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Development of a simultaneous crushing and scarification technique for the treatment of burned sites

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Abstract

FERIC monitored a prototype machine designed to perform simultaneous crushing and scarification for the treatment of burned sites. The prototype was productive, but couldn't always produce an adequate number of plantable microsites, particularly on sites with thick humus.

Introduction

In 1995, a 35 000-ha fire ravaged a part of the eastern Abitibi region of Quebec occupied by mature spruce stands. Most of these stands could still be harvested, but the trees in some areas remained standing, and in these areas, the establishment of natural regeneration was not always adequate. In particular, a thick layer of charred and hardened humus on some sites impeded the germination of black spruce while promoting the establishment of ericaceous vegetation such as Kalmia.

Under these conditions (with the need to clear residual trees and humus) and in the absence of seed trees, site preparation is intended primarily to improve planter access to the site and planter safety, while promoting the creation of plantable microsites. The traditional treatment used to attain these objectives would be windrowing, but this type of treatment often creates severe disturbance. Moreover, the windrows remove some of the site from production and have a negative visual impact.

To avoid the drawbacks of windrowing and provide a more productive approach, among other goals, Donohue Inc.'s Abitibi Division helped Les Entreprises Forestières Amtech to develop a new machine capable of providing a simultaneous crushing and scarification treatment.

Figure 1. Simultaneous crushing and scarification performed by a bulldozer equipped with a roller-crusher on the front and a passive-disc scarifier pulled behind.

Description of the equipment

The machine consists of a 138-kW Caterpillar D6R bulldozer whose blade has been replaced with a roller-crusher (Figure 1) built from an old Marden B-10GK tandem roller. The roller, which is equipped with 14 blades, has a diameter of 1.45 m, a width of 3.05 m, and a weight of around 7 tonnes. The blades alternate between 20 and 25 cm high and were spaced approximately 45 cm apart at the cutting edge. The bulldozer also pulled a TTS-35 passive-disc scarifier.

Site conditions

FERIC monitored the trials in three contiguous blocks with very similar operating conditions, except for the thickness of the humus layer (Table 1). The terrain was relatively stony and had a good bearing capacity, with little roughness and a slight slope. The site contained 600 residual burned trees per hectare with an average DBH of 13 cm. The quantities of brush and debris on the ground were insufficient to significantly affect the machine's work.

Table 1. Description of site conditions, productivity, and treatment quality

		Block 1	Block 2	Block 3	Average
Terrain conditions					
Ground strength		good	good	good	good
Roughness		low	low	low	low
Slope		low	low	low	low
Residual trees	Density (stems/ha)	600	650	560	614
Brush	Density (stems/ha)	1950	1650	2580	1957
Humus	Thickness (cm)	24	19	16	19
Surface debris	Volume (m^3/ha)	34	23	21	26
Stoniness (%)		32	35	48	37
Productivity					
Area (ha)		2.58	3.96	1.98	8.52
Travel speed (m/min)		50	53	47	50
Productivity (ha/PMH)		0.97	1.04	0.93	0.99
Plantability (%)					
Good		55.0	63.8	63.0	60.4
Marginal		12.0	15.0	18.0	15.0
Nil		33.0	21.2	19.0	24.6
Microsites available (number/ha)		1675	1969	2025	1884

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Results

The crusher-scarifier proved to be productive in terms of the area treated per productive hour, despite the block size, which was smaller than that typically treated in site-preparation operations. By working in a series of concentric passes, the operator limited the amount of turning around that was required and maintained an average productivity comparable to that in conventional scarification: around 1 ha/productive machine hour (PMH) (Table 1). However, the treatment quality was not always sufficient to meet the provincial standards for planting (a minimum of 1875 plants/ha). The aggressiveness of the scarification was questionable given that the number of plantable microsites decreased with increasing humus thickness on these sites.

Scarification is normally done using 4-m-wide passes and a spacing of 2 m between furrows. Thus, the roller was a bit too narrow (at just over 3 m) to ensure complete treatment of the site, and this may have been responsible for the slightly tight spacing between passes during scarification (3.6 m rather than 4.0 m). Despite the terrain's stoniness, the roller-crusher's blades did not appear to sustain any serious damage. No blade had to be changed over the course of the summer, even after treating more than 700 ha (of which 558 ha had relatively stony terrain).

Implementation

The machine that we observed was a prototype working in its first season of operation. As such, the roller assembly on the front of the bulldozer was homemade, and was intended primarily to verify the feasibility of the concept. The productivity results suggest that the operation has interesting potential, even though the machine's operation was interrupted by frequent breakdowns and work stoppages. This is not unusual during trials of a prototype. Based on the results of this first season, and with technical support from FERIC, the contractor has begun modifying the design of the roller-crusher to considerably decrease the shock loads on the front of the carrier. These modifications should help improve mechanical availability.

The marginal number of plantable microsites produced by the crusher-scarifier suggests a lack of aggressiveness by the scarifier when working in the crushed debris. This was particularly true on sites with thicker humus. For the next season of operation, the contractor is studying the possibility of using another type of scarifier, with direct-mounted discs at the rear of the bulldozer and with longer and more aggressive teeth on the discs.

In its original configuration, it's obvious that the equipment offers too marginal a mechanical availability and scarification quality for it to provide an efficient and economical treatment. However, if the designer can improve these aspects, the equipment should permit a treatment that overcomes the disadvantages of conventional windrowing at a very competitive cost.

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