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Volume recovery comparison for four different harvesting methods in short-rotation blue gum plantations

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Introduction

The majority of Australian hardwood plantations have been planted with the intention of harvesting high quality woodchips for export, with a rotation of eight to 12 years. Currently, there are numerous harvesting methods operating to produce pulpwood chips in Australia. They can be broadly placed into three categories:

- Cut-to-length (CTL): The trees are processed into short logs (~5 m) at the stump, and forwarded to roadside for transport.
- Whole tree to roadside (WTR): The trees are felled, bunched and skidded to roadside as whole trees, for processing into long logs (~10m) prior to transport.
- In-field chip (IFC): The trees are felled, bunched and skidded to the roadside as whole trees, then processed into wood chips, and loaded directly onto trucks for transport. In this study two different in-field chippers were used—one using a delimbing and debarking flail integrated with the chipper (IFC-DDC) and the other using a chipper with a separate flail machine for delimbing and debarking (IFC-F/C).

This study follows up preliminary results from the volume recovery comparison (CRC for Forestry Bulletin 9, April 2010). This bulletin provides further results, comparing volume recovery from a broader range of harvesting methods currently in use. It covers one aspect of an overall research project, which also collected data for the analysis of machine and method productivity, reviewed issues associated with transport, and compared woodchip quality output between methods.

It also compares the yields in delivered green metric tonnes (GMt) and bone dry metric tonnes (BDMt) from four different harvesting methods currently operating in *Eucalyptus globulus* (blue gum) plantations in Western Australia.

Study description

The study was conducted on a blue gum plantation in south-west Western Australia. All products produced during the study were delivered to the APEC chip mill in Albany. The study site was an area of 5.95 hectares and was a first rotation (1R), 10.5 year old (planted in 2000) blue gum plantation. The study investigated the four harvest methods, CTL, WTR, IFC-DDC and IFC-F/C, under the following conditions:

- Each harvest method worked in uniform stand conditions. The layout of the site consisted of eight adjacent gullets. Each gullet was three rows of trees wide (~12 m) and ~500 m long.

- Each method harvested two gullets, as shown in Figure 1, and worked within normal operating procedures.
- Feller-bunchers were required to leave 100–150 mm stump height to enable coppicing of the second rotation (2R). Therefore, this study could not take into account the potential to reduce stump height with some methods.
- The harvest of the study site occurred over nine consecutive days, in January 2011.
- Every truckload of pulpwood chips or logs was closely monitored to ensure the weight was accurately attributed to each gullet. Restrictions were not placed on the timing of delivery in order to ensure the study corresponded as closely as possible to normal operations.

The diameter and heights of 38% of the trees were recorded to estimate the average tree size and volume of the stand, enabling a productivity analysis of harvesting equipment.

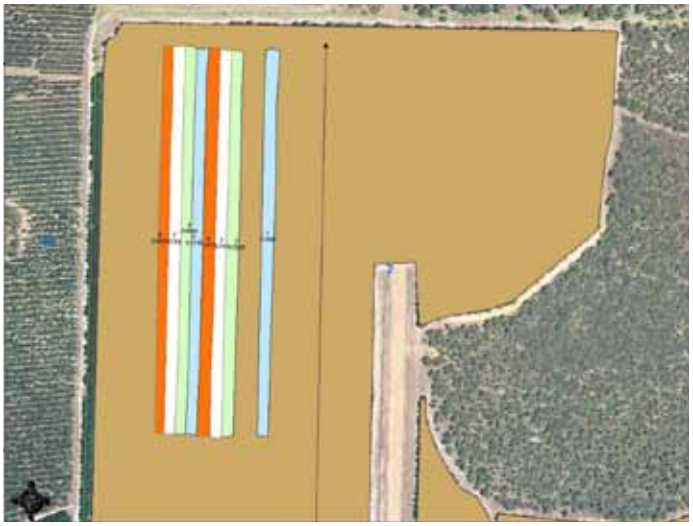

Figure 1. Layout of the study site

Each gullet was mapped accurately, using a GPS to obtain the exact area for each individual method.

