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Contents

Returning delimbing slash to the cutover in integrated operations

Abstract

Integration of the extraction and delimbing phases in full-tree harvesting allows the use of grapple skidders to return the delimbing slash to the cutover as soon as it is produced. In the operations FERIC observed, this handling of the slash had little or no effect on skidder and delimber productivity.

Keywords:

Extraction, Grapple skidder, Delimbing, Stroke delimber, Integrated operation, Productivity, Delimbing slash.

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Introduction

Several forestry companies have integrated the delimbing and extraction phases of their full-tree harvesting systems in an effort to reduce the frequency of stem breakage (Légère 2001). In fully integrated operations, the grapple skidders feed the delimbers directly and can be used to return the delimbing slash to the cutover. This approach was studied previously by FERIC (Desrochers 1999); in one of the operations studied, slash was returned to the cutover after harvesting was complete (i.e., in a separate phase), whereas in the other, slash was returned in an integrated operation. FERIC conducted three additional studies of slash handling between 1999 and 2001 with Bowater Canadian Forest Products Inc. (formerly Produits Forestiers Alliance inc.) in the Lac Saint-Jean region of Quebec. The study's goal was to evaluate the impact of returning slash to the cutover (Figure 1) on the productivity of the machines during harvesting with the protection of regeneration and of soils (HPRS). This report presents the results for the three modes of operation we observed.

Figure 1. A grapple skidder carrying delimbing slash.

Description of the operations

The three studies took place in different sectors of Bowater's Mistassini operations. The stands were all primarily black spruce (at least 72%), with volumes between 105 and 166 m³/ha. The block depths ranged from 220 to 325 m, with maximum slopes of 13 to 20%. The harvesting equipment in each study consisted of a feller-buncher, two grapple skidders, and one or two stroke delimbers working at roadside. Three operating modes were observed:

Semi-integrated mode with occasional return of slash

In this mode, a delimber worked with two skidders during the day and one skidder at night. A second delimber occasionally helped out. The skidders generally did not feed the delimbers directly, but instead piled their loads ahead of the delimber, with instructions not to climb onto the piles. They only occasionally delivered their loads directly to the delimber and departed with delimbing slash. This approach avoided delays in which the skidder or delimber was forced to wait for the other machine to complete its work. However, the limited space available at roadside for piling the trees sometimes forced the skidders to climb onto the piled trees to drop their load, leading to stem breakage.

Integrated mode with systematic return of slash

In this mode, two skidders directly fed two delimbers. Each waited until the delimber had completed delimbing its current batch of trees before dropping a new load. The skidders picked up slash before each return trip, and distributed it along the extraction trails.

Integrated mode with occasional return of slash

This mode was identical to the previous one except that operators received no instructions concerning the return of slash to the cutover. Instead, they cleared the work area as needed and occasionally used the slash to fill wet spots along the trails.

One skidder and one delimber were timed during each study. A slash inventory was performed for the first two modes, and a rutting survey was performed in the second study.

Results

Productivity

Table 1 presents the distribution of productive time for skidders working in each of the three operating modes. The time elements for a conventional extraction cycle (travelling loaded and unloaded, loading, maneuvers, unloading, and operational delays) were grouped together under "extraction". To facilitate comparisons, the extraction cycles were standardized at a distance of 150 m.

Skidder productivity was not measured directly. In integrated mode, the skidders and the delimbers worked together and their productivity was thus considered identical (Table 2). In semi-integrated mode, there were more skidders than

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Table 1. Distribution of work cycle time elements for the grapple skidders

	Semi-integrated mode with occasional return of slash		Integrated mode			
			With systematic return of slash		With occasional return of slash	
	min	% PMH	min	% PMH	min	% PMH
Work cycle elements						
Extraction	8.21	97.3	5.96	78.7	9.18	96.0
Handling slash	0.20	2.4	0.48	6.3	0.15	1.6
Waiting for delimber	0.03	0.3	1.14	15.0	0.23	2.4
Total time/trip	8.44	100.0	7.58	100.0	9.56	100.0
Frequency of handling of slash (%)	30		79		15	

Table 2. Delimber productivity and distribution of work cycle time elements

	Semi-integrated mode with occasional return of slash		Integrated mode			
			With systematic return of slash		With occasional return of slash	
	min	% PMH	min	% PMH	min	% PMH
Work cycle time elements						
Delimbing	0.30	88.3	0.29	86.6	0.42	91.2
Handling slash	0.03	7.6	0.02	6.0	0.02	5.0
Waiting/passage of skidders	0.01	4.1	0.03	7.4	0.02	3.8
Total time/cycle	0.34	100.0	0.34	100.0	0.46	100.0
Stems/PMH	195		284		148	
Volume/stem (m^3)	0.13		0.11		0.13	
Productivity (m^3/PMH)	25.4		31.2		19.2	

delimbers (1.5 skidders per delimber); thus, their average productivity equaled roughly 67% of the delimber's productivity.

