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LOGGING RESIDUE HANDLING - A STUDY OF TWO CUTOVER PREPARATION TECHNIQUES

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Figure 1 - Dense slash on steep land. This type of site presents a considerable obstacle to re-establishment

ABSTRACT

The amount of slash burning for site preparation is decreasing. Consequently, mechanised methods are increasing. Areas of cutover which have steep slopes and high volumes of slash pose a major problem to re-establishment.

A recent development for windrowing is using a hydraulic excavator fitted with a rake. Excavators have the ability to traverse steeper slopes than bulldozers with a minimum of soil disturbance. A machine was studied in Berwick Forest in an area of very heavy slash on steep to rolling terrain. A conventional line dozing

operation was studied in a similar area. The excavator had a lower production rate than the bulldozer but worked on consistently steeper slopes and in heavier slash.

Both operations produced good planting sites with a minimum of damage to the soil. The excavator leaves a greater area clear of slash.

INTRODUCTION

The amount of logging undertaken on rolling or steep country is increasing. This, combined with the decreasing popularity of burning as a site preparation treatment, means that other methods of treating steep sites with high slash volumes are required.

The area used for the study in Berwick Forest had been logged with skidders. The volume of slash associated with ground-based systems is often higher than that of cable systems as trimming and heading off is done on the cutover, rather than at the landing.

With the exception of gravity rollers conventional mechanical operations such as windrowing and V-blading are generally limited to a maximum slope of about 25° for reasons of safety, productivity and to minimise soil disturbance.

This study looked at two operations; a line dozing treatment using a 110 kW hydrostatic drive bulldozer and a windrowing treatment using a 20 tonne hydraulic excavator fitted with a 2m wide rake instead of a bucket (Figure 2).

The aim of the study was to determine the production rates, slope capabilities and site effects of the two techniques.

ACKNOWLEGEMENTS

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Figure 2 - Excavator with rake clearing dense slash

STUDY PROCEDURE

Prior to the production study on the machines, the sites to be worked were assessed for soil density by penetrometer profiles and soil bulk density samples. Slash density was assessed by the line intersect method (Van Wagner, 1968). During the production study activity sampling was used to collect information on how much time was spent on various activities (Brisley, 1971). The length, width and slope of cleared lanes was also measured. After the site preparation treatments were completed the measurements of soil and slash density were repeated. As part of this study, an area of about 1 hectare was set aside for a trial to compare long term growth rates of trees planted in line dozing, excavator windrowing and untreated slash.

RESULTS

	MACHINE TYPE / OPERATION.			
OPERATION DATA.	Bull dozer/line blading. Liebherr 731, 110 kW, Angled bull blade.		Excavator/windrowing. Hitachi 200EX, 20 tonne 2 metre root rake.	
Activity sample.	Element	% of time	Element	% of time
	Push	43.6	Rake to windrow	47.9
	Sidecast	4.0	Rake for access	13.8
	Reverse	6.0	Walk forward	8.6
	Turn	4.7		
	Travel	26.4	Travel	22.5
	Stuck	9.9	Stuck	0.8
	Delays	5.1	Delays	2.7
	Personal	0.3	Personal	3.7
	Total	100	Total	100
Confidence limit. Limit of error.	95% ± 1.6		95% ± 1.6	
Production	0.69 hectares/PMH.		0.46 hectares/PMH.	
Cost.*	$125 hectare.		$210 hectare.	
SITE DATA.				
Slash density				
Pre-treatment	190 m³/hectare (60-272)		273 m³/hectare (126-615)	
Post-treatment				
Cleared lane	31 m³/hectare (7-63)		23 m³/hectare (8-69)	
Windrow	315 m³/hectare		1030 m³/hectare	
Slopes worked.				
Max. climbed	24°		33°	
Max attempted	28°		36°	
Mean	12.2°		17.2°	
Proportion 20°+	5%		31%	
Proportion 30°+	0		5%	
Proportion of top soil moved into windrow.	0.0005%		0.00003%	
Resulting site.				
Bay width	3.6 metres.		16.4 metres.	
Windrow width	4.5 metres.		4.8 metres.	
Centre to centre	8.1 metres.		21.2 metres.	
Proportion of site accessible to planter.	44%		77 %	

* Costs derived using the procedure shown in the LIRA Costing Handbook (Wells,1981).

