Loading Productivity of Untrimmed and Trimmed Pulpwood

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Abstract

The increase in biomass usage for fuels and energy has required a re-examination of harvesting and transportation systems to efficiently deliver these products to market. Some biomass markets accept forest residues or whole trees (including stem wood, bark and needles) as a feedstock. Therefore, there is less need to remove limbs and tops or deconstruct the tree other than to make transport more efficient. Transporting untrimmed wood or whole trees directly to the mill would appear to be a viable option to achieve increased harvesting productivity and efficiency. In the spring of 2014 a pilot study was undertaken to examine the advantages and disadvantages of untrimmed wood in the wood supply chain. In the fall of 2014, a second study examined the productivity of loading untrimmed (whole) pulpwood trees compared to loading trimmed pulpwood trees.

Keyword: whole tree, pulpwood, biomass, loading

1. Introduction

Woody biomass is defined as “The trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment that are the byproducts of forest management.” (Patton-Mallory, 2008). Woody biomass can come from mill residues or from the harvesting site itself as the by-product of the primary timber product. These byproducts may be bundled, baled, chipped or chunked and require different handling and transportation systems. The potential increased efficiency of transporting untrimmed or whole trees was examined by Thompson et al. (2014). The hypothesis was that by not deconstructing the tree in the woods, multiple products can be hauled on one truck to the mill resulting in increased harvesting and transportation productivity. Once at the mill, the biomass portion of the tree can be separated from the traditional forest products.

The initial pilot study in the spring of 2014 examined the loading and trimming times for a harvesting crew transporting untrimmed pulpwood in Perry, Florida. A second study gathered

additional data on the same harvesting crew loading untrimmed pulpwood and a second harvesting crew loading trimmed pulpwood.

Slash pine (Pinus elliottii) is the dominant plantation species planted in the Perry, Florida region. The Georgia Pacific Foley mill purchases untrimmed trees. Many local landowners plant dense stands (1000 trees/ac) and clearcut at 18 to 22 years old with no intermediate thinnings. The majority of the product removed from these stands is pulpwood with a small component of chip-n-saw logs.

2. Methods

A video camera was used to record the loading, trimming, and binding time for the two harvesting crews. Any loading activities that occurred out of view of the video camera were recorded with a stop watch. Load weights were recorded from load tickets. Elemental time analysis was performed using Timer Pro software (Timer Pro, 2013). The loading cycle was broken down into its individual elements and the trimming and binding time was recorded. Cycle elements are listed in the order of a typical sequence in Table 1. During the study period no recordable delays were observed.

Table 1: Pulpwood loading cycle elements for a knuckleboom loader.

Element	Definition
Sort	Element begins when grapple is lowered toward the banked wood. It Includes all activities involving preparing stems to be loaded. These include sorting pulpwood and chip-n-saw logs, removing vines and small hardwoods. The element ends when a grapple of wood is heeled.
Swing to Trailer	Element begins after sorting is complete and a grapple of stems is heeled and is complete when stems are lowered and un-heeled at the foot of the trailer.
Arrange	Element includes all activities involving arranging the stems on the trailer to achieve a compact load.
Swing to Pile	Element begins after arranging stems on the trailer has ended and grapple has started back towards the pile of stems. Element ends when grapple is lowered to begin sorting.

The harvesting crews each consisted of a rubber-tired feller-buncher equipped with a shear head, a rubber-tired grapple skidder and a knuckleboom loader. The knuckleboom loader separated the pulpwood from the chip-n-saw logs, processed the chip-n-saw logs and removed any vines and scrub hardwoods. The receiving mill allows for the tops of the chip-n-saw logs to be mixed into the pulpwood loads if they are longer than 16-ft in length. The untrimmed pulpwood loads utilized the knuckleboom loader to break off excessive limbs and tops to make the loads road legal. The truck would pull up to allow the loader to use the grapple to break off a portion of the overhanging limbs and tops. The driver would then use a chainsaw to complete the trimming of the load, bind the load and add flags and a light. The trimmed pulpwood crew did not utilize the loader to help trim the load. All trimming was performed by the driver with a chainsaw. Three trucks were assigned to the untrimmed crew and four trucks were assigned to the trimmed crew.

3. Results

Over a three day period in September 2014, twelve loading cycles of untrimmed pulpwood and fifteen loading cycles of trimmed pulpwood were observed. Table 2 below summarizes the load data for each crew.

Table 2: Load data for two harvesting crews loading untrimmed and trimmed pulpwood.

Untrimmed Crew	**Obs**	**Min**	**Max**	**Avg**
Loading (min)	12	7.04	13.29	9.89
Driver Trim (min)	12	4.03	11.24	6.91
Loader Trim (min)	12	1.01	2.05	1.54
Total Trim (min)	12	5.75	12.56	8.45
Total Load Time (min)	12	13.49	24.34	18.34
Total Stems (#)	12	85	123	98
Net Load (lbs)	12	48200	57360	52140
Trimmed Crew	**Obs**	**Min**	**Max**	**Avg**

Loading (min)	15	7.37	17.66	11.6
Driver Trim (min)	15	3.43	9.63	6.96
Loader Trim (min)	15	.	.	.
Total Trim (min)	15	3.43	9.63	6.96
Total Load Time (min)	15	14.29	24.53	18.56
Total Stems (#)	15	97	165	131.6
Net Load (lbs)	15	47040	59680	53161

Driver trim times were almost identical for each crew. The loader trim time for the untrimmed crew added 1.54 minutes to each load on average. Loading time for the untrimmed crew was 9.89 minutes compared to 11.60 minutes for the trimmed crew. This can be attributed to the 131.6 average stems per load compared to 98.3 stems per load for the untrimmed crew. Of the 15 loads observed for the trimmed crew, 9 loads included chip-n-saw tops. Only 3 of the 12 untrimmed loads contained chip-n-saw tops. Total average loading cycles for each crew were almost the same at 18.34 and 18.56 minutes for the untrimmed crew and trimmed crew, respectively. Average net load for each crew differed by 1021 lbs.