Detailed time and motion and volume recovery studies were undertaken on each harvesting method. The equipment used and the process for each method is described below (Figure 2).

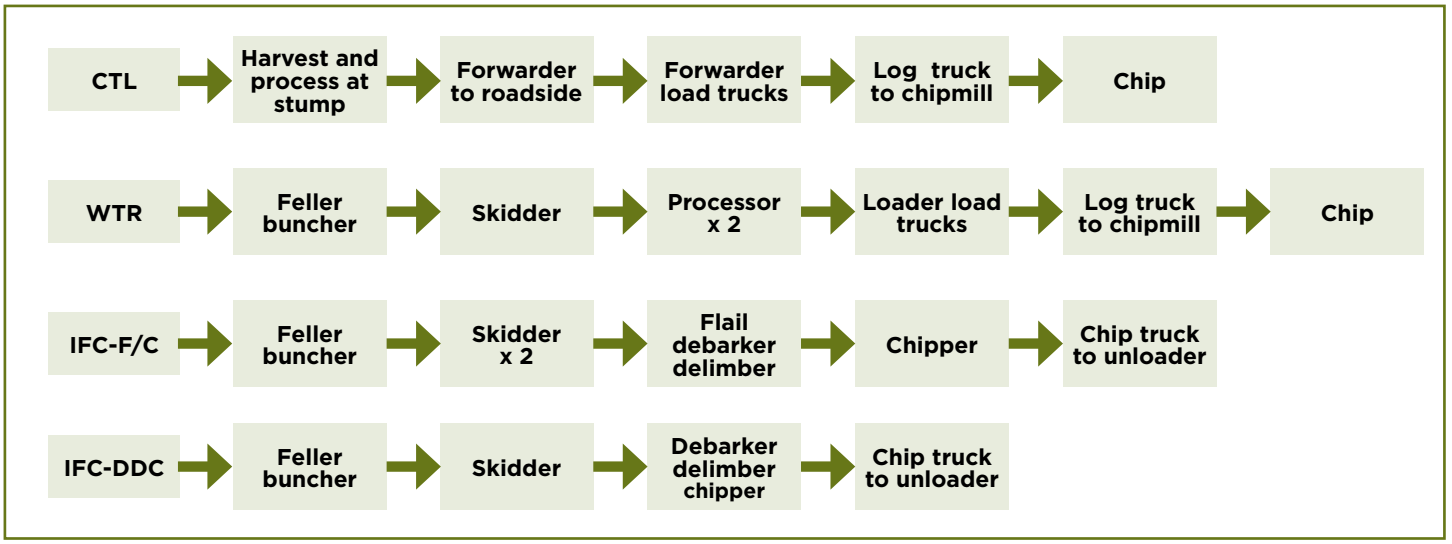

Figure 2. Equipment used and process for each harvest method

Results

Tables 1, 2 and 3 show the pre-harvest estimated tonnes and actual weight delivered in GMt and BDMt for each harvest method. Table 2 shows the delivered weight, adjusted by piece size to enable a direct comparison of the methods in the same stand conditions.

When compared with the other methods, the delivered weight produced by the CTL method was affected by the delivered wood age. CTL logs were, on average, eight hours older than the WTR and 24 hours older than the IFC and, therefore, had more time to dry out. These results have been taken into account in the BDMt calculations in Table 3, by using 40.75% moisture content for CTL and WTR, and 43.5% for the IFC methods.

It was observed during the study that the single grip harvester and processors used in the production of logs (CTL and WTR methods) had excellent utilisation of the trees with a small end diameter of 5 cm. However these machines can only process the stemwood, while the in-field chippers can process the whole tree, including all branches and tree tops.

