SITE PREPARATION TRIALS FOR CONVERSION OF LOGGED INDIGENOUS FOREST

A. E. BEVERIDGE AND B. K. KLOMP
Forest Research Institute, Rotorua

Summary

Six experimental treatments are described for site preparation in heavy reverted forest on the Mamaku Plateau. These treatments are alternatives to conventional clearfelling and burning and several have produced excellent planting sites on difficult soils at relatively low cost. The most successful treatment on easy terrain was to kill the dense overwood by aerial spraying before crushing and burning. Cattle grazing substantially reduces the cost of clearfelling and can assist in producing a planting site after a poor burn. Some treatments have enabled complete planting of the site and radiata pine (*Pinus radiata*) has not required releasing from subsequent invasion by grasses.

INTRODUCTION

OPERATIONAL METHODS of preparing logged indigenous forest for plantations of exotic species have been discussed at a Forest Research Institute symposium on land preparation (Chavasse, 1969). It was estimated that in the next 30 years some 400,000 acres, or 30% of the new land required for planting, will consist of logged indigenous forest but recent developments indicate that these figures may be underestimates. A high proportion of logged indigenous forest reverts to a derelict state before site preparation is undertaken.

Adequate site preparation and establishment of the new crop have proved difficult in many localities. Problems include insufficient reduction of slash by burning, regrowth of ferns and woody species, invasion of cleared ground by grasses, excessive soil disturbance by tractors, difficulty of planting trees in fibrous root mats and death of pine seedlings as a result of infection by the fungus *Armillaria mellea*. A successful method of site preparation must be judged not only by its initial cost but also by the extent to which it results in the establishment of a tree crop of reasonable uniformity on a high proportion of the ground.

The trials described in this paper were carried out in forest that had been logged for podocarps 15 to 40 years previously and were at altitudes of 1,900 to 2,200 ft. Vegetation had reverted to a dense growth of shrub hardwoods and tree ferns with a partial overwood of residual trees, mainly tawa (*Beilschmiedia tawa*) and kamahi (*Weinmannia racemosa*). Merchantable tawa remained on the older cutover sites (25 to 40 years old).

The results of early site preparation trials on the Mamaku Plateau were previously reported at this Conference (Beveridge, 1966). Continuation of this work has confirmed that clearfelling and burning on these wet, silty soils gives a better planting site than does windrowing of slash by tractors. The best planting sites have been produced by treatments which involve various combinations of aerial spraying, tractor crushing, burning and felling. Cattle have also been successfully used to reduce the cost of site preparation.

METHODS

The treatments involved in each site preparation trial are outlined in column three of Table 1. Each treatment covered a block of five or ten acres. After the completion of a treatment the block was planted with radiata pine (*Pinus radiata*) so that the suitability of the site for tree growth could be assessed. Most planting stock was well-grown 1½/0 seedlings, but in Trials 2 and 5, one-year-old rooted cuttings were also used.

SPRAYING OPERATIONS

Aerial spraying was intended to condition the vegetation for subsequent crushing or burning and the spray mixes used were those that had proved successful when applied with ground equipment. At Mamaku good results have been achieved in five successive summers by confining spraying to relatively calm early morning periods, usually when the temperature was below 60° F and the relative humidity was above 90%. Aerial spraying in these trials was done under these conditions and no attempt was made to use minimum dosages or to experiment with techniques of spraying. Because of the relatively small size of experimental blocks and the need to reduce spray drift to a minimum, a helicopter equipped with standard boom and nozzles was used.

CRUSHING OPERATIONS

In crushing with a tractor and blade (Trials 1 and 2), the blade was raised so that the tractor merely passed over the slash without piling it. This left the topsoil uncompacted and broke up the fibrous root mats that impede planting.

RESULTS

Results of treatments and an evaluation of the regime used in each trial are given in columns four and five of Table 1.

