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A SURVEY OF SITE PREPARATION OPERATIONS IN NOVA SCOTIA

INTRODUCTION

In Nova Scotia, during the past decade, the dominant method of site preparation has been the brush rake and burn method. In 1991 this method was replaced because of costs and concerns over possible nutrient depletion resulting from the burning of brush. In addition, many cutovers in Nova Scotia are presently being left 1-3 years before planting because of possible damage by seedling debarking weevils (*Hylobius congener* D.T; Pendrel, 1987). This delay results in dry, brittle slash and reduces the need for intensive methods of site preparation, such as brush raking.

During 1990 and 1991, a survey of site preparation operations was conducted at 14 different locations representing a range of site and slash conditions (Table 1). The purpose of the survey was to assess the effectiveness and productivity of 4 alternative site preparation methods in an operational setting.

These site preparation operations were not carried out on the same sites, therefore the reader is cautioned not to make direct comparisons between machines or treatments. Previously, experimental trials were undertaken to compare several site preparation methods on similiar sites (NSDLF, 1991a).

METHODS

Site Preparation Equipment Procedures

The 4 methods surveyed were: (i) corridor raking, (ii) dragging with anchor chains and shark-fin barrels, (iii) crushing using loaded forwarders, and (iv) crushing with rollers and choppers. All are considered low cost alternatives to the brush rake and burn method of site preparation. The methods were chosen based on their suitability for use on sites left up to 3 years following harvest. The prime movers for 9 of the operations were skidders. Forwarders and dozers were used for the remainder.

Corridor raking

Corridor raking was carried out with either fixed or retractable tooth rakes. In each case the

Table 1. Pre-treatment assessment of site conditions by location.

Location	Slash Depth (cm)	Duff Depth (cm)	Stump Height (cm)	Pre-harvest Cover Type	Slash Condition[1]	Slash Loading[2]	Date of Harvest	Method of Harvest[3]	
Alpine Ridge	55	5	22	SW	Dry	H	Summer,90	SHW	Chainsaw
Musquodobit Hbr.	43	5	25	SW	Dry	M	Winter,89	SHW	Chainsaw
Deepdale	30	8	15	SW	Dry	L-H	Summer,88	SHW	Chainsaw
Fairmont	34	9	22	SW	Dry 25% Gr 75%	M-H	Summer,90	SHW	Chainsaw
Amherst	37	12	23	SW	Dry 50% Gr 50%	M	Spring,91	SHW	Chainsaw
Clarence	31	7	25	SW	Dry 75% Gr 25%	M-H	Winter,89	SHW	Chainsaw
Cape George	30	9	15	SW	Dry	L	Summer,88	SHW	Chainsaw
Rights River	0	10	22	SW	Dry	L	Summer,89	FT	Chainsaw
Bowles Point	29	10	23	SW	Dry	L-M	Summer,89	SHW	Chainsaw
Victoria Harbour	27	3	33	SW	Dry	L	Summer,87	SHW	Chainsaw
Fort Ellis	35	5	20	MW	Dry	M	Summer,89	TL	Chainsaw F.Buncher
Kemptown	45	8	21	SW	Dry	M	Summer,89	TL	Chainsaw
Gabarus	41	9	27	MW	Dry 70% Gr 30%	H	Summer,90	SHW	Chainsaw
D'Escousse	74	6	20	MW	Dry	H	Summer,90	SHW	Chainsaw

1. Condition of slash within plots based on the colour and condition (dry, green).
2. Subjective assessment based on the depth, size (stem diameter), distribution and condition of slash in the plots.
   Light (L) = 0-33% of plot covered with dry and/or green slash composed of small branches or fine debris, ≤25 cm average depth of slash.
   Medium (M) = 34-66% of plot covered with a mixture of dry and /or green slash composed of small to medium sized branches; 25-45 cm average depth of slash.
   Heavy (H) = 67-100% of plot covered with a dense layer of dry and/or green slash composed of medium to large branches; 45 cm+ average depth of slash.
3. Type of wood produced and method of harvest (SHW=Shortwood, FT= Full tree, TL=Tree length; Chainsaw or Feller Buncher).

