the Jonsereds were largely attributable to the inexperience of the operators. The Moxy crane was clearly the slowest. This was not due to the operator; the crane's movements and responses were slow. Loading the Moxy took 56% of its cycle time, the single largest component. It would appear that with changes to the crane this could be substantially reduced.

Table 1 - Summary of bin wood loading times by loader type

Crane Type	Minutes per grapple	Logs per grapple	Logs per minute	M³ per minute	M³ per hour
Log Lift*	0.63	3.8	6.2	0.93	56
Jonsered*	0.97	4.1	4.2	0.62	37
Jonsered**	0.93	4.2	4.5	0.67	40
Excavator**	0.60	2.5	4.2	0.62	37
Moxy*	0.80	2.3	2.9	0.43	26
Moxy**	1.16	3.2	2.7	0.40	24

Note - Where appropriate calculations use a standard log size of 0.15 m³

* Loading to itself

** Loading to another truck

DISCUSSION

The collection of waste wood already extracted to the landing and then discarded is the most economic option for increasing overall fibre recovery (Twaddle, Stokes and Watson, 1989). All the systems studied here fit that criteria.

There are major differences in the reported costs of these three operations and the influence of having the wood presented by the logging crew for collection was evident. It can save $7 to $8.00 per m³, if the excavator is not required to sort through the landing surrounds. It also allows for a larger proportion of the potential volume to be recovered.

During the study, there was a great deal of bin wood material available for collection which met the dimension specifications, but which was rejected and not picked up due to advanced sap stain and drying.

The most efficient way for the wood to be collected was for it to be placed in a heap somewhere on the skid by the logging gang for collection by the bin trucks. Pushing the wood into the skid surrounds where it had to be retrieved by a machine independent of the trucks added considerable cost. It also meant that only part of the available volume was recovered, especially in hauler operations where some of the wood was pushed over banks out of reach or was buried under a layer of other debris and was not visible or accessible. Scheduling of the collection is crucial to the success of the operation. If the wood is to be retrieved by excavator it has to have access to the skids before the material has become excessively sap-stained or is too dry. Chipping of wood is affected by the wood's moisture content. Dry wood can lower chipper production significantly in comparison to green wood (Watson et al 1986).

If a theoretical system is costed, assuming:

- wood in Kaingaroa Forest

- presented on the skid

- collected by a self-loading truck paired with a truck trailer unit

- taking highway loads to Mount Maunganui,

the cost of the wood delivered to Mount Maunganui would be approximately $27.00 per m³, possibly less depending on the configuration of the trucks used. This compares very favourably with the current system using the excavator and self-loader and paired truck (System 1) at around $35.00 per m³.

The only change in work method for the logging crew would be to push the wood into a heap on the skid, separate from the branch material, as opposed to pushing all the waste into one large heap off the skid. The cost of this has not been determined but would be minimal. However, this system would require efficient scheduling of trucks to collect the wood so as to cause least disruption to the crews during their working day. Regular uplift of the wood to avoid the heaps becoming excessively large would also be necessary.

The collection of short sections of stem wood creates the opportunity to deliberately manufacture them and maximise the value recovery of the resource. Previously, the bin wood portion may have been added to a length of higher quality wood to make a pulp log which met the minimum length of pulpwood specification.

Integration of residue harvesting systems with conventional logging systems offers the greatest potential for cost effective harvesting of residues (Mitchell 1990, Sturos 1982). Bin wood should be treated as just another log type.

CONCLUSIONS

Three systems for collecting short sections of stem wood waste for use as chip were studied, including: sorting and stacking the wood from skid surrounds with an excavator for transport by paired self-loading bin trucks, collection from skid site heaps by a self-loading bin truck, and collection from skid sites heaps and skid surrounds with a self-loading off-highway dump truck for accumulation of large volumes for reloading into highway trucks.

The short sections of stem wood waste created during value recovery driven log making operations were successfully recovered from skid surrounds. The wood was then transported to a site for utilisation as chip. Costs for these operations were between \$24.00 and \$70.00 per m^3, depending on the equipment used, over leads in excess of 110 km. For short leads in off-highway operations (System 3) this may be substantially reduced, to around \$5 to \$6.00 per m^3.

The type of loading crane, and experience of the operator can significantly affect the time taken to, and cost of, loading the wood.

The systems described are very dynamic and many different options are being considered and developed. The systems reported here are not necessarily the ones which will be used in the future.

Managing the logging systems to enable hot deck recovery of the bin wood would lead to lower costs and increased volumes being recovered.

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The costs stated in this report were derived using the procedures shown in the LIRO Handbook, Business Management For Logging. They are indicative only and do not necessarily represent the actual costs of the operations.

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