Advantage
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Contents

Reduction of stem damage by integrating skidding with delimbing

Abstract

In 2000, FERIC estimated the reduction in stem breakage and damage in a hot-logging system in which delimbing was integrated with skidding. The results showed that in a well-synchronized operation, no significant productivity loss occurs. Certain types of damage, notably those that arise at the small end of the stem, can be significantly reduced because the skidder no longer creates piles of wood at roadside before delimbing. During the study, 48% of the stems from a traditional system (with skidding and delimbing in separate phases) exhibited at least one form of damage, compared with only 27% in the integrated system.

Keywords:

Delimbing, Skidding, Productivity, Stem damage, Grapple skidder, Stroke delimber, Hot logging.

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Introduction

Stem breakage and damage occurs frequently during full-tree harvesting, primarily during the extraction and delimbing phases. The traditional approach consists of the skidder and delimber working in separate phases ("cold decking"), with the skidder piling the stems at roadside before delimbing. Stems can easily be damaged when the machine climbs onto the piles to unload. A previous FERIC study on stem damage in a traditional operation (Favreau 1998) estimated that up to 16% of the wood harvested in a full-tree system can be damaged. In addition, the stems tangled within the piles created by the skidder make the delimbing operation more difficult and render the stems susceptible to additional damage. Another FERIC study (Favreau 1997) demonstrated that the damage caused during delimbing itself can represent up to 5% of the total damage.

Figure 1. A delimber and grapple skidder working together in a hot-logging operation.

To reduce the frequency of this stem damage, several companies integrate the delimbing phase with the extraction phase ("hot logging"). In this integrated approach, the stems are usually delimbed as soon as they arrive at roadside (Figure 1). Thus, the skidder creates no piles.

This report describes the results of a study conducted in the summer of 2000 in the operations of Alliance Forest Products Inc. (Mistassini, Que.), and compares the frequency, position, and types of stem damage caused by a traditional "cold-deck" operation with damage levels in an integrated operation. The study also estimated the productivity of the two approaches.

Methodology

The homogeneous cut block chosen for comparing the differences between the two systems was composed of black spruce (62%), fir (27%), and white birch (11%). The total volume before harvesting averaged 166 m³/ha. The terrain was firm and even, and its slope ranged from 0 to 15% [CPPA class 2.1.1(2)]. The same contractor performed the extraction and delimbing phases in both the traditional and the hot-logging approaches. FERIC estimated the operation's productivity primarily to determine the magnitude of the roadside delays experienced by the skidder and the delimber working in a hot-logging operation.

Immediately after harvesting, the spruce stems produced by both the systems were transported to the wood yard of Alliance Forest Products' Mistassini mill and spread out in separate piles so we could assess stem damage levels. First, we examined all the stems on at least three visible faces to identify and measure the externally visible damage. Thereafter, we slashed a number of sample stems into logs to detect internal damage.

Damage was grouped by each stem's DSH (diameter at stump height) class and by the position of the damage along the stem (bottom, middle, or upper third of the length) compared with an undamaged reference stem (Figure 2). In this report, the term "damage" includes the following possibilities:

- Damage at the small end (DSE) at a stem diameter of more than 8 cm.
- Damage at the large end (DSH), excluding sawing damage caused by the felling head.
- A visible fracture along the stem.
- Stripping of fiber along the stem to a depth of more than 2 cm.
- Cracks along the stem that run deeper than 2 cm.

Productivity of the two systems

FERIC performed time studies on the skidding and delimbing phases to compare the productivity of the two harvesting systems.

Productivity during grapple skidding

Two grapple skidders were used during the study: a John Deere 748E and a Timberjack 660. In all, we timed 106 trips in the hot-logging operation, versus 140 trips in the traditional operation. Table 1 presents the work cycle time elements and the extraction productivity for these trips. No significant productivity difference was attributed to the extraction approach, although the skidder working in the hot-logging operation occasionally had to wait for the delimber to become available so it could unload and also sometimes had to redistribute the delimbing slash. The additional time requirement (0.6 min/cycle) was compensated for by the significantly