In trial 1, shrub hardwoods and small trees desiccated by aerial spraying offered little resistance to the tractor blade and broke off at ground level or just below, leaving no depressions or root plates with soil attached. Crushing of the desiccated vegetation resulted in a well fragmented and compact fuel and after burning there were few obstacles to rapid and complete planting of the site. While attachment of a water-filled crushing roller to the tractor hindered manoeuvrability of the tractor in a first pass over the vegetation, two passes produced a site that could be planted without having to burn the slash.

DISCUSSION

Clearfelling and burning is the operational method most commonly used for preparing a planting site in logged and reverted indigenous forest. In wet climates increasing use is being made of aerial spraying with desiccants to treat green vegetation amongst slash before burning. This operation is particularly useful when a delay in the time of burning has allowed regrowth of ferns, hardwood coppice and grasses. The cost of such aerial spraying is currently \$10 to \$12 per acre. The cost of clearfelling reverted cutover forest on the Mamaku Plateau after a light salvage logging of tawa is \$40 to \$50 per acre, though this figure may be much lower if there is intensive utilization of tawa for pulpwood.

TABLE 1: FURTHER SITE PREPARATION TRIALS IN LOGGED INDIGENOUS FOREST, MAMAKU

<i>Trial No.</i>	<i>Site</i>	<i>Treatments</i>	<i>Results of Treatments</i>	<i>Evaluation of Treatment and Total Cost* (excluding burning)</i>
1	15-year-old cutover with no merchantable residue	<p><i>Crushing and burning of desiccated vegetation</i></p> <p>Canopy desiccated by aerial spraying 2,4,5-T (3.6 lb) 20 gal diesel oil Jan. 1967. No felling prior to spraying.</p> <p>Crushed in dry conditions by TD25 with crushing roller Jan. 1969, trees over 12 in. diameter felled.</p> <p>Burnt 6 weeks after crushing. Planted Aug. 1969.</p>	<p>Bulk of shrub hardwoods killed and visibility greatly improved.</p> <p>Desiccated vegetation disintegrated. Crushed at rate of 2.5 acres per hour.</p> <p>Most of dry slash consumed in slow, safe fire. Whole site planted with ease. Vigorous tree growth in first 2 years; mean height increment 40 in. No releasing required despite dense grass growth in second year after planting.</p>	<p>Very successful. Suitable for 10- to 20-year-old cutover. Ground left in good condition for planting and tree growth. The crushing roller was not necessary and the desiccation period could have been reduced to 1 year.</p> <p><i>Cost per acre \$35</i></p>
2	15-year-old cutover with no merchantable residue	<p><i>Crushing of green vegetation followed by spraying and burning</i></p> <p>Bulk of vegetation crushed by D7, Feb. 1969, large trees felled. No felling prior to crushing.</p> <p>Thistles and fireweeds aurally sprayed with paraquat (1 lb) in 20 gal water, Jan. 1970. Burnt three weeks after spraying. Planted Aug. 1970.</p>	<p>Thorough job by skilled operator at rate of one acre per hour.</p> <p>Good desiccation and excellent burn.</p> <p>Whole site planted with ease. Followed by second invasion of tall, dense fireweeds.</p>	<p>As for Trial 1 but highly skilled operator required for crushing; operation more hazardous because of poor visibility.</p> <p><i>Cost per acre \$40</i></p>