treatment was performed by the prime mover and rake assembly pushing through the slash and creating rows approximately 2.4 to 3.0 metres wide (the width of the rake). As slash built up in front of the rake, the operator pushed off to one side, thereby creating a row of intermittent slash piles in the adjacent unraked strip. The distance between slash piles along the row varied depending on the type and amount of slash on-site. To limit the width of the slash piles, the slash was always cleared away from the previous pile. This procedure resulted in approximately 50-60% of the area being raked. A previous report (NSDLF, 1991b) summarizes the results of corridor raking experimental trials.

Anchor chains and shark-fin barrels

The anchor chain and shark fin barrel assembly surveyed consisted of two empty finned barrels, spaced 2.0 metres apart and attached to a draw-bar behind the skidder. Attached to each barrel was 4.3-6.1 metres of anchor chain, with spikes welded to each link.

The operator began on the outside edge of the site, gradually working toward the center. Scarification occurred as a result of the twisting and crushing action of the barrels and chains moving over the slash. On sites with a uniform cover of slash, the treatment created parallel strips approximately 0.5 metres wide and spaced 2.0 metres apart. Where there was less uniform-

ity in the slash cover, the prepared strips were not as apparent. Depending on the width of the leave strip, approximately 50 to 60% of the site was scarified.

Crushing

i) Strip crushing : rollers & choppers

Strip crushing is a term that describes a method of site preparation using rollers or choppers. The operator began on the outside edge of the cutover working towards the centre. After every pass the roller or chopper was moved over approximately 4.4 metres. This resulted in a 2.4 metre crushed section (width of drum) and an adjacent strip approximately 2 metres wide that was left undisturbed. Depending on the width of the equipment, approximately 55% of the site was crushed.

ii) Loaded forwarder

This treatment was performed using a forwarder fitted with high flotation tires and its bunk half full of pulpwood. The operator began on the outside of the cut and gradually worked towards the center. Site preparation occurred as a result of the crushing action of the tires moving over the slash. On each successive pass the "driver-side" wheels of the forwarder were placed between the tracks made from the last pass.

This resulted in approximately 75% of the site being crushed. A single pass treatment was sufficient to crush the slash.

Data Collection

Data were collected to determine,

1) pre-treatment conditions,
2) site preparation productivity and
3) post treatment conditions.

Pre-treatment conditions

Slash and site conditions were assessed at each location prior to treatment (Table 1). Assessments were completed by running parallel lines across the site and establishing 2 metre radius circular plots at regular intervals along the lines.

Recorded at each plot was slash depth, duff depth, stump height, pre-harvest cover type, slash conditions (dry or green) and slash load. Slash load was a subjective assessment based on the depth, distribution and condition of the slash at each plot. Loading was categorized as either nil, light, moderate or heavy.

Plantability and accessibility were also assessed prior to site preparation (Table 2). The assessment was conducted by running parallel lines across the site and making assessments at 1.8 metre intervals along these lines. Plantability at each plot was determined by simulating the procedure of planting a tree using a dibble (planting tool). A difficulty rating of easy, moderate or difficult was determined from the amount of effort required to place the dibble into the ground. Sites were considered plantable if a suitable microsite could be found within 0.5 metres of the plot center. Sites were considered non-plantable if they were (i) more than 75% bare mineral soil, or (ii) were considered too difficult to plant because of obstacles such as slash, rocks, or duff.

Accessibility, or the degree of difficulty in moving between plots, was also recorded as easy, moderate or difficult. Both plantability and accessibility were calculated as a proportion of the total number of microsites assessed.

Productivity study

A continuous time study was performed at each site. Timing began when the machine started site preparation and ended when the job was complete. Both productive and non-productive times were recorded (Table 3). Productive time was defined as the period in which the prime mover and implements were engaged in site preparation. Productivity was determined by dividing the total area of the site by the productive time (ha/PMH).

Post-treatment conditions

Post-treatment assessments were performed immediately following site preparation by establishing lines perpendicular to the direction of travel of the prime mover. To assess plantability and accessibility, plots were established at 1.8 metre intervals along the lines using the same procedures as defined for the pre-treatment (Table 2).

