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ROLLER CRUSHING OF CUTOVER AS A LOGGING RESIDUE MANAGEMENT TECHNIQUE

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Figure 1 - Gravity roller crushing operation in Omataroa Forest

ABSTRACT

Fire as a land clearing tool is losing popularity and alternative methods of treating cutover residue are now used to facilitate restocking operations. On relatively flat and undulating land, less than 20°, several mechanical site clearing options are available. In some instances where slash levels are low, no treatment is required. However, on very steep land (over 35°), mechanical slash treatment options are presently limited to gravity roller crushing. The slope capacity of gravity roller crushers is almost unlimited as long as the slope is greater than 15°.

A recent study of a bulldozer-based gravity and towed roller crushing operation in Omataroa Forest (eastern Bay of Plenty) showed that this method of slash treatment is competitive with other means of

mechanical site preparation. In this operation, gravity rolling was cheaper than towed roller crushing.

The production rate for steep slopes (average 27°) was 0.85 ha/PMH gravity rolling and for flat to rolling areas (average 4°), 0.5 ha/PMH towed rolling. The roller crushing caused an increase in the amount of soil disturbance, over that created by the logging operation. Overall, the volume of logging residue was low.

INTRODUCTION

The area of forest being re-established on steep land is increasing. This, combined with a move away from burning, has led to other methods of site preparation of cutover being used.

On steep slopes with sensitive or unstable soils, the use of mechanical site preparation such as line raking is limited because of low production rates and the potential for environmental damage. One mechanical option which can be used on very steep slopes is gravity roller crushing. Gravity rollers require a slope in excess of 15° to get the roller moving. Their slope capacity above this is virtually unlimited (Everts, 1981).

While roller crushing is an accepted method of land conversion for new planting their use as a means of treating logging residue is relatively new.

Gravity rollers are normally based on a bulldozer of 100 kW or larger and some modifications to the winch are required such as fairleads and sheaves. The roller is then raised and lowered over the hill side with the bulldozer remaining at the top of the slope being worked.

This study looked at a single rope gravity roller based on a Cat D6C (104 kW). A fairlead had been fitted above the winch to improve fleeting of the 120m of rope on to the drum. The roller was 3m wide, 1.4m in diameter, weighed approximately 6 tonnes and had 12 evenly spaced and sized blades to break the slash into small pieces. These unsharpened blades were 150mm high and 12mm thick. Most gravity rollers can also be used as towed rollers on flatter land, using the same bulldozer as the prime mover.

The aim of this study was to determine the production rate of the roller crusher and the amount of soil disturbance created. The soil in the study area is a very friable black scoria over a more solid layer of yellow white pumice. A subsequent study is planned to assess the effects of roller crushing slash on planting production, planting quality and tree growth. To this end, an area was set aside for a growth trial where strips of crushed and uncrushed slash were created side by side.

For the purpose of this study, slash is defined as all woody material left on site, including branch material, non merchantable heads, etc. The volumes of slash quoted should not be confused with the amount of merchantable material left on site.

ACKNOWLEDGEMENTS

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STUDY PROCEDURE

Prior to the study of the roller crushing operation, the site to be treated was assessed for slash density (Van Wagner, 1968) and soil disturbance levels created at logging. After crushing these measurements were repeated.

The production study was done over a total of 21.75 productive machine hours (PMH), with 16.75 hours on steep slopes and 5.0 hours on flat/rolling land. Activity sampling was used to determine the proportion of productive time spent on various elements and non productive time was deducted from total time spent. The area treated was measured and the slopes worked recorded.

RESULTS

Table 1 - Activity sampling data

STEEP SLOPES		FLAT/ROLLING	
ELEMENT	% OF TIME	ELEMENT	% OF TIME
Roll Down	27.3	Tow Roller	63.2
Roll Up	45.6	Turn	6.5
Position Tractor	18.8	–	–
Travel	7.3	Travel	7.4
Stuck	0.9	Stuck	22.8
Total	99.9	Total	99.9
Limit of error Confidence limit	± 1.9 95%	Limit of error Confidence limit	± 3.1 95%

(Note : Travel = travel within the block, i.e. from refuel to work face, not travel between sites).

The time the tractor spent stuck on the flat area (Table 1) was a significant contributor to its lower production rate (Table 2). Much of this was from one occurrence, (38 mins stuck), where the bulldozer became bellied on a large stump and was eventually freed by a skidder from a separate operation. The operator did not consider it to be an unusual occurrence to either get stuck or to spend an hour or more getting free again. This delay could be remedied by paying closer attention to stump height during logging.

Table 2 - Production rates and costs

	STEEP LAND	FLAT LAND
Production Rate	0.85 ha/PMH	0.5 ha/PMH
Cost Per Hectare	$163.21/ha	$277.45/ha

