

Assessment of residues from whole-tree and cut-to-length harvesting in Southern Pine plantations, Toolara, south-east Queensland

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Introduction

Previous studies by the CRC for Forestry and AFORA indicate a significant amount of harvesting residue left in clear-felled pine plantations. A previous study by HQPlantations Pty Ltd (HQP) in south-east Queensland Southern Pine plantations indicated that processing trees at stump (cut-to-length (CTL)) can result in higher harvesting residues than processing trees at road side (whole tree method (WT)). Forest harvesting residue is a renewable sustainable source of biomass currently in use in Europe and North America for bioenergy via biomass heating systems. The level of harvesting residues left on-site after merchantable wood extraction (left-slash) depends on various parameters such as harvesting method, harvesting equipment, stand species, site and stand quality. Retaining woody debris on-site contributes to site fertility and plantation growth through nutrient recycling and conserving soil moisture. It also reduces erosion risk. AFORA are developing a national data base on the quantity and nature of harvesting residues across a range of eucalypt and pine operation sites. Sixteen case studies have been carried out to date (Bulletin 31, 2012). This project aimed to increase the pool of data, sampling different plantation regions, different species and contrasting harvesting methods.

Study area and research method

Sites for the two harvesting methods (whole tree and cut-to-length) were located in compartments 4 and 6 Bungawatta, Toolara State Forest, located north-east of Gympie in south-east Queensland (Figures 1 and 2). The whole tree site comprised residues from 30-year-old Honduras Caribbean Pine (*Pinus caribaea* var. *hondurensis*) and the CTL site was 29-year-old slash pine (*P. elliottii* var. *elliottii*) that was clearfall harvested during April-May 2014 to a 7 cm small end under-bark diameter to produce sawlog and pulpwood. Residue sampling occurred in late July 2014.

The whole tree operation consisted of a feller-buncher to fell the trees and a skidder to extract whole trees to road side where the trees were processed into (generally) stem-length logs. Assessments of 'left-slash' in the whole tree harvesting site excluded roadside processing debris piles, which are generally aligned in a linear fashion just in from the roadside. The cut-to-length operation included a harvester to fell and process the trees at-stump and a forwarder to extract the (generally 6m) logs to the landing.



Figure 1 Figure 2 : Cut- to- length extraction site



Figure 4 : Sampling method



Figure 3 : Fractioning method

CRC for Forestry and AFORA have developed standard methods to measure the amount of left-slash after industrial wood recovery (Figure 3). The method is based on a one-hectare study area within which numerous 0.5m x 0.5m sample plots are assessed to weigh harvesting residues. After a brief investigation on each harvesting site, a representative study area was selected to collect 18 samples per harvesting method (site), with 5 per site fractioned to evaluate the proportion of needles, bark, cones and branches (Figure 4). Results were analysed using the Student's t-test.

Results

As indicated in Table 1, the average weight of harvesting residues from the whole-tree harvest technique (excluding the heavy line of debris against the roadside) was 31.7 green metric tonnes per hectare (GMt/ha). This was significantly less than the cut-to-length harvest operation (77.6 GMt/ha).

Table 1. Results of left-slash assessment for contrasting harvesting techniques

	Whole tree	Cut-to-length
Number of plots	18	18
Min (GMt/ha)	12.8	20.0
Max (GMt/ha)	64.0	235.8
Average (GMt/ha)	31.7*	77.6

* Excludes rows of stem-processing 'left-slash' parallel to roadsides

Figures 5 and 6 show the composition of residues for WT and CTL harvest techniques, respectively.

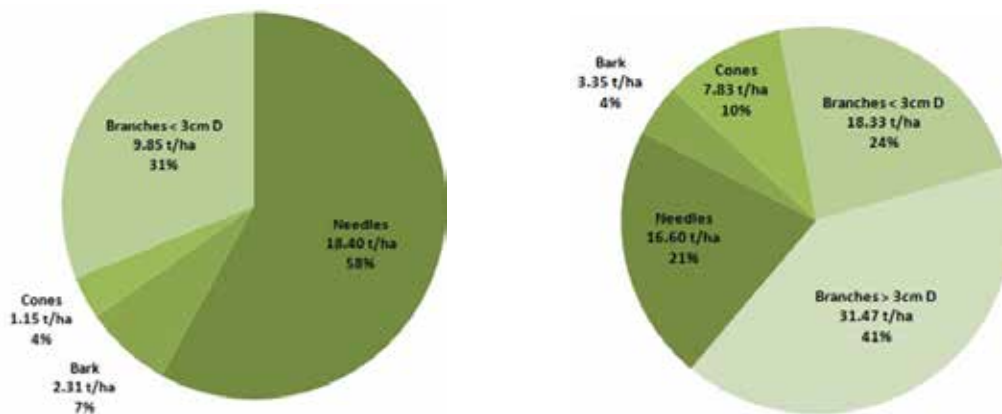


Figure 5: Residues of whole tree extraction **Figure 6:** Residues of cut-to-length extraction

Cut-to-length harvesting resulted in a higher total weight of residues, especially small and large branches, compared to the WT method. In the CTL site, 41% of residues were large branches (about 31.5 GMt/ha) (Figure 7) while in the WT site there were no large branches, probably because most of these are dragged to the roadside zone where the whole-tree stem is processed (Figure 8). Hence, needles (58%) and small branches less than 3 cm diameter (mid diameter over bark) (31%) formed most of the weight of residues across the General Plantation Area (GPA) for WT harvesting. Bark weight for both sites ranged from 4% to 7% of residues.



Figure 7: Large logs remained only on the CTL harvest site



Figure 8. Processing debris along roadside arising from Whole-Tree

harvesting. These debris lines were NOT assessed in this study.

According to the USDA guidelines for the Pacific North West, at least 4-5% of total green forest biomass should remain on the operation site to avoid soil degradation and growth decline in the next rotation (Sessions, 2012). Table 2 presents the total estimated biomass and left-slash for both harvesting techniques. For WT, 10.8% of total biomass remains across the GPA while for CTL the percentage was 18.8%. This may indicate a low potential risk of unsustainability on these sites however comprehensive studies are required to determine acceptable minimum left-slash levels for the wide range of site conditions experienced across Australia’s diverse plantation estates.

Table 2. Wood recovery and left-slash percentage

	Industrial wood recovery (GMt/ha)	Left slash (GMt/ha)	Total biomass (GMt/ha)	Left slash share of total biomass (%)
Whole Tree	262.2	31.7	293.9	10.8%
Cut-to-length	334.5	77.6	412.1	18.8%

Take-home messages

- Cut-to-length harvesting yielded significantly higher residue levels (77.6 GMt/ha) distributed across the GPA compared to whole-tree harvesting (31.7 GMt/ha). The CTL residues were less than the average of previous studies in radiata pine (98.7 GMt/ha) (Bulletin 31). There was no study carried out by AFORA on pine plantation harvested by WT to compare the result however the left-slash of 31.7 GMt/ha in this case study is higher than average left-slash of Eucalypt plantation sites (6.1 GMt/ha).
- The weight of large branches left following CTL harvesting was 31.5 GMt/ha in this case study. Depending on the economics of harvest and haul operations, this may represent a viable resource of ‘fibre-plus’ material to be extracted by modified bin-load forwarders (Bulletin 32, 2012) for MDF or for bioenergy production (Bulletin 19, 2011).

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More information

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