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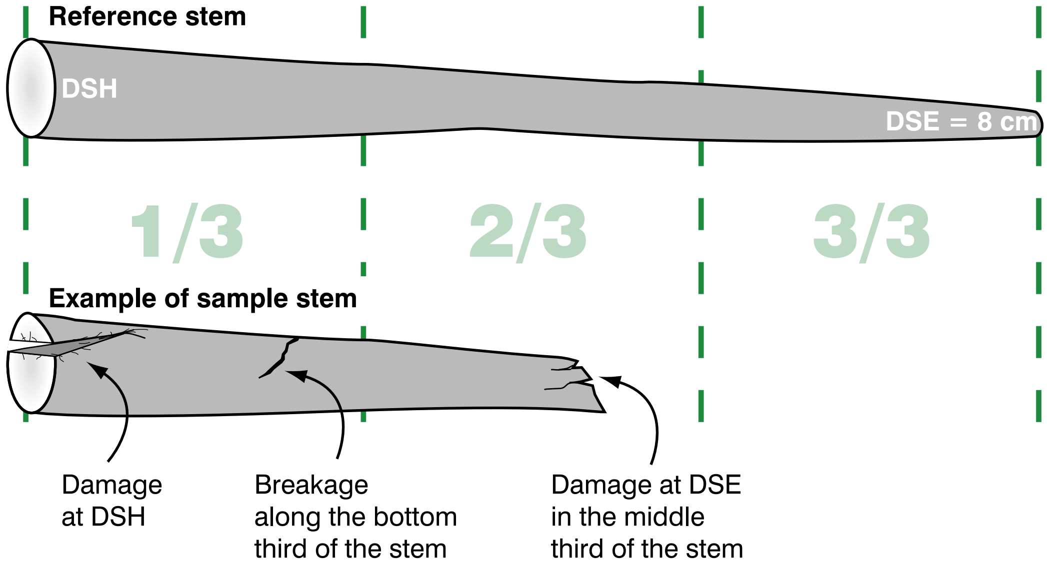

Figure 2. Illustration of the types of damage recorded and of their position in comparison with a reference stem of the same DSH.

Table 1. Productivity of the grapple skidder in the two approaches (n.a. = not applicable)

	Approach		
	Traditional		Hot logging
Elements of the work cycle (min)			
Traveling empty (distance standardized at 150 m)		2.16	
Maneuvering		0.65	
Loading		0.56	
Traveling during loading		0.05	
Traveling loaded (distance standardized at 150 m)		2.56	
Unloading	1.34		0.96
Operational delays		0.07	
Waiting for delimber	n.a.		0.32
Moving delimbing slash or returning it to the cutover	n.a.		0.28
Total time/trip	7.39		7.61
Number of stems/trip		16.0	
Average volume/stem (m^3)		0.143	
Productivity (m^3/PMH) [a]	18.6		18.0

[a] Hardwood stems are included in this productivity.

shorter unloading time. However, hot-logging operations require good planning to ensure that the additional time (waiting and redistributing slash) does not reduce extraction productivity.

Productivity of the delimber

Delimbing was performed at roadside by a Denis stroke delimber mounted on a Kobelco SK220LC carrier. Table 2 presents the results obtained for the softwood stems delimbed in the two approaches. The productivity in the traditional approach was 18% greater than that obtained in hot logging, but this difference could be attributed entirely to the greater average stem volume handled by this system. As well, an examination of the work cycle time elements for the delimbing operation provided no evidence that the productivity difference related to the approach being used. The delimber working in the hot-logging operation was nearly always supplied by two grapple skidders, and experienced few delays while waiting for a skidder (0.02 min/cycle). However, longer extraction distances could increase the duration and frequency of these delays.

Evaluation of stem damage

In all, we examined 893 stems from the hot-logging operation and 1077 stems from the traditional approach in the mill's wood yard to determine the frequency of damage and the positions of the damage on the stem. Figure 3 presents the frequency of the three main categories of damage (DSH, along the stem, and DSE), as well as the positions of the damage along the stem (bottom, middle, or upper third of the stem; see Figure 2).