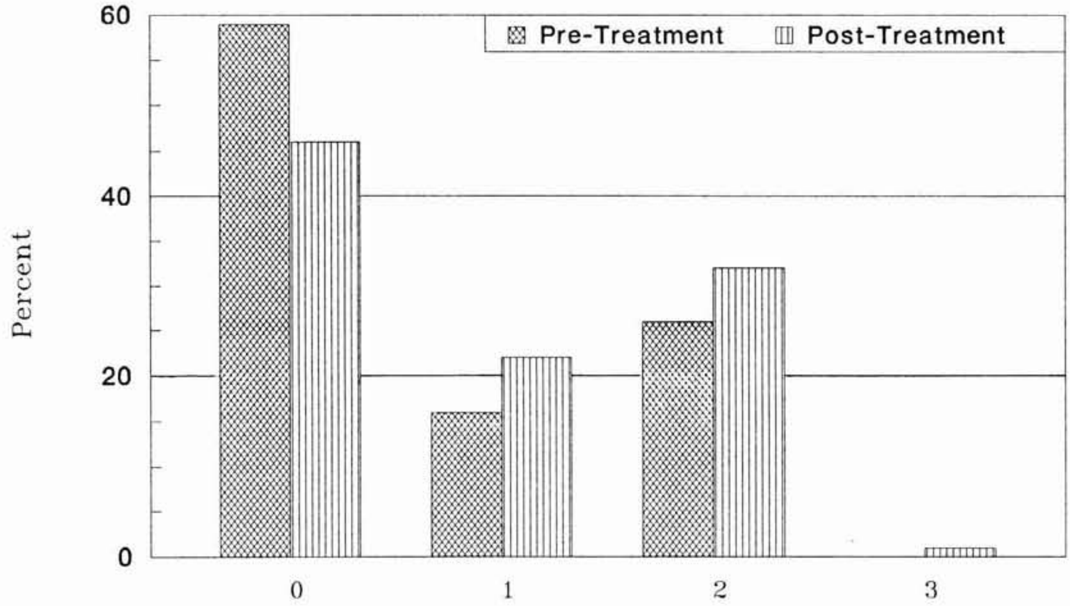
Costs per hectare are based on the following values and have been calculated using the LIRA costing format (Wells, 1981).

Table 3 - Operation costs

ITEM	COST/DAY
D6C + Roller Crusher	$628.04
Driver	$123.77
Vehicle	$44.93
Chainsaw	$12.70
Overheads (3%)	$24.28
Profit (10%)	$83.37
Total Cost/Day	$917.09

Neither the steep nor the flat site was 100% treated. Areas of light or no slash were skipped over at the operator's discretion. Therefore, this cost/ha relates only to the area treated.

Average slash densities were, for the steeper areas, 53 m^3/ha and for the flatter sites 32 m^3/ha. Slash distribution was very uneven; some areas had virtually no slash, others had quite dense heaps (250m^3/ha+). These figures represent the amount of slash on the whole site. The high density areas were very small.



(Note: 0 = No disturbance - NIL
1 = Litter disturbed - LIGHT
2 = Top soil disturbed - MODERATE
3 = Sub-soil disturbed - SEVERE)

Figure 2 - Soil disturbance before and after roller crushing

SOIL DISTURBANCE

Figure 2 shows the differences in soil disturbance between before and after roller crushing.

Soil disturbance in this operation comes from two sources. Firstly, the c-frame of the roller dragging on the ground, which usually only causes light to moderate disturbance. Secondly, during various manoeuvres bulldozer tracks can cause moderate to severe soil disturbance. However, in this operation the bulldozer usually operated from tracks created during logging and so the roller crushing operation was not greatly increasing the area of disturbed soil.

DISCUSSION

The two main advantages of the roller crusher are :

- the ability to work very steep slopes at a rate comparable to other site preparation operations on flat/rolling terrain (1986 Forestry Handbook ; Hall, 1992).

- low levels of soil damage, i.e. minimal levels of soil compaction or disturbance.

The roller crusher works best on slash which has had a few months drying after logging. The more brittle the slash, the better it breaks down (Craig Wilson pers comm).

The greatest soil disturbance occurred at the top of the ridges where the bulldozer manoeuvred to position the roller. This was a small proportion of the area treated and was largely on existing logging tracks.

On flatter areas, soil disturbance was less as the bulldozer did fewer tight turns and the c-frame of the roller was not dragged on the ground.

The roller crusher appeared to work well in light to moderate slash. Where slash was heavy, a dense mat of crushed material was created. This made access possible but could pose a substantial barrier between the planter and the ground. This layer would have to be moved aside to plant a seedling properly.

For maximum production in all ground-based site preparation operations, low stump heights are essential. This is true for roller crushing on both flat and steep land. On flat land, the bulldozer became bellied on high stumps and on steeper slopes the roller can get stopped by high stumps on either up or downhill runs, often forcing the bulldozer to reposition to clear the roller from the obstruction. The roller can also slew off track after hitting large obstacles when running downhill at speed and the subsequent repositioning of the roller further lowers production.

CONCLUSION

Roller crushing of slash for site preparation with a gravity roller is a useful option for forest managers faced with light to moderate slash on steep slopes.

The production rates and costs of this operation were similar to other mechanical site preparation treatments.

REFERENCES

Everts D. (1981) : "Gravity Rollers - A Land Preparation Technique for Steep Country". New Zealand Forest Service. Forest Research Institute, What's New in Forest Research No. 103.

Hall P. W. (1992) : "Logging Residue Handling - a Study of Two Cutover Preparation Techniques". LIRO Report Vol. 17, No. 14 1992.

Van Wagner C. E. (1968) : "The Line Intersect Method in Forest Fuel Sampling". Forest Science, Vol. 14, No. 1. pp 20-26.

1986 Forestry Handbook. New Zealand Institute of Foresters (Inc). Edited by Hamish Levack.

Wells, G. (1981) : "Costing Handbook for Logging Contractors". LIRA Handbook.

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 costs for this operation.

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