

**THE SITE PREPARATION - TRIAL REVIVAL  
PROJECT:  
THE LONG-TERM EFFECTS OF  
CULTIVATION ON THE GROWTH OF PINES  
ON VARIOUS SOILS NATIONWIDE**

**Malcolm Skinner, Doug Graham,  
and Mark Kimberley**

**Report Number 124**

## TABLE OF CONTENTS

ABSTRACT .....	1
INTRODUCTION.....	2
METHODS.....	3
RESULTS AND DISCUSSION .....	5
Part 1 All trial sites and a simple comparisons of control versus cultivation(s).....	5
Part 2 Comparisons of cultivation effects at individual trial sites.....	6
General Discussion.....	7
ACKNOWLEDGEMENTS .....	8
REFERENCES.....	8

## ABSTRACT

At 11 forest sites across New Zealand where cultivation was a factor in time-of-planting trials trees were assessed for growth responses to cultivation at rotation end by the use of MARVL software. The results were not statistically significant because of the lack of appropriate replication but the productivity trends are of value and interest. Assessed over all trials there were gains to cultivation of about 30 m<sup>3</sup>/ha by rotation end with little difference in yield between the ripping and the bedding treatments. According to MARVL analysis there were no changes in log grades attributable to cultivation.



**Site preparation - an expensive operation: matching costs with benefits is the theme of the Site Preparation Trial Revival Project**

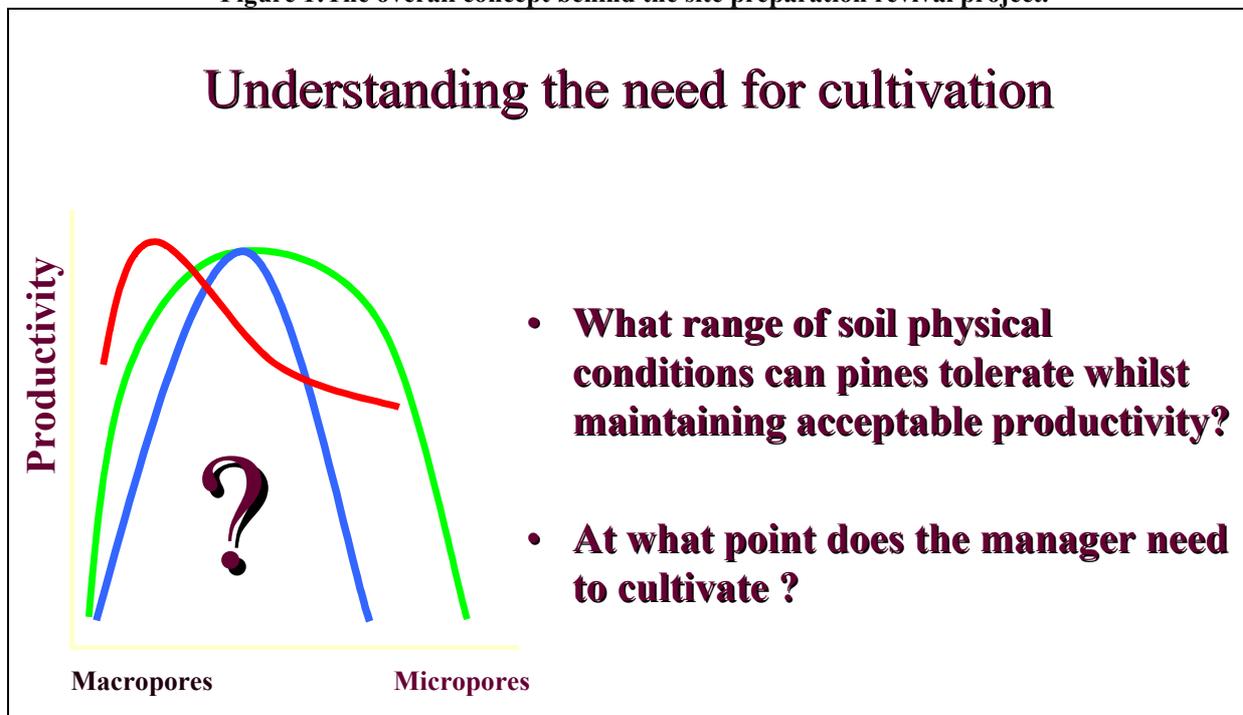
## INTRODUCTION

In the 1970's and early 1980's a series of trials was established on a variety of soil types from Northland to Southland examining the effect of cultivation and fertiliser at time-of-planting. The cultivation by fertiliser experiments were installed as split-plot factorials, with the main plots as the cultivation treatments (either ripping, or ripping and bedding). The fertiliser treatments were generally slit applied doses of soluble fertiliser applied to trees on a row by row basis. Because of the short-term nature of the fertiliser treatments the trials were designed to be operative for about 6 years.