Figure 3 indicates that in the traditional approach, the frequency of damage in all three categories was roughly twice that in stems produced by the hot-logging operation. Damage at the small end of the log (in the upper third) was the most frequent type observed, with 32% of stems from the traditional approach broken at a diameter of 8 cm or more versus 14% in the hot-logging operation. In addition, 30% of the damage at the small end occurred within the middle third of the stem, and this can lead to significant fiber loss. Damage measured along the stem occurred primarily within the bottom third of the stem. This type of damage

Table 2. Productivity of the delimber in the two approaches (n.a. = not applicable)

<table>
<tr><th rowspan="2"></th><th colspan="2">Approach</th></tr>
<tr><th>Traditional</th><th>Hot logging</th></tr>
<tr><td>Elements of the work cycle (min)</td><td></td><td></td></tr>
<tr><td>Loading</td><td colspan="2">0.17</td></tr>
<tr><td>Delimbing</td><td colspan="2">0.14</td></tr>
<tr><td>Piling stems</td><td colspan="2">0.10</td></tr>
<tr><td>Operational delays</td><td colspan="2">0.00</td></tr>
<tr><td>Redistributing branches</td><td colspan="2">0.02</td></tr>
<tr><td>Waiting for a skidder</td><td>n.a.</td><td>0.02</td></tr>
<tr><td>Total</td><td>0.43</td><td>0.45</td></tr>
<tr><td>Number of stems/cycle</td><td>1.07</td><td>1.13</td></tr>
<tr><td>Average volume/stem (m³)</td><td>0.140</td><td>0.111</td></tr>
<tr><td>Stems/PMH</td><td>149</td><td>151</td></tr>
<tr><td>Productivity (m³/PMH)</td><td>20.9</td><td>16.8</td></tr>
</table>

arises primarily at roadside when the skidders, after having climbed atop the pile to unload, damage the stems while descending from the pile. Damage at the large end of the stem (the bottom third, DSH) also occurred during this phase, and 5% of the stems produced by the traditional operation experienced this type of damage (Figure 4).

Figure 5 can be used to estimate the frequency of damage at the small end as a function of the top diameter (DSE) value specified by the client. Figure 5 indicates that the frequency of the damage increases in both systems as DSE decreases. The frequency of damage at the small end (DSE) also increases as DSH increases in both systems, as shown in Figure 6. However, the difference between the traditional approach and the hot-logging operation tends to decrease as DSH increases.

Figure 7 illustrates how the frequency of damage along the stem increases with increasing DSH in both approaches. Again, this damage is normally inflicted when the skidder descends from the piled wood in the traditional approach. As a result, this type of damage was infrequent in the hot-logging operation, and increasing DSH had little influence on the frequency of damage in this approach. Most of the damage observed along the stem (90%) occurred within the bottom third of the stem (Figure 3).

We also arranged to have 176 stems slashed into 1-m sections to gauge the presence of internal damage (Figure 8). An additional 6 and 8% damage were detected in stems produced by the traditional and hot-logging systems, respectively. Including this additional damage, 48% of the stems produced by the traditional operation were damaged, versus 27% in hot logging. The 48% reported for the traditional approach is similar to the values reported by Favreau (1998), excluding the internal damage and damage along the stem. While measuring the internal damage, we also collected data on the positions and lengths of the damage to let us simulate the effect on lumber yield; this will be done within a joint FERIC–Forintek project that will take place in 2001.

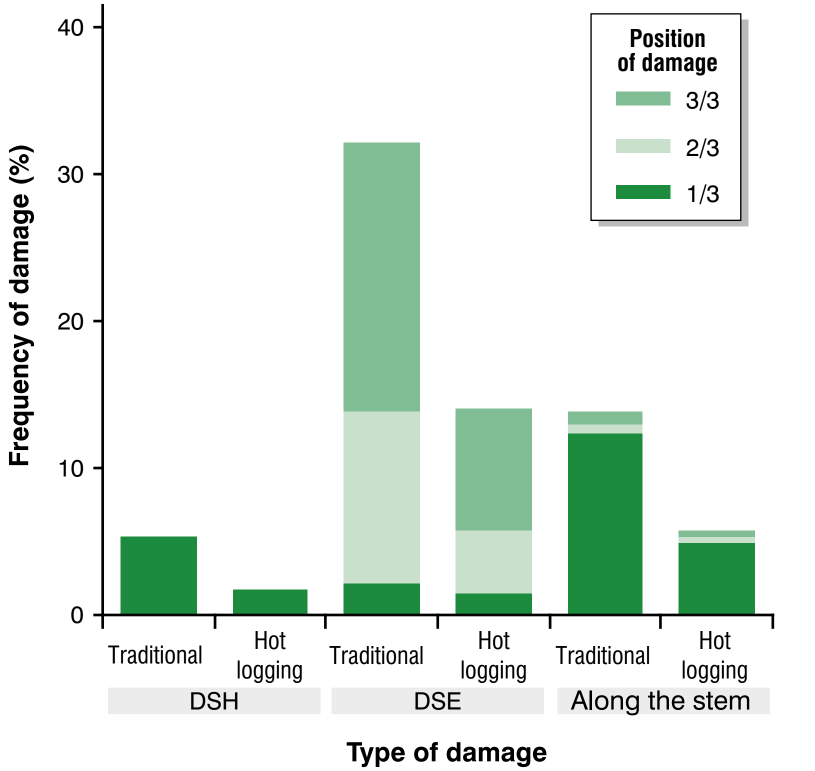

Figure 3. Frequency and position of damage in the two extraction and delimbing systems.

