Piling for Burning versus Piling for Biomass Extraction

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ABSTRACT

The objective of this trial was to determine the difference in overall cost between three methods of preparing logging residues after the initial harvest: piling for burning, piling for comminution (post primary harvest), and processor piling for comminution (during primary harvest). Secondary objectives included analyzing the effects the three methods had on plantability, fire risk and feedstock contamination.

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1. INTRODUCTION

The Ministry of Forests, Lands and Natural Resource Operations tasked FPInnovations with developing a Best Management Practices for Integrated Harvest Operations in British Columbia guidebook (Spencer, 2017), with a focus on biomass extraction principles. One of these principles states that it is beneficial for both primary and secondary harvesters to neatly pile logging residue if it is destined for biomass extraction rather than the traditional practice of piling for burning.

Traditional debris piling practices require the piling of logging residues into a conical or windrow-shaped pile and then clearing the area around the pile of all organics. Little care is taken to exclude contaminants (dirt and rocks) from the pile or to keep the residual pieces intact and aligned as the pile is destined for burning. However, if the burn piles are targeted for secondary use (chips, hog, pellet stock) at a later date, contamination and poor alignment of the pieces can significantly decrease the productivity of the secondary harvester (grinding or chipping) and lead to an inferior end product.

Burning of residue includes two costs: (1) piling the residue and (2) burning the residue. If the residue is neatly handled by processors, comminution (grinding/chipping) is the only cost, but if the residue is not neatly handled by the processor, two costs (piling, grinding/chipping) are incurred. The major difference in outcome between piling for burning and piling for biomass extraction is that value is derived from the comminuted product. There is no financial payback from burning residue.

The piling of residue for biomass extraction starts at the log-processing stage. Processor operators are encouraged to drop residual tops parallel to each other and avoid criss-crossing and tangling. Long butts should be dropped in front of the pile of tops. After processing, re-piling may not be necessary if the residue is arranged neatly enough.

This trial consisted of two parts. The first part examined the establishment, productivity, and costing of the piling process. The second part examined the costing and productivity associated with comminution of the piles established in part one.

2. OBJECTIVE

The main objective of this trial was to determine the difference in overall cost between three methods of preparing logging residues after the initial harvest: (1) using a loader to pile for the purpose of burning; (2) using a loader to pile for the purpose of comminution, and (3) piling by the processor for the purpose of comminution (during primary harvest).

Secondary objectives included analyzing the effects the three methods had on plantability, fire risk and feedstock contamination.

3. METHODOLOGY

In the first half of the trial, a cutblock was chosen along the Bobtail Forest Service Road (FSR), southwest of Prince George, British Columbia. Residual piles were assigned one of three piling treatments:

a. Residue neatly piled by the processor and then repiled for burning (6 piles).
b. Residue neatly piled by the processor and then re-piled for easier biomass extraction (7 piles).
c. Residue neatly arranged by the processor and then left as is for biomass extraction (10 piles).

In the two methods requiring re-piling (a and b), a Hitachi butt'n'top loader with a power grapple re-piled the residue. Loader piling was timed with a stopwatch. Note: additional piles were scheduled for biomass and burn piling, however, mechanical breakdown on the third day forced a smaller sample than desired.

In the second half of the trial, the residue piles were ground up for pellet feedstock with a Peterson 5710 horizontal grinder. The grinder was timed with a stopwatch.

Using the load weights collected from load slips, the productivity and costs of each piling method could be determined. A sample was taken from each load for moisture content analysis (see Appendix 1) to convert findings to oven dry tonnage.

Contamination was assessed in each sample using a particle shaker. Contaminants were visually identified in each size class and weighed.

Visual assessments for plantability and fire risk were performed. However, a second analysis in the spring, when the snow has melted, is recommended.

4. RESULTS AND DISCUSSION

Pile Building

Fire Piles

Six piles were created to simulate traditional practices where piles are built for burning. The loader operator worked around the pile, breaking off long pieces that stuck out from the main pile, and scraping organic material into the sides and top of the piles, thus creating a fire break between the dispersed slash and the pile. While effective for burning, this method creates a pile contaminated by soil content, and composed of many smaller broken pieces mixed into longer pieces of opposing alignment (Figure 1).

Figure 1. Residue pile built for burning treatment.

Biomass Piles

Seven piles were rebuilt by the loader from the leavings of the processor. This involved sorting residual tops into a deck-like shape and placing long butts in a neat pile near the front of the deck (Figure 2). However, because this debris was designated for pellet feedstock (pellet creation is far more sensitive to contamination than simply burning as hog fuel), and the long butts had sunken into the soft ground below the piles, the researchers decided to simply stack the tops above the long butts, and leave the long butts undisturbed. As it turned out, at the time of grinding, gathering the long butts from the frozen ground was effective and little to no soil was removed along with the long butts.

Figure 2. Deck-like piling of residual tops

Processor Piles

Processor operators were instructed to keep tops aligned and neat during the initial harvest. Long butts were dropped in front of the tops (see Figure 3). Ten piles, untreated by a loader, were chosen as a control sample. The logging contractor told researchers that having the processor operators keep the residue piles neat did not lower productivity from the usual method of simply throwing the tops haphazardly into the cutblock. This statement was proven in a recent trial that investigated the effects on productivity between two different residue handling practices (Spencer, 2017).