Figure 1 shows the average time for the four elements of the loading cycle and the average count of Swing to Trailer elements per load. Swing to Trailer, Swing to Pile, and Arrange were similar for each crew. The trimmed crew averaged 20 Swing to Trailer elements per load compared to 15 per load for the untrimmed crew. This reflects the increased number of stems per load as noted in Table 2. Sorting time for the untrimmed crew averaged 15.7 seconds per observation for the untrimmed crew compared to 9.4 seconds for the trimmed crew. The increased time to sort reflects more vines and scrub hardwoods in the material and the added effort required to get the untrimmed trees untangled from each other while loading.

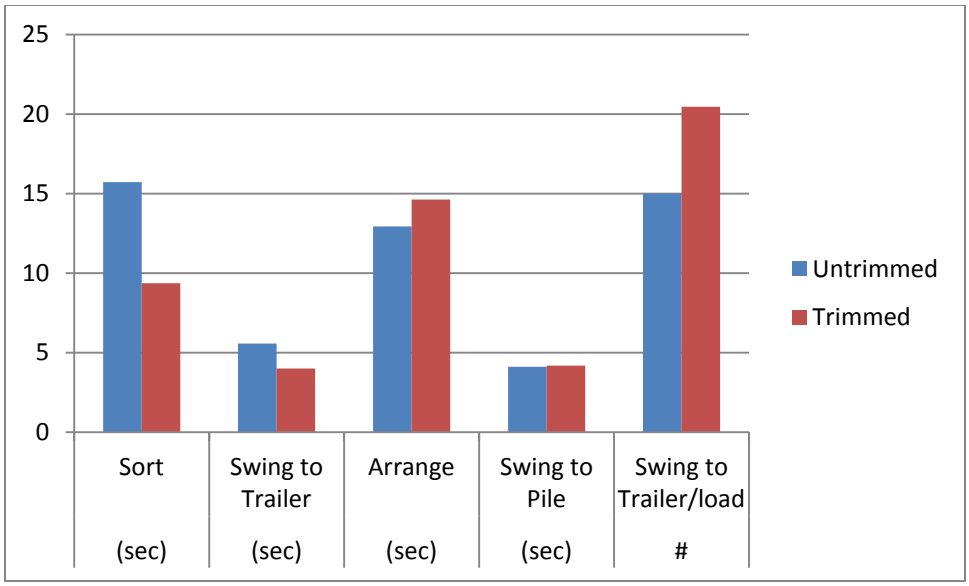

Figure 1: Cycle elements for two harvesting crews loading untrimmed and trimmed pulpwood.

4. Discussion

Achieving efficient transport of woody biomass is an essential component in making it a viable product. This study is part of a larger effort in identifying alternative ways to harvest and transport woody biomass. The initial results indicate that loading and transporting untrimmed trees was just as productive as hauling trimmed trees. Net load was within approximately 1000 pounds for both crews, averaging 26 tons per load. Time to load was also almost identical at just over 18 minutes per load. This equates to approximately 84 tons/hr for both crews.

The knuckleboom loader of the trimmed crew was not observed actually limbing and topping any of the pulpwood loads, either during the loading process or between loads while the loader was sorting and processing chip-n-saw logs. The crew foreman indicated that the tops and limbs of the slash pine (Pinus elliottii) could easily be broken off by driving over them. The feller buncher operator and the skidder operator purposely drove over the tops of bundles of trees in the field and at the landing in an effort to break off the tops and limbs. The data suggests that these efforts did increase the productivity of the knuckleboom loader by removing the need to limb and top the trees.

The untrimmed crew averaged 34 fewer stems per load compared to the trimmed crew. This difference can either be attributed to a larger overall tree size or the increased volume associated with hauling untrimmed trees. Stand data was not obtained during the study;

therefore we cannot verify a difference in average tree size between the two sites. An analysis of the load data for the untrimmed crew showed that the 3 loads that contained tops averaged 111 stems per load compared to 94 stems per load for the 9 loads that did not contain tops. The average weight for the loads with tops was 50660 lbs. compared to 52598 lbs. for the loads with no tops. These results indicated that the addition of tops (with needles and small limbs) added volume to the loads while reducing payload. The trimmed crew averaged 143 stems per load for the 9 loads with tops and 53131 lbs. per load. The 6 loads without tops averaged 114 stems and weighed 53206 lbs. The trimmed crew's average load weights differed by 75 lbs. indicating that the tops included in the loads had been stripped of their needles and branches.

5. Conclusions

Loading untrimmed pulpwood achieved similar productivity as hauling trimmed pulpwood. This would indicate that hauling untrimmed trees to utilize woody biomass without requiring a separate harvesting operation is a viable alternative.

The next phase of the research will focus on the complete harvesting and stand management system. Questions that need to be answered include: How much material is being trimmed from the loads to make them road legal? How much extra woody biomass is being removed overall from the stand?

6. References

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