Figure 4. Damage at the large end of the stem (DSH) inflicted during unloading of stems at roadside by the skidder in the traditional operation.

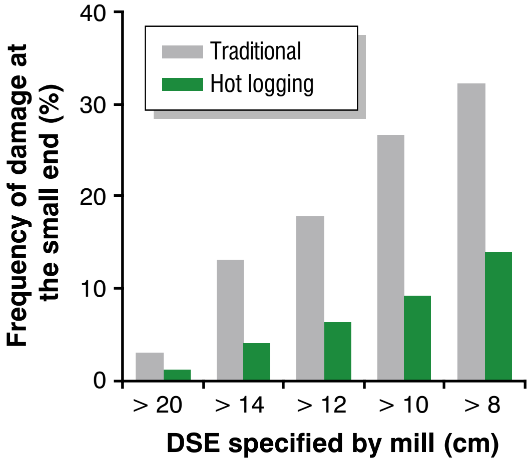

Figure 5. Frequency of damage at the small end of the stem in both systems as a function of the top diameter (DSE) value specified by the mill.

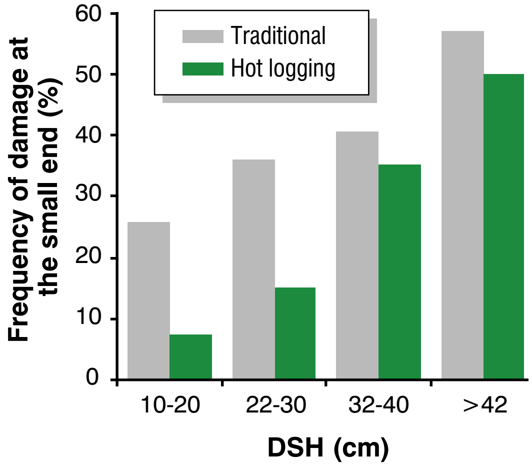

Figure 6. Frequency of damage at the small end of the stem in both systems as a function of DSH class (for a specified DSE of 8 cm).

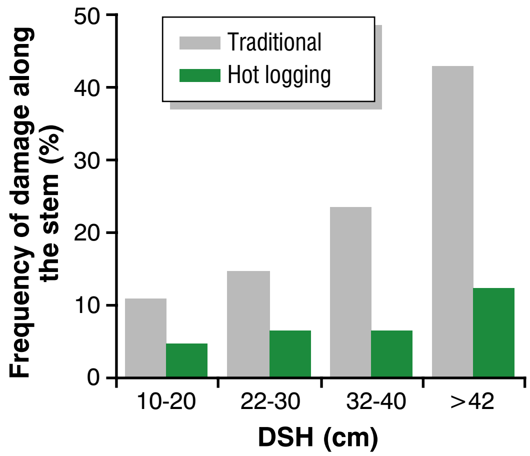

Figure 7. Frequency of damage along the stem, by DSH class, for the two systems.

Figure 8. Slashing of stems into 1-m sections with a single-grip harvester to permit an assessment of internal damage.

Implementation

FERIC's study demonstrated that the stem damage that occurs in a full-tree system was halved by combining the skidding and delimbing phases into a hot-logging operation. To ensure efficient implementation of a hot-logging operation, we recommend:

- Good synchronization of the extraction and delimbing phases is essential to maintain productivity equivalent to that obtained in a traditional full-tree system. The cut blocks must be designed (for example, by adjusting their depth) so as to avoid having either skidders or delimbers waiting for each other.
- The delimbing sites must be located on sufficiently firm ground that the skidders can travel over the ground frequently and can maneuver easily.
- The study also demonstrated that damage levels increase with increasing DSH. Stands with a high average stem volume are thus likely to benefit the most from a hot-logging approach, since the value of the stems is greater.

Acknowledgments

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