Figure 3. Processor-piled residue.

Productivity and Costing

Piling

Productivity and cost of piling were calculated for each piling method (Table 1).

The productivity and cost for piling of residues for burning was slightly higher than that of piling for biomass extraction. There is likely little significance to this difference.

Table 1. Productivity and cost for building residue piles.

Piling treatment	Productive machine hours	Volume (Odt)	Piling productivity (odt/PMH)	Machine rate ($/PMH)	Piling cost ($/odt)
Piling for burning	2.4	121.8	50.4	$ 180.00	$ 3.57
Piling for biomass	6.7	407.3	61.1	$ 180.00	$ 2.95
Processor only	0	447.7	N/A	$ 180.00	$ -

Grinding

The lowest grinding cost occurred in the piles that were re-piled for biomass extraction. This was because the arrangement of the debris pieces made it easy for the loader to pull tops directly from the pile and place them onto the infeed deck of the grinder (Figure 4). Whereas the loader had to take time to break the tops or pull them away from the pile, and then align them so they could be properly placed onto the grinder's infeed deck in the other two methods (Figure 5). This was especially true for the piles built for burning.

The ease with which the loader could feed the grinder from biomass piles allowed the operator to keep the grinder infeed filled consistently. For the fire and processor piles, there were occasions when the grinder was underloaded because the operator had to spend time pulling the piles apart and aligning the tops. Productivity and cost of grinding were calculated for each pile type (Table 2).

Table 2. Productivity and cost of grinding residue piles.

Piling treatment	Productive machine hours	Volume (Odt)	Grinding productivity (odt/PMH)	Grinding rate ($/PMH)	Grinding cost ($/odt)
Piling for burning	3.0	121.8	40.8	$550.00	$13.47
Piling for biomass	8.8	407.3	46.3	$550.00	$11.88
Processor only	10.2	447.7	44.0	$550.00	$12.49

Figure 4. Loading the grinder with residue from biomass piles.

Figure 5. Loading the grinder with residue from piles created for burning.

Total cost

The treatment with the lowest total cost was the scenario where the processor operators piled the residues neatly in the initial harvest (Table 3), because no re-piling costs were incurred.

The biomass extraction treatment had the next lowest total cost. The difference between piling for biomass extraction and piling for burning is mainly due to lower grinding costs. As previously noted, differences in piling costs are not significant.

Table 3. Total cost for piling and grinding residue piles.

Piling treatment	Grinding cost ($/odt)	Piling cost ($/odt)	Total cost ($/odt)
Piling for burning	$13.47	$3.57	$17.04
Piling for biomass	$ 11.88	$2.95	$14.83
Processor only	$12.49	$0.00	$12.49

Contamination of feedstock

The levels of contamination incorporated into the feedstock for each pile type were assessed. Contamination is given serious consideration in the pellet feedstock operation as sand and rock can drastically shorten the lifespan of pellet dies as well as increase the proportion of ash created when the pellets are burned. Although there is a cost to contamination in shortened die life, this was not calculated for this study which focussed on in-woods costs.

Contamination was only found in the piles created for burning. This was due to the piling technique. The outlying debris pieces were scraped along the ground toward the pile by the loader and placed onto the sides and the top of the pile. This usually resulted in soil and rocks being scooped up with the wood pieces as the ground was soft at the time of piling (July). The soil and rocks would then fall down through the pile, contaminating a large portion of it (Figure 6). Although the grinder operator tried to minimize the amount of contaminants placed in the grinder, some inevitably ended up in the feedstock (Figure 7). The samples collected from the piles created for burning contained a high ratio of contaminants (~2%) compared to the ratio of contaminants from the other piling methods (almost none). The contaminants primarily consisted of fine dirt <3 mm (Figure 7).

Figure 6. Leftover pile after grinding of fire pile (note the contaminants interspersed within).

Figure 7. Contaminants pulled from a load derived from piles created for burning. These concretions broke into fines when warmed above freezing.

The piles created specifically for biomass extraction contained little to no contaminants because only the tops from the original processor piles were manipulated during pile creation, when the ground was soft (July). Although long butts were intentionally left untouched during re-piling to avoid contaminants, the grinding operator was able to collect them without contamination because the ground was frozen and he took care not to scalp the soil beneath.

The processor-created piles also showed little to no contaminants for the same reason as the biomass piles. Long butts were collected only if the operator determined he could do so without scalping the soil underneath them.

Residual Volume

The volume of residue on the site following grinding was visually assessed, in terms of fire risk as well as plantability. Although the volumes were visually assessed after grinding, it is recommended that a second assessment be completed in the spring after snow melt, when fuel depths can be better measured.

Fire Risk

The volume left after grinding the biomass and processor piles was very low because most of the fibre had been fed into the grinder. In places where leftover material, deemed too dirty to grind, was concentrated, the loader operator broke up and spread the pieces over a large area. At the time of grinding, researchers judged that the leftover residue would create a fire risk no worse than that of the dispersed slash located away from roadside. Leftover residue was generally short, long butt pieces (~30 to 50 cm long, Figure 8), as well as some needle accumulations. Most of the longer pieces (>2 m long) had been fed through the grinder.