In the early 1990's the NZ Forest Site Management Cooperative (NZFMC) initiated a field day examining site preparation techniques and the variety of stories that had developed in relation to the need for cultivation as one of a variety of site preparation techniques. As a result, the NZFMC funded 2 reports on site preparation techniques in New Zealand and overseas (Hunter-Smith, Smith and Graham, 1996, and Smith, Hunter-Smith and Graham, 1996).

In 1998, as a result of the commissioning of the above reports, it was decided that valuable data on long-term effects of cultivation could be obtained from the trials established in the 1970's and 1980's, by focussing on the growth of trees now near rotation end in the trials' main plots.

Figure 1: The overall concept behind the site preparation revival project.



The objective of the Trial Revival project was to:

- Assess the effects of cultivation on tree productivity over a rotation (see Figure 1), and
- Correlate changes in soil physical properties with changes in tree productivity.

An initial report (Skinner et al 2001) concentrated on 6 sites in the North Island. This final report details and summarises cultivation effects on growth and wood value nation-wide from measurements completed between 2000 and 2002.

## **METHODS**

At each site the crop was assessed by the MARVL procedure (Method of Assessment of the Recoverable Volume by Log-types). The assessment was based on trees located within each of the main-plots. Details of each trial are presented in Table 1.

AK578/1,2,3,4 in Te Kao Forest: At the three Te Kao sand sites (AK578/1, 3, 4) cultivation was achieved by ripping to a nominal depth of 50 cm. However, to create any pan disturbance the ripper would have had to reach a depth of 1 m. The clay site (AK578/2) was mistakenly rotary hoed through contractor error. Following the rotary hoeing the contractor ripped the site, but the depth was only to 0.4 m. Penetration of the pan (to improve soil drainage) was not achieved.

AK522 and AK662 at Waipoua and Utaura: These sites are located 40 km SW and 10 km NW of Kaikohe (Northland) respectively. The cultivation treatment at AK522 was bedding alone, whereas at AK662 the site was ripped and bedded.

RO1063 and R1964 in Kaingaroa Forest: At Kaingaroa Forest RO1063, scrub was cleared by shear blading, then the site was bedded. The shear blading treatment did result in considerable scalping of the topsoil as a result of the poor "floating" ability of the blade. At RO1964 the cultivation was deep ripping to 1 m.

WN261/2 in Karioi Forest: At this site the cultivation treatment was ripping alone.

NN373/1 in Golden Downs and SD401/4 in Naseby Forest: At these South Island sites, the cultivation treatment was ripping alone.

**Table 1. Trial identification, location, soil type, ownership and stand age**

<b>Trial identification</b>	<b>Location and Trial Attributes</b>	<b>Soil type</b>	<b>Current forest ownership</b>	<b>Stand Age</b>
<b>AK578/1</b>	Aupouri Peninsula at Te Kao 4 blocks, control and rip, 26 stems/main plot	Te Kopuru sand	CHH Forests	27
<b>AK578/2</b>	Aupouri Peninsula at Te Kao 4 blocks, control and rip, 22 stems/main plot	Rangiuru clay	CHH Forests	27
<b>AK578/3</b>	Aupouri Peninsula at Te Kao 4 blocks, control and rip, 27 stems/main plot	Te Hapua complex	CHH Forests	27
<b>AK578/4</b>	Aupouri Peninsula at Te Kao 4 blocks, control and rip, 14 stems/main plot	Ohia sand	CHH Forests	27
<b>AK522</b>	Waipoua Forest 2 blocks, control and bedded, 13 stems/main plot	Te Kopuru sand	CHH Forests	25
<b>AK662</b>	Utakura Forest 4 blocks, control and rip+bed, 15 stems/main plot	Wharekohe loam	Whitecliffs Sawmilling Company	25
<b>RO1063</b>	Kaingaroo Forest 2 blocks, control and bed, 26 stems/main plot	Kaingaroo loamy sand	Fletcher Challenge Forests	24
<b>RO1964</b>	Kaingaroo Forest 2 blocks, control and rip, 6 stems/main plot	Kaingaroo sand	Fletcher Challenge Forests	22
<b>WN261/2</b>	Karioi Forest Research 3 blocks, control and ripped, 19 stems/main plot	Pokaka sandy silt loam	Winstones Forest	24
<b>NN373/1-4</b>	Golden Downs Forest 4 blocks, control and ripped 19 stems/main plot	Korere Hill soils	Weyerhaeuser NZ Inc	27
<b>SD401/4</b>	Naseby Forest 2 blocks, control and ripped	Naseby silty loam	Ernslaw One Ltd	29

