Advantage

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Contents

Evaluation of feller-directors in tolerant hardwood selection cuts

Abstract

FERIC studied the productivity and effectiveness of directional-felling heads in tolerant hardwood selection cuts. The feller-directors proved capable of handling the demands of this type of operation, and delimbing quality matched or exceeded that achieved with feller-bunchers. However, the feller-director with the smaller carrier and lower-capacity head encountered more difficulty than the larger head–carrier combination. Delimbing the stems using the feller-directors decreased productivity, but not enough to make the operation uneconomical.

Keywords:

Feller-directors, Selection harvesting, Hardwoods, Productivity, Hultdins 850 Superfell felling head, Denis D-55 felling head.

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Introduction

Selection cuts in tolerant hardwoods have recently become increasingly mechanized to compensate for shortages of competent manual fellers. A survey of member companies (Godin 1998) revealed that some hardwood selection cuts were now using dedicated feller-bunchers or excavator-based carriers equipped with intermittent-saw felling heads and directional-felling heads. Although mechanized felling has proven effective in such stands, processing remains problematic because of the large limbs and the need to recover maximum value from the stems.

Previous FERIC research (Meek 1997a) indicated that it was practical to delimb larger branches and remove crowns immediately after felling. However, manual delimbing can be difficult and dangerous, and removing branches with a feller-buncher reduces sawlog recovery because using the continuously rotating saw blade inadvertently damages the stem during delimbing and topping. As well, partially delimbed stems produced by feller-bunchers require additional processing to remove branch stubs (Meek 1997b). Directional-felling heads, like single-grip heads, offer greater maneuverability and their chain saws pose less risk of stem damage. This report summarizes studies of two such heads in four operations.

Machine and site descriptions

FERIC's studies evaluated the Hultdins 850 Superfell and Denis D-55 directional-felling heads (Figure 1), each in two Quebec operations. This Hultdins head was studied on two relatively large carriers (a John Deere 653E tracked carrier at Mont-Laurier and a Timberjack 608 carrier in the Papineau-Labelle Réserve near Montpellier). At the first site, the head incorporated a live heel and a "rake" about 0.7 m wide, which the operator used to prepare microsites suitable for yellow birch seeding where the terrain was favorable. The Denis D-55 head was evaluated at two sites near La Tuque on a

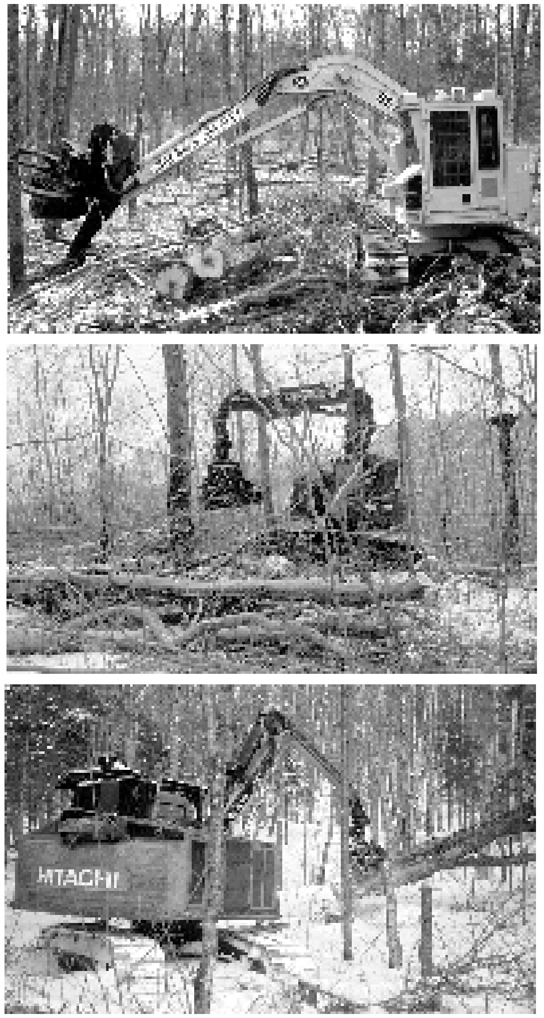

Figure 1. The three feller-directors in FERIC's study: the Hultdins 850 head on a John Deere 653E carrier (top) and a Timberjack 608 carrier (middle), and the Denis D-55 head on a Hitachi EX100M carrier (bottom).