3	25-year-old cutover	<p><i>Multiple burning on clear felled site</i> Salvage logging of tawa and clear-felling followed by first burn in Feb. 1966.</p> <p>(a) Second burn half block in Feb. 1969, 4 weeks after aerial spraying rank grass with paraquat (1 lb) in 20 gal water. Planted Aug. 1969.</p> <p>(b) Second burn half block in Mar. 1971, 3 weeks after aerial spraying bracken, grasses and shrub hardwoods with paraquat (1 lb) + 2,4,5-T (2 lb) in 30 gal water.</p> <p>To be planted in August 1971 after autumn grazing newly-germinated grass and fireweeds.</p> <p><i>Partial felling, double spraying and burning</i> All trees over 40ft high felled and tawa logs extracted. First aerial spraying with 2,4,5-T (7.2 lb) in 20 gal diesel oil, Dec. 1967. Second aerial spraying with ammate (40 lb) + 2,4,5-T (2 lb) in water at 20 gal, Jan. 1970. Burnt three weeks after second spraying. Unburnt patches crushed by tractor (valley bottom and flat ridge tops). Planted Aug. 1970.</p>	<p>Much slash unconsumed, access difficult.</p> <p>Most of herbaceous vegetation consumed but slash remained with some reduction by rot and fire; toetoe little affected by spraying and recovered after burn. Access good and whole site plantable.</p> <p>Thorough desiccation of foliage resulted in quick, fierce burn but large dimension slash and green stems of shrubs remained. No significant recovery of toetoe.</p> <p>Both plots reverted to dense York-shire fog after second burn.</p> <p>100% defoliation of trees and shrubs followed by crown death. Dense regrowth of ferns and shrubs.</p> <p>Patchy ground fire after partial desiccation of ground vegetation. Steep slopes burnt well.</p> <p>3½ hours for patch crushing over 10 acres. 80% of ground planted with some difficulty.</p>	<p>Method only suitable for areas where the initial burn was very poor. Regrowth could not be burnt without prior desiccation during five years period following the first burn. Cost per acre: (a) \$55 (b) \$60</p> <p>This operation accounted a partial failure owing to incomplete desiccation from second spraying and poor burn. Cost per acre, including crushing \$50</p>
4	25 year-old cutover			

TABLE 1—contd

Trial No.	Site	Treatments	Results of Treatments	Evaluation of Treatment and Total Cost* (excluding burning)
5	40-year-old cutover	<p>Clearfelling and burning after cattle grazing</p> <p>Half area mob-stocked with cattle for two successive winters before salvage logging, clearfelling and burning.</p> <p>Whole area sown with ryegrass and clovers in Mar. 1970. Planted with 17 in. high seedlings and 12 in. high cuttings of radiata pine, Jul. 1970. Proportion of tree released from grass by spot application of chemicals, using inverted-cone sprayer.</p> <p>Half area grazed in spring 1970 with sheep and then cattle.</p> <p>Half area not grazed.</p>	<p>Undergrowth cleaned out. Cost of felling understoreys was 10 man-hours per acre in grazed area and 15 man-hours per acre in ungrazed area. Excellent burn with no difference between grazed and ungrazed blocks.</p> <p>Two successive winter grazings are adequate for substantial reduction of felling costs and destruction of toetoe. Planting in new pasture indicates that large seedling stock of radiata pine are very tolerant of grass competition and offer promise of future grazing in plantations established on cleared and burnt sites.</p> <p>Cost of clearfell per acre: Ungrazed area \$45 Grazed area \$35</p> <p>Little damage to seedlings by sheep but more by cattle. More severe damage to cuttings.</p> <p>Seedlings in ungrazed area grew vigorously in first growing season whether released or unreleased. Mean height increment 9 in. Many cuttings smothered.</p> <p>Ground vegetation destroyed or de-</p>	<p>Method may be suitable for farm foresters where cost of clearfelling is high or fierce</p>
6	40-year-old cutover	Cattle grazing, aerial spraying and spot burning Jul. 1969. Indigenous forest grazed		

by beef breeding cows. Dec. 1969. Salvage logging—6 tawa felled per acre. 26/1/70. Sprayed by helicopter with 2,4,5-T (7.2 lb) in 20 gal diesel oil 18/2/70. Spot burnt heads of logged tawa.	foliated in 50 grazing days per acre. Defoliation of hardwoods from 70 ft canopy to lowest tier. Ground fire spread through 50% of block, consuming litter and killing surviving trees and shrubs. Lush sward established by spring on burnt and unburnt ground and on logging tracks.	burns are not desirable. Fell- ing of a few large unmer- chantable trees envisaged be- fore site is planted. <i>Cost of aerial spraying per acre \$16</i>
Mar. 1970. Sown with ryegrass and clovers. Dec. 1970. First grazing by cattle of ryegrass sward. Objective is to mob- stock periodically with cattle to break down dead understorey, re- move coppice and seedling regrowth and produce site suitable for plant- ing radiata pine.		