An analysis of variance was performed using PROC GLM (SAS, 1989) to test the effect of cultivation with the following experimental terms: site, block (block within site), cultivation, and cultivation across site, with stocking included as a covariate. The treatment versus site means are therefore adjusted to a common (average) stocking to make comparisons between treatments and sites more sensitive.

## RESULTS AND DISCUSSION

At all sites the experimental replication for cultivation (2 to 4 blocks) was minimal for statistical purposes. This was recognised to be the case at the outset of this project but the effects of cultivation may still have been strong without necessarily having strong statistical significance.

For ease of discussion the results are presented as:

- No cultivation versus cultivation (rip, bed, and both), and
- No cultivation versus rip, bed, and both, across all trial sites.

This manner of presentation uses the sites as treatment replicates to seek more information on statistical significance.

Attention is then focussed on each trial site as an independent entity examining

- No cultivation with the average of all cultivation treatments (rip, bed, both)

### Part 1 All trial sites and a simple comparisons of control versus cultivation(s)

Figure 2 shows that on a New Zealand wide basis there was a gain of a little over 30 m<sup>3</sup>/ha to cultivation. The increase was not statistically significant ( $p > .05$ ). In the MARVL computation stump height was set at 0.2 m and no breakage was allowed so there was no significant difference between measured volume and merchantable volume.

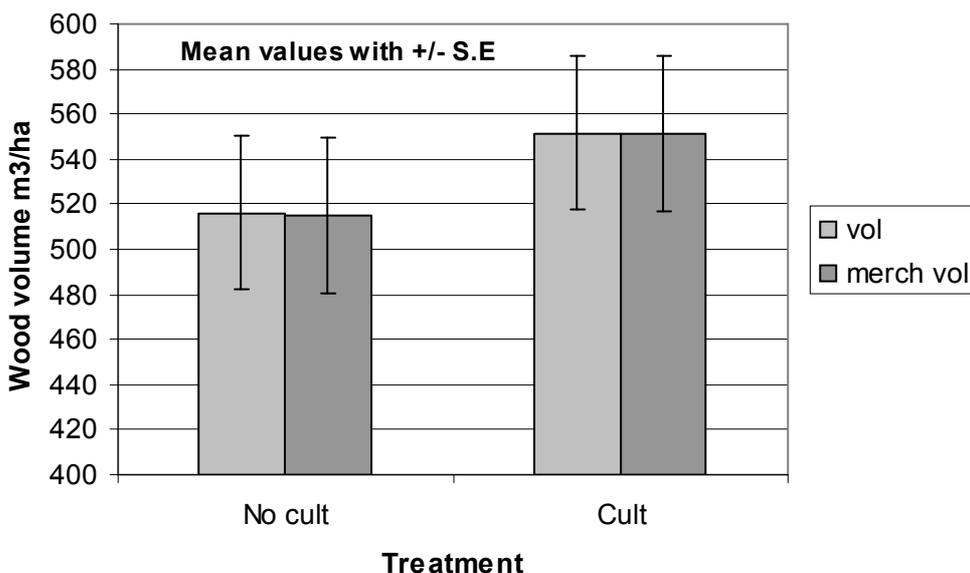
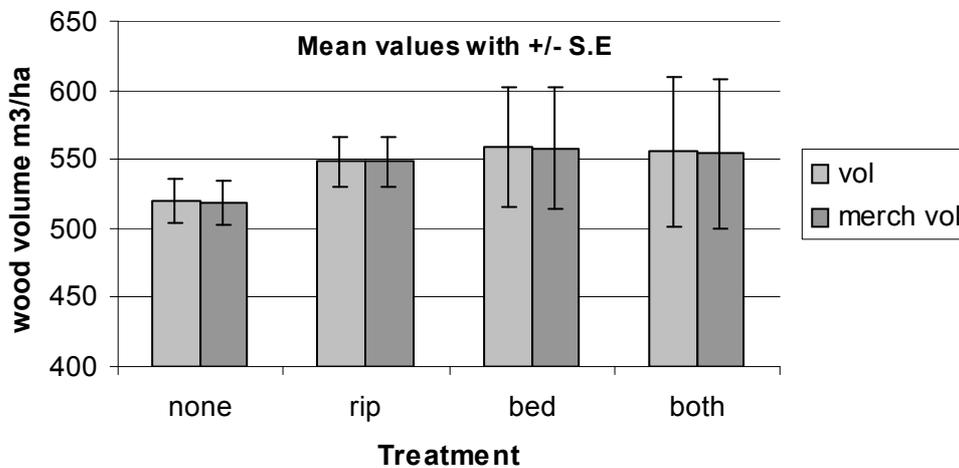