Hitachi EX100M carrier. Table 1 presents the site conditions.

The terrain was similar on all three sites: moderately firm ground, few obstacles, and a rolling topography with gentle to moderate slopes. Each stand had a similar hardwood species composition (mostly sugar maple, yellow birch, white birch, and white ash), with a smaller softwood component (balsam fir and white spruce).

Work methods

Stems were marked for removal prior to harvesting. Extraction trails were not flagged, so the machine operators chose the travel routes. They felled the marked trees, then delimbed and topped them by placing the felling head on the stem and activating the saw. Delimbed stems were then piled in relatively open areas near the extraction trails. The larger John Deere 653E and Timberjack 608 carriers let operators position felled trees in front of the machine before delimbing and topping. The smaller Hitachi EX100M had more difficulty maneuvering large stems and required extra movements to position the machine before delimbing or topping.

Table 1. Site descriptions

	Hultdins 850 Superfell		Denis D-55	
	Site 1	Site 2	Site 3a	Site 3b
Terrain (CPPA)	2.2(3).2(3)	2.2(3).2(3)	2.2(3).2(3)	2.2(3).2(3)
Stand density (trees/ha)	450	500	220	450
Basal area (m^2/ha)	24.4	25.5	18.4	19.6
Volume (m^3/ha)	200	180	160	150
Average stem diameter (cm)	26.1	25.7	32.7	23.6
Average volume per standing tree (m^3)	0.445	0.370	0.724	0.338

Results

Detailed time studies compared the productivities with and without topping and delimbing of the trees (Table 2) and measured the work cycle time elements (Table 3). On the Mont Laurier site, the operator used the integrated rake to prepare 126 microsites per hectare (each ca. 4 m^2) at an estimated cost of \$115/ha. Details of the site preparation will appear in a future FERIC report.

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The productivity decreases as a result of delimbing ranged from 9 to 24% in terms of volume and stems per PMH. On site 1, 19% of the harvested trees had not been marked and the average residual diameter increased by 2%. On site 2, the operator removed too much volume by harvesting larger trees. On sites 3a and 3b, the operator harvested roughly the same number of trees per PMH as with the larger carriers, but the smaller trees reduced the volume productivity (m^3/PMH). The Timberjack 608–Hultdins combination on site 2 proved most productive overall (26.9 and 35.4 m^3/PMH with and without delimbing, respectively). Although the Hitachi EX100M had the lowest productivities (17.2 and 19.0 m^3/PMH with and without delimbing, respectively), its direct costs were comparable to those of the Hultdins head.

Table 3 presents the average times for each work cycle element. Delimbing plus moving to delimb accounted for 11 to 25% of total cycle time, but this is justifiable given that manually delimbing felled hardwoods can be tedious and dangerous. The main operational delays involved the chain detaching from the saw bar, usually while removing large branches (when the trees were difficult to control) or when felling a large tree required more than one cut. The Hitachi–Denis D-55 combination spent slightly more time travelling than the other machines mainly because 1 m of snow was present on the ground, because of the additional movements required to position the machine prior to delimbing and topping, and because of increased travel during bunching.

The larger Hultdins Superfell 850 directional-felling head easily felled large trees (40 to 50 cm in DBH), whereas the Denis D-55 head sometimes required multiple cuts to fell such trees, and these trees appeared difficult for the small Hitachi carrier to control. The delimbing quality with the directional-felling heads was better than that with a feller-buncher, which produced only partially delimbed trees (Meek 1997a).