Table 1 - Study results for bulldozer line blading and excavator windrowing

(Note : Travel = walking back up cleared lane to the start of the next lane, travel between blocks is not included in this study).

This area will be planted in July 1992 and information will be collected on the effect of slash density on planting production, planting quality and tree growth. The results from this study will be published in a separate report.

Machines working in cutover have to deal with a number of major obstacles, such as stumps, wet areas and short sections of very steep slopes. Sometimes these obstacles occur together and considerable amounts of time can be lost due to the machines becoming stuck due to these obstructions.

During the study the bulldozer got stuck on nine occaisions, average time = 11 minutes. Six of the occurrences were due to the slope being too steep for the bulldozer to climb back up and three occurrences were due to being bellied on stumps. The bulldozer was fitted with a winch and was able to free itself in all cases. However, considerable time was taken to achieve this because:

- Stumps had to be prepared with a chainsaw to stop the strop slipping off.

- The winch could not free spool and the rope had to be driven off.

The excavator got stuck on four occasions, average time = 3.5 minutes. All were due to the slope being to steep for the excavator to climb back up. The excavator was able to quickly free itself from stuck positions by levering itself over obstacles with its boom.

The excavator worked more steep ground, (20°+), and less flat ground, (less than 10°) than the bulldozer (Figure 3).

Soil disturbance levels caused by logging were similar for all treatments prior to the site preparation operations. Both operations caused a drop in the level of undisturbed soil and a slight increase in the amount of litter, topsoil and subsoil disturbance. (Table 2).

Soil compaction was measured by penetrometer and soil bulk density sampling. The soil bulk density showed no

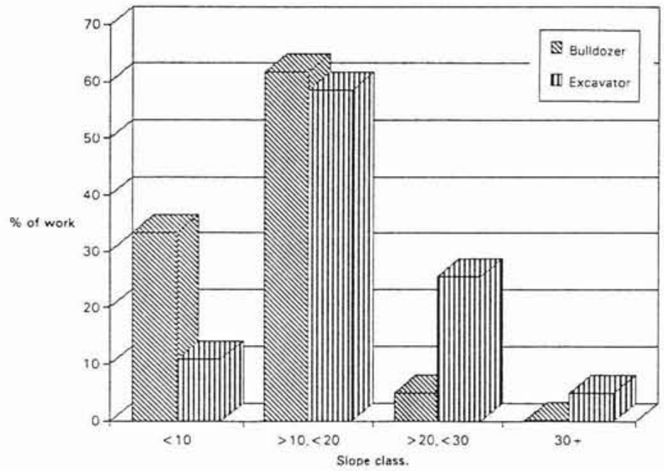

Figure 3 - Proportion of work in different slope classes

	SOIL DISTURBANCE.							
	PRE-TREATMENT				POST-TREATMENT			
	SOIL DISTURBANCE LEVEL. (% OF AREA)				SOIL DISTURBANCE LEVEL. (% OF AREA)			
TREATMENT TYPE	0	1	2	3	0	1	2	3
UNTREATED	74	14	9	3	NA	NA	NA	NA
EXCAVATOR WINDROW	70	28	2	0	47	33	18	2
LINE BLADE	53	25	16	6	42	34	16	8

Table 2 - Levels of soil disturbance before and after site preparation.

(Note : Soil disturbance levels.
0 = No disturbance.
1 = Litter layer disturbed.
2 = Top soil disturbed.
3 = Sub soil disturbed.)

	SOIL BULK DENSITY (Standard deviation)	
Treatment type	Pre-treatment	Post-treatment
Undisturbed	0.86 (0.15)	N/A
Excavator Windrow	0.89 (0.18)	0.85 (0.14)
Line blade	0.90 (0.14)	0.96 (0.09)

Table 3 - Soil bulk densities before and after site preparation

significant differences between the three plot areas prior to treatment and no significant changes with treatment (Table 3).

The soil penetrometer profiles also showed no significant differences between areas prior to treatment or changes with treatment (Figure 3).

DISCUSSION

Due to the differences in the terrain worked, slash levels encountered, type of site produced and job prescriptions, it would not be possible to draw a direct comparison between the two operations (Figure 3).

However, the following comments are worth noting:

- The line blading operation was $85 per hectare cheaper on the sites both machines could work.
- The excavator leaves a cleaner, tidier site with wide parallel bays, leading to a more uniform establishment pattern and potentially lower planting and tending costs.
- The excavator has the greater ability to tackle steep slopes.
- Neither machine caused significant amounts of soil compaction or removal and both had acceptable levels of soil disturbance.