Leftover residue from the piles created for burning generally contained long butts and tops that were contaminated by dirt and rocks and deemed unfit for pellet feedstock (Figure 9).The volume left after grinding the piles that had been created for burning was considerable (~13%) and needed to be re-piled for later burning to mitigate fire risk. The cost of burning is an additional cost not calculated here that adds further expense to the 'fire pile' method.

Figure 8. Leftover residue after grinding processor and biomass extraction

Figure 9. Residue leftover after grinding piles created for burning.

Plantability

After removal, the pile footprints were assessed for plantability by a researcher with eight years of planting experience (Figure 10). Plantability was considered very good (easy) in the footprint of the biomass and processor piles. The footprint of fire piles was also considered to be easily plantable in the portion that had been cleaned up and re-piled. However, for fire piles the post-grinding residual piles will need to be burned before planting can occur in the area they occupy.

Figure 10. Example of pile footprint of biomass extraction pile.

5. TAKE HOME MESSAGES - CONCLUSIONS

Three take-home messages were derived from the alternative piling trial.

Have processor operators take care when handling residues in the primary harvest

It was clear that the best method of treating harvest residues was to insist that the processor operators neatly pile the residues as they processed logs. Although the cost of grinding itself was lower when the residues were re-piled for biomass before grinding, the cost of re-piling led to an overall higher cost to the comminution process. There was also no difference in the amount of residual volume (post grinding) between piling for biomass and simply grinding the neat processor piles.

Stop piling for burning

If there is ANY chance that residuals will be utilized for chips, pellet feedstock, or hog fuel, the processor operator should take care to pile residues neatly at the time of stem processing. The licensee will benefit from reduced burning costs and will have the opportunity to plant in the footprints of the piles sooner than if piles are burned. The logging contractor that harvested the trial cutblock reported that there was no loss in productivity by having processor operators pile the residues neatly versus just throwing the tops haphazardly. This means that the primary harvester does not see any financial gains or losses from handling the residue differently. The grinding operator could see a savings of $1/oven dry tonne (odt) if the residues are neatly handled in the primary stage compared to piling for burning (see Table 4).

Table 4. Breakdown of savings by supply chain participant

Supply chain participant	Savings ($/odt)	Explanation
Licensee	$1 to 5	Reduced pile-burning costs
Primary harvester (logger)	$0	No savings, but no loss either, procedural change only
Secondary harvester (grinder)	~ $1	Difference between grinding residue piled for burning and residue piled neatly by processor operators

After grinding, spread excess concentrations of debris to avoid plantability issues and decrease fire risk

If small accumulations of residue remain after grinding, the operator usually has sufficient time between loads to scatter the concentrations outside the pile footprint. The scattered residue does not inhibit plantability or create fuel buildup that would contribute to fire risk.

6. REFERENCES

Spencer, S. 2017. Best Management Practices for Integarted Harvest Operations in British Columbia. FPInnovations. Guidebook

7. APPENDIX 1 – MOISTURE CONTENT DATA

Load #	DATE	MC
1	15/12/2016	25.0%
2	15/12/2016	25.0%
3	15/12/2016	25.2%
4	15/12/2016	26.7%
5	15/12/2016	24.8%
6	15/12/2016	23.5%
7	15/12/2016	25.8%
8	16/12/2016	22.5%
9	16/12/2016	22.5%
10	16/12/2016	26.5%
11	16/12/2016	29.8%
12	16/12/2016	25.6%
13	16/12/2016	24.0%
14	16/12/2016	22.1%
15	16/12/2016	24.6%
16	16/12/2016	32.6%
17	16/12/2016	24.4%
18	16/12/2016	25.7%
19	16/12/2016	27.7%
20	19/12/2016	31.9%
21	19/12/2016	31.9%
22	19/12/2016	22.7%
23	19/12/2016	26.4%
24	19/12/2016	27.8%
25	19/12/2016	23.0%
26	19/12/2016	23.6%
27	19/12/2016	25.3%
28	19/12/2016	26.8%
29	19/12/2016	21.1%
30	19/12/2016	21.9%
31	19/12/2016	20.8%
32	20/12/2016	33.6%
33	20/12/2016	33.6%
34	20/12/2016	23.2%
35	21/12/2016	23.8%
36	21/12/2016	23.4%
37	21/12/2016	21.9%
38	21/12/2016	23.4%
39	21/12/2016	25.2%
40	21/12/2016	27.2%
41	21/12/2016	24.9%
42	21/12/2016	25.8%
43	21/12/2016	23.3%
44	21/12/2016	24.2%
45	21/12/2016	26.5%
46	22/12/2016	23.7%
47	22/12/2016	23.7%
48	22/12/2016	21.9%
49	22/12/2016	27.1%
50	22/12/2016	26.4%
51	22/12/2016	26.3%
52	22/12/2016	27.6%
53	22/12/2016	26.8%
54	22/12/2016	25.9%

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