Table 1. Estimated yield from the plantation

Harvest method	Area (ha)	Original stocking (sph)	Merch trees		Merch volume	
			(n)	(sph)	(GMt/ha)	(BDMt/ha)*
CTL	1.52	791	4337	729	128.4	64.2
IFC-F/C	1.45					
IFC-DDC	1.46					
WTR	1.53					

*Assumes 50% moisture content of standing trees

Table 2. Delivered weight comparison in GMt

Harvest method	Delivered weight (piece size adjusted)		Difference	Rank
	(GMt)	(GMt/ha)	(Est. wt to del'd wt, %)	
CTL	206.7	136.0	6%	4
WTR	224.3	146.6	14%	3
IFC-F/C	232.7	160.5	25%	2
IFC-DDC	236.8	162.2	26%	1

Table 3. Delivered weight comparison in BDMt

Harvest method	Delivered weight		Difference	Rank to account for rain
	(BDMt)	(BDMt/ha)	(Est. wt to del'd wt, %)	
CTL	123.7	81.4	27%	4
WTR	128.5	84.0	31%	3
IFC-F/C	130.9	90.3	41%	2
IFC-DDC	134.3	92.0	44%	1

It was also noted that, within this particular stand, the final stocking of merchantable trees could vary. Stocking variation can affect available standing volume, from which recovery is calculated. Standing volume was calculated on 38% of standing trees and this subset confirmed some variability across the whole stand, between the methods and gullets.

The study was conducted in a continuous sequence to eliminate any inconsistencies caused by a variation in the weather conditions. However during a period of the study, an unseasonal, heavy rainfall event occurred during the felling, processing and loading phases of the WTR method gullets. Weather stations in the area indicated rainfall over the two days in excess of 30 mm. These wet conditions make it difficult to directly compare the WTR yield in GMt with the other methods because the moisture content of the wood was 44.1%—higher even than the in-field chipped wood. A ranking was applied to the results (Table 3) to take this rainfall event into account.

Reduced stump heights, which are typical for feller-buncher operations, will somewhat improve the volume recovery from the methods using this equipment.

Once at the mill and prior to chipping, CTL and WTR logs passed through a flail to remove any passenger bark. This bark was collected and weighed, with the results presented in Table 4.

Table 4. Delivered passenger bark

Harvest method	Bark weight (tn)	Bark %
CTL	1.0	0.48%
WTR	2.14	0.89%

Chip samples were collected and analysed from each harvest method. Eight samples were taken; one from each trailer of delivered chips or logs (see Table 5 for results).

Generally, chip samples reached specified size and bark requirements; however there were a few exceptions. Four out of eight (50%) samples of oversize (>28.66 mm) from WTR and two out of eight (25%) from IFC-F/C were above specification. Five out of eight bark samples (62%) from the IFC-DDC were above specification, putting this result well over the 0.5% prescribed limit, and bark content of the chips from this method was higher than other harvesting methods under the study conditions (Table 5).

Table 5. Chip sample results

Harvest method	>28.66 mm	>22.2 mm	>9.5 mm	>4.8 mm	<4.8 mm	Bark
CTL	3.68%	36.12%	53.10%	6.11%	0.97%	0.02%
WTR	5.17%	27.53%	59.26%	6.86%	1.08%	0.11%
IFC-F/C	3.36%	16.31%	68.24%	9.88%	2.03%	0.18%
IFC-DDC	3.07%	20.35%	66.50%	7.87%	1.53%	0.67%

Take-home messages

- There is less volume recovery from CTL and WTR harvesting operations in blue gum plantations than from IFC harvest operations.
- Moisture content can have a substantial impact on the weight of pulpwood chips delivered, with wood age being a contributing factor.
- Bark content of chips produced by IFC-DDC in the study conditions is a potential problem for meeting required quality specifications and should be monitored carefully.

Organisations supporting this research

Albany Plantation Export Company (APEC) supported this research by providing access to its plantation, contractors, equipment and resources.

More information

CRC for Forestry website:
http://www.crcforestry.com.au/research/programme-three/index.html

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