Waiting time for skidders working in semi-integrated mode was practically nonexistant, but reached 15% in the integrated mode with systematic return of slash. In the integrated mode with occasional return of slash to the cutover, the waiting delays were reduced as a result of the more difficult terrain and slower skidders. Handling of slash was considerably more frequent in the integrated mode with systematic return of slash, and this is reflected in the proportion of cycle time

devoted to handling slash. However, this handling (to fill wet spots in the trail) still represented 1.6% of PMH in the integrated mode with occasional return of slash to the cutover.

The time elements in a conventional delimbing cycle (traveling, extracting stems from piles, picking up stems, delimbing, depositing stems, maneuvering, and operational delays) were grouped under "delimbing" (Table 2). "Waiting/passage of skidders" represents delays while the delimber waited for a skidder to drop its load as well as periods when the delimber lacked trees to delimb. The proportion of PMH required to handle slash was similar in all three studies because the operator still had to clear the work area whether or not skidders removed the slash. The productivity differences between the three studies related primarily to the speed of the operators.

In integrated mode, waiting time for the delimbers generally increases with increasing extraction distance. In the integrated operations we observed, the extraction trails were relatively short (Table 3) and the terrain was relatively gentle. Longer waits could be expected in more difficult terrain and with longer trails.

Distribution of slash on the cutover

In the integrated mode with systematic return of slash to the cutover, two felling patterns were used: "conventional" (1-in-1), in which there was standard spacing between the extraction trails, and "2-in-1" (Gingras and Plamondon 1998), in which extraction trails were more widely spaced (Table 3). The majority of the slash was deposited in discontinuous heaps along the first half of the trails (closest to the landing). In the semi-integrated mode,

Table 3. Distribution of slash in the different operating modes

	Semi-integrated mode with occasional return of slash	Integrated mode with systematic return of slash	
	2-in-1	2-in-1	1-in-1
Depth of the cut block (m)	300	218	225
Average trail width (m)	4.3	6.3	4.7
Average distance between extraction trails (m)	22.4	26.4	9.8
Coverage of the site by extraction trails (%)	16.1	19.3	32.4
Coverage of the trails by slash (%)	44.0	31.7	23.8
Average slash height within the trails (cm)	15	45	45

the trails were covered with a compact and continuous layer of slash for the first 145 m from the landing (Figure 2). The area covered by slash represented between 6 and 7% of the cutover, all modes combined. In the semi-integrated mode, a layer of slash averaging 24 cm deep remained in the delimbing area, and would require scarification before planting. The quantity of slash left at roadside was not measured for the other operating modes.

Because of the nature of the study site, the rutting inventory for the integrated mode with systematic return of slash to the cutover revealed no decrease in the abundance and severity of soil disturbance due to the presence of slash; the majority of the slash (70%) was deposited on the more solid trail sections in the half of the trails nearest to the landing, whereas the ruts were found in the more distant half of the trails. The rutting index[1] (extraction and felling trails combined) averaged 18.6% in the harvesting pattern with widely spaced trails (2-in-1) and 30.0% in the pattern with standard trail spacing (1-in-1).

Figure 2. Slash spread on the extraction trails.

Implementation

Returning slash to the cutover had little or no effect on machine productivity; the skill of the skidder and delimber operators had a much greater impact. Although the systematic return of slash required more handling by the skidders and delimbers, integration of the extraction and delimbing phases inevitably creates waiting for both machines, and these delays can be used to handle slash without affecting overall productivity. In addition, the systematic return of slash to the cutover ensures that the delimber's workspace is continually being cleared, and this decreases the risk of missing a stem under the slash and results in cleaner piles of delimbed stems. In non-integrated operations, the cost of returning slash to the trails can be quite high because slash disposal becomes a separate phase (Desrochers 1999).

In the trails, slash should be used first to decrease rutting. On firmer sites, it can be left on the least-productive terrain (rocky outcrops) or in discontinuous heaps along the trail to facilitate infill planting or the establishment of natural regeneration. Operators should avoid needlessly spreading the slash to ensure that the slash occupies the least space possible. Slash can be left temporarily at the end of the landing

[1] Percentage of the extraction and felling trails that exhibited ruts more than 20 cm deep for a length of more than 4 m.

and gathered later for use where it is needed most. The 2-in-1 harvesting pattern concentrates skidder traffic and slash on fewer trails, thereby decreasing the frequency of soil disturbance and the overall percentage of the cutover covered by slash. Returning the slash in a separate operation leads to additional skidder traffic and prevents the skidders from taking advantage of the presence of slash on the trails to decrease soil disturbance during extraction.

Reduction of the slash volume in the delimbing areas facilitates the recovery of these areas and improves the esthetics of the operations by avoiding the creation of piles or windrows. The slash left behind in the delimbing areas sometimes requires light scarification, but the need for site preparation will be considerably lower than in traditional delimbing areas, and its costs will be reduced.

In addition to significantly decreasing stem breakage and the amount of landing space, the integrated operations return slash to the cutover as soon as it is produced. Our study demonstrated that the increased handling of slash had little or no effect on machine productivity. Given the significant advantages provided by the systematic return of slash, this approach should be considered in any integrated operation.

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