Table 2. Pre and post-treatment assessments of accessibility and plantability by site preparation method and location

Method	Location[3]	Accessibility[1] (%)							Plantability[2] (%)								
		Pre			Post			Increase[4]	Pre				Post				Increase[5]
		Easy	Mod	Diff	Easy	Mod	Diff		Plant	Easy	Mod	Diff	Plant	Easy	Mod	Diff	
Corridor Raking	Alpine Rdge.	45	29	26	89	9	2	44	63	75	21	4	91	88	11	1	28
	Musq. Harb.	50	30	20	74	25	1	24	40	25	60	15	66	40	55	5	26
	Deepdale	40	30	30	60	25	15	20	55	40	25	35	91	50	20	30	36
	Average	**45**	**30**	**25**	**74**	**20**	**6**	**29**	**53**	**47**	**35**	**18**	**83**	**59**	**29**	**12**	**30**
Anchor Chains	Cape George	65	15	20	70	12	18	5	85	60	25	15	93	70	20	10	8
	Rights River	55	30	15	89	11	0	34	45	60	25	15	92	84	12	4	47
	Bowles Pt.	81	18	1	90	10	0	9	82	66	20	14	91	80	15	5	9
	Average	**67**	**21**	**12**	**83**	**11**	**6**	**14**	**71**	**62**	**23**	**15**	**92**	**78**	**16**	**6**	**21**
Strip Crushing	Victoria Harb.	50	30	20	75	15	10	25	62	65	20	15	84	75	20	5	22
	Fort Ellis	50	30	20	65	20	15	15	60	55	20	25	71	70	15	15	11
	Kemptown	30	50	20	65	25	10	35	60	50	25	25	85	50	30	20	25
	Average	**43**	**37**	**20**	**68**	**20**	**12**	**25**	**61**	**57**	**22**	**22**	**80**	**65**	**22**	**13**	**16**
Forwarder Crushing	Gabarus	15	30	55	70	20	10	55	60	27	43	30	90	50	30	20	30
	D'Escousse	10	20	70	69	23	8	59	20	30	45	25	79	55	22	23	59
	Average	**13**	**25**	**63**	**69**	**22**	**9**	**57**	**40**	**28**	**44**	**27**	**85**	**53**	**26**	**22**	**44**

1 Accessibility: the degree of difficulty in movement over the site by a planter, expressed as easy, moderate or difficult
2 Plantability: the percentage of the area considered plantable and the degree of difficulty in planting the site estimated as easy, moderate or difficult
3 Assessments were conducted at 11 of the 14 locations.
4 Increase in easily accessible microsites
5 Increase in plantable microsites.

RESULTS & DISCUSSION

Corridor Raking

On corridor raked sites, productivity ranged from 0.6 to 1.0 ha/PMH for an average of 0.8 ha/PMH, with a utilization rate of 78% (Table 3).

Corridor raking, on average, raised plantability from 53 to 83% and the percentage of easily accessible microsites from 45 to 74% (Table 2). The largest increase in the percentage of plantable sites was recorded on the oldest clear-cut (Deepdale, 3 years old; 55-91%).

Anchor Chains

Productivity using anchor chains ranged from 0.6 to 0.8 ha/PMH for an average of 0.7 ha/PMH, with a utilization rate of 77%. Non-productive time was usually caused by the chains hooking together or catching on stumps. At each site a single-pass treatment was sufficient.

At 2 sites, plantability was high prior to site preparation, therefore the use of anchor chains resulted in only slight increases in plantability (8 and 9% at Cape George and Bowles Point, respectively). However, where plantability was low prior to treatment (45%, Rights Brook), an increase of 47% was recorded following treatment. On all sites, post-treatment plantability exceeded 90%. The percent of easily accessible microsites was raised from 67 to 83%.

Crushing

i) Strip crushing: rollers & choppers

Productivity ranged from 0.9 to 1.3 ha/PMH for

Table 3. Productivity and prime mover information by site preparation method and location.