Table 2. Harvesting productivity results for all sites

	Hultdins 850 Superfell		Denis D-55	
	Site 1[a]	Site 2	Site 3a	Site 3b
Study duration (PMH)	6.3	4.3	4.7	4.9
Volume harvested (m^3/tree)	0.667	0.656	0.499	0.351
Productivity with delimbing				
Trees/PMH	32	41	36	49
m^3/PMH	21.3	26.9	18.0	17.2
Direct cost ($/$m^3$)[b]	4.65	4.16	4.21	4.41
Productivity without delimbing				
Trees/PMH	37	54	43	54
m^3/PMH	24.7	35.4	21.5	19.0
Direct cost ($/$m^3$)[b]	4.01	3.16	3.52	3.99

[a] These results *do not* include site preparation.
[b] Estimated direct operating costs are $99/PMH, $112/PMH, and $76/PMH, respectively, for sites 1, 2, and 3 (a and b). These direct costs exclude transport costs, supervision, profits and other overhead.

Table 3. Time elements of the work cycle

	Hultdins 850 Superfell				Denis D-55			
	Site 1		Site 2		Site 3a		Site 3b	
	(min/m^3)	%	(min/m^3)	%	(min/m^3)	%	(min/m^3)	%
Travel	0.54	25	0.40	18	0.91	27	0.84	24
Brushing	0.10	5	0.06	3	0.17	5	0.26	7
Felling	0.36	17	0.37	17	0.62	18	0.73	21
Moving to delimb	0.05	2	0.08	3	0.08	2	0.05	2
Delimbing	0.26	12	0.49	22	0.49	15	0.30	9
Bunching	0.56	27	0.63	27	0.78	24	0.74	21
Operational delays	0.25	12	0.23	10	0.31	9	0.59	17
Total cycle time	2.12	100	2.26	100	3.36	100	3.51	100

However, even with the directional-felling head set flush against the tree, the thickness of the protective plate under the chain saw left branch stubs that the skidder operator had to subsequently remove. Nevertheless, unlike feller-buncher heads, directional-felling heads are less likely to damage stems severely. This mechanized delimbing was relatively economical, at an average cost of $0.69/m³ in the four studies versus $1.20/m³ for manual delimbing after felling with a feller-buncher (Meek 1997a).

Implementation

Directional-felling heads appear well suited to felling, delimbing, and topping hardwoods in selection cuts. With a proper heel-and-rake attachment on the head, minor site preparation work could also be integrated with the felling operation. To implement mechanized harvesting in hardwoods with directional-felling heads, consider the following points:

- A large carrier (e.g., the Timberjack 608 or John Deere 653E) combined with a large felling head (e.g., the Hultdins Superfell) can be more productive, since felling and maneuvering a stem take longer for small carriers (e.g., the Hitachi EX100M) equipped with small felling heads (e.g., the Denis D-55). Even so, the smaller machine may cost sufficiently less that direct wood costs are comparable.
- The work quality was also better with the larger carrier and head, which required fewer cuts to fell large trees, decreased the potential for "barber chairs", and facilitated stem rotation and handling during delimbing. However, removal of branch stubs by the skidder operator or at the landing will still be necessary.
- With asymmetrical tops or a leaning tree, operators should remove some of the crown on the larger or lower side to reduce the risk of damage to the butt log.
- Orient the felling head's bottom protective plate towards the crown before topping to recover the maximum amount of wood from the tree.
- Since logs are measured based on their small-end diameter, remove forked portions of trees during topping. Sawlogs with forked ends have lower potential value if no upgrading is done at the landing.
- Avoid tearing off branches with the felling head's grab arms. This usually results in stem damage and further reductions in value.
- After felling, pile the tree-length wood near trees with poor form and low vigor, which can serve as bumper trees during extraction and thereby decrease damage to residual stems.
- Never grab high-quality residual trees with the felling head's grab arms to help the machine travel uphill. This causes damage that greatly reduces the quality and longevity of the tree. Using the heel and rake, if present, would be more suitable.
- Keep extraction trails as straight as possible to minimize damage to residual stems during extraction.

Mechanized hardwood selection cuts currently take place primarily during the day. Without operational modifications such as flagging trails, using a navigation system (e.g., GPS), or adding high-intensity lighting systems, night selection cuts would be difficult. Much of the operator's work involves navigating within the stand and finding the trees to be felled, so good visibility is essential (Meek 1997a). These issues are currently under study by FERIC.

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