*Details of costs can be given by the authors.

The cost of trial methods 1 to 5 described above are thus comparable with, or cheaper than, the cost of clearfelling followed by aerial desiccation. Method 6 promises to be the cheapest if the farmer finds that the production of beef in five or more years of grazing compensates for the cost of fencing and sowing of grass. At least two years of profitable grazing can be obtained from the forest before any other treatment is done and grazing may be continued after the planting of radiata pine into a grass sward; these points are shown by Trial 5 and other trials described by Beveridge and Knowles (1971).

Defoliation and long-term desiccation of a heavy overwood with 2,4,5-T in diesel oil has been so successful that the amount of 2,4,5-T could probably be reduced from 7.2 lb to 3.6 lb per acre, resulting in a reduction of approximately \$5 per acre of the cost of treatment in Trials 1, 4 and 6.

Water-based 2,4,5-T has always given inferior results for long-term desiccation of the predominant hardwood species in reverted indigenous forest.

Disadvantages of conventional clearfelling and burning may include difficulties with obtaining suitable labour, the relatively high cost, the uncertainty of obtaining a clean burn in wet climates (even with the insurance of post-felling desiccation) and the hazard of burning uncompact broadcast slash under favourable burning conditions. While the trial methods have their own limitations, some of them offset the disadvantages mentioned above and in the introduction but the treatments involving crushing (Trials 1 and 2) are limited by terrain. The best results are produced by crushing in dry conditions and green vegetation must be very thoroughly and carefully crushed to give a good fuel.

If there is a shortage of labour for clearfelling on steep terrain, the methods used in Trials 4 and 6 offer prospects of success.

Two of the main benefits of Trials 1, 2 and 3 are the recovery of the whole site for planting and the relatively even growth of radiata pine planted on these sites. Burning of clearfelled slash rarely enables the whole site to be planted, while windrowing of slash usually results in a poor recovery of planting ground and uneven growth of tree seedlings.

Several of the trials involve treatments spread over a period of more than one year, during which interest charges accumulate before planting is done. The site preparation period should obviously be reduced to the minimum consistent with good results. Thus one year is sufficient to allow desiccation of younger cutover (less than 20 years) between aerial spraying and crushing, while two years may be needed for older cutover. The treatments in Trial 3 spread over a period of six years from clearfelling to second burn constituted a salvage operation because planting immediately after a poor burn would have resulted in a poor tree crop. The effect of grazing after the second burn has indicated that cattle could have been used much earlier to break down slash and remove herbaceous material and that the desiccation spray and second burn would not be necessary where such grazing is practicable.

An invasion of grasses replaced the first year's growth of fireweed on cleared ground with all methods of site preparation on the Mamaku Plateau. Yorkshire fog (*Holcus lanatus*) was followed by toetoe (*Cortaderia fulvida*); the latter has proved difficult to control with chemicals in young plantations where trees require releasing. Radiata pine does not require releasing from grass provided that: there is no delay between the final site preparation treatment and planting; site preparation leaves the soil in a state that allows fast early growth (no excessive compaction and waterlogging); sturdy planting stock about 15 in. high is used.

In the wet, cool climate of the Mamaku Plateau where annual rainfall is 80 to 100 in., radiata pine has been shown to be very tolerant of competition from ryegrass (*Lolium* spp.) and naturally invading grasses, mainly Yorkshire fog.

Sowing of ryegrass and clovers after burning suppresses both fireweeds (mainly *Erechtites* and *Senecio* spp.), and toetoe. Toetoe may also be controlled before tree planting by cattle grazing (Trial 5) or by aerial spraying with paraquat/2,4,5-T followed by burning (Trial 3(b)).

Whilst there are many differences in soils, climate and forest type over the million acres of logged and reverted indigenous forest in New Zealand, it is considered that most of the methods of site preparation found to be successful at Mamaku could be applied elsewhere.

REFERENCES

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