Method	Location	Prime Mover		Area (ha)	Productivity		Util[3] (%)
		Type	Model		Productive[1] (ha/PMH)	Total[2] (ha/hr)	
Corridor Raking	Alpine Ridge	Forwarder	TimberJack®230	6.8	0.6	0.4	67
	Musquodobit Harbour	Skidder	Timber Jack® 380A	6.7	1.0	0.8	80
	Deepdale	Forwarder	Timber Jack®230	5.2	1.0	0.8	80
	Fairmont	Skidder	Ranger 667	14.5	NA[4]	0.5	-
	Amherst	Forwarder	Hanover® D Model	4.8	0.6	0.5	83
	Clarence	Dozer	Caterpillar® D6C	2.6	NA	0.6	-
	Average				**0.8**	**0.6**	**78**
Anchor Chains	Cape George	Skidder	John Deere® 640D	6.6	0.7	0.6	86
	Rights Brook	Skidder	John Deere® 640D	7.3	0.6	0.4	67
	Bowles Point	Skidder	Timber Jack®240A	8.0	0.8	NA	-
	Average				**0.7**	**0.5**	**77**
Rollers: Strip Crushing	Victoria Harbour	Dozer	Caterpillar® D6C	2.6	0.9	0.8	89
	Fort Ellis	Skidder	Timber Jack®540	8.8	1.3	0.9	69
	Kemptown	Skidder	John Deere® 640D	12.4	1.0	1.0	100
	Average				**1.1**	**0.9**	**86**
Forwarder Crushing	Gabarus	Forwarder	Tree Farmer CD6	15.4	0.7	0.6	86
	D'Escousse	Forwarder	Tree Farmer C5D	7.4	0.3	0.3	100
	Average				**0.5**	**0.5**	**93**

1 Productivity in hectares treated per productive hour (ha/PMH).
2 Productivity in hectares treated per total time (ha/hr).
3 Utilization is the percentage of available time the machine was involved in site preparation.
4 Data not available.

an average of 1.1 ha/PMH, with a utilization rate of 86%. Non-productive time was usually a result of the roller becoming stuck. The high productivity is attributed to the fact that only 55-65% of the cutover is crushed. Strip-crushing, on average, raised plantability from 61 to 80% and the percentage of easily accessible microsites from 43 to 68% (Table 2).

ii) Loaded forwarder

Productivity at the 2 sampled sites was 0.3 and 0.7 ha/PMH, and averaged 0.5 ha/PMH, with a utilization rate of 93%.

Large increases in both plantability and accessibility were recorded following treatment. Although only 2 sites were prepared in this manner, plantability increased from 40 to 85%, while easily accessible microsites increased from 13 to 69%.

SUMMARY

Following are the results of a survey of 14 site preparation operations involving 4 methods of site preparation: (i) corridor raking, (ii) dragging with anchor chains, (iii) strip crushing using rollers and choppers, and (iv) crushing using half-loaded forwarders.

Productivity is expressed in hectares/productive-machine hours (ha/PMH).

1. Each of the 4 methods proved acceptable methods of site preparation where the slash was primarily dry and brittle.

2. Productivity for corridor raking ranged from 0.6-1.0 ha/PMH for an average of 0.8 ha/PMH with a utilization rate of 78%. Plantability increased from 53 to 83%, and accessibility from 45 to 74%.

3. Productivity for anchor chains ranged from 0.6-0.8 ha/PMH for an average of 0.7 ha/PMH with a utilization rate of 77%. Plantability was increased from 71 to 92% and accessibility from 67 to 83%.

4. Productivity for strip crushing, using rollers and choppers ranged from 0.9-1.3 ha/PMH for an average of 1.1 ha/PMH with a utilization rate of 86%. Plantability was increased from 61 to 80% and accessibility from 43 to 68%.

5. Productivity for crushing using half-loaded forwarders ranged from 0.3-0.7 ha/PMH for an average of 0.5 ha/PMH with a utilization rate of 93%. Plantability was increased from 40 to 85% and accessibility from 13 to 69%.

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