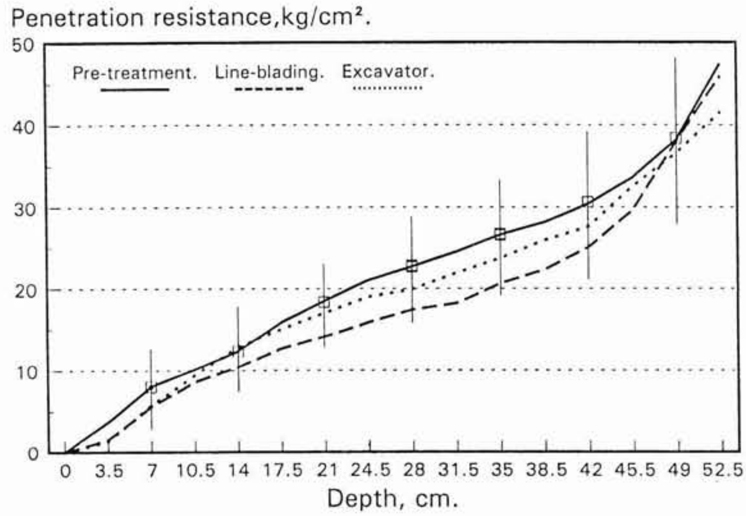

Figure 4 - Soil profiles - resistance to penetration

There is, however, the potential, especially with the bulldozer line blading for an inexperienced or poorly trained operator to do considerable damage to the site by pushing a lot of topsoil off the planting site into mounds of slash.

Both operators observed during this study were experienced and highly skilled.

The production rates were:

Line blading 0.69 ha/PMH
Excavator windrowing 0.46 ha/PMH

Cleared lanes were oriented parallel down the prevailing slope. In both studies the land worked was steep and irregular enough that the machines could not work back uphill, but had to walk to the top of the slope before starting down again.

If these operations were carried out by the same machines in an area where the slope was uniformly 10° or less then they would be able to work in both directions. In both cases production would rise significantly (Table 4).

	Line blade	Excavator windrow
Current 1 way clearing of lanes.	0.69 ha/PMH @ $125/ha.	0.46 ha/PMH @ $210/ha.
Possible 2 way clearing of lanes. (Estimate).	0.83 ha/PMH @ $105/ha.	0.55 ha/PMH @ $175/ha.

Table 4 - Potential gain in production if the machines were able to work both up and downhill.

Because of their different characteristics, it may be possible to use the machines to compliment each other.

The excavator with the modified root rake was a specialist machine that is able to work efficiently over a wide range of sites. The bulldozer was an ancillary machine from a logging operation and is much more site specific, but is able to be used for site preparation in conjunction with the logging.

The slash levels encountered on this site were high, higher than might be expected on a more "average" site, but there will be many sites such as these being logged in the near future, i.e. high stocking of untended trees and no chip/pulp market.

CONCLUSIONS

It is possible, given good machine operators, to do mechanical site preparation with both types of machine with a minimum of damage to soils. Soil penetration resistance and soil bulk density showed no significant changes. There was inevitably some soil disturbance additional to that created by logging but this was largely limited to a mixing of the litter and topsoil layers. Virtually no top soil was removed from the site.

The excavator has a greater capacity to work steep slopes than the bulldozer and has less time lost to being stuck due to its ability to free itself from stumps, etc. with its boom. The production rates found in these operations are consistent with those found in past studies (NZIF 1986, Dorion 1989). Production rates observed during the study were:

Line blading - 0.69 hectares/productive machine hour (PMH), at a cost of $125 per hectare (Wells, 1981). The average slope worked was 12.2°. Cleared lines were 3.6 metres wide, 8.1m centre to centre. Slash density was 190 m³/hectare.

Excavator windrowing - 0.46 hectares/PMH, at a cost of $210 per hectare. Average slope worked was 17.2°. Cleared lanes were 16.4 metres wide, 21.2 m centre to centre.Slash density was 270 m³/hectare.

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The costs stated in this Report have been derived using the procedure shown in the LIRA Costing Handbook for Logging Contractors. They are an indicative estimate and do not necessarily represent the actual costs for this operation.

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