Figure 2 Effect of cultivation on measured and merchantable wood volume at harvest

Figure 3 shows that the positive effects to cultivation can be ascribed to ripping or bedding alone, and that there was little significant benefit to combining both ripping and bedding.



**Figure 3 Effect of specific type of cultivation on harvest volume**

In terms of \$ value, the increased volume was reflected by an increase in value from about \$47 000 to about \$52 000 per hectare (data not shown). Cultivation costs are generically in the order a few hundred dollar per ha.

## **Part 2 Comparisons of cultivation effects at individual trial sites**

Figure 4 below shows the effect of cultivation (as the average of rip, bed, and both) at each of the 14 New Zealand wide sites. At the Northland sites (AK552, AK578/1-4, and AK662) there were gains to cultivation although not statistically significant ( $p > 0.4$ ) due to the lack of replication. In some instances the gains were reasonably substantial (100 m<sup>3</sup>/ha). The AK578 series represent very early attempts at cultivation on podzolised soils. In the late 1960's/early 1970's there was a lack of appreciation of the possibility of nutrients other than phosphorus (P) limiting growth. At these sites it is now recognised that nitrogen (N) is a secondary limiting nutrient. That is, if N fertiliser had been applied in conjunction with P, the gains to cultivation would have in all likelihood been more fully expressed. An understanding of the lack of cultivation effects at some of the Northland sites awaits further investigation on soil physical properties (a continuing part of this project).

At the 2 Kaingaroa forest sites, and at Karioi, cultivation did not have a significant effect on growth and had no effect on harvest value. It would seem therefore that over a complete rotation

the volume of soil exploited by the roots was similar between the control and cultivation treatments. Confirmation of nil difference(s) in soil physical properties awaits the results of the soil physics work. In the South Island, the Golden Downs (Nelson) site showed a non-significant growth gain and the Naseby (Otago) site showed no growth gains to cultivation.

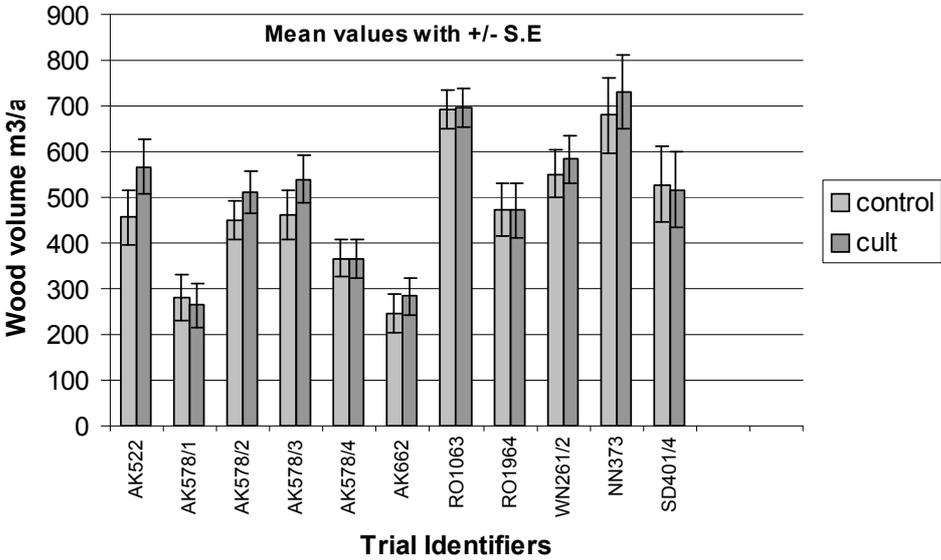


Figure 4 Effect of cultivation on harvest volume at all sites

**General Discussion**

The overall lack of growth responses across New Zealand, with the exception of a selection of sites in Northland, is more of a reflection of the sites available for this study, than a truism that on most New Zealand soils pines do not respond to cultivation. Hunter and Skinner (1986) reported fertiliser studies on the Northland podzols where the fertiliser response was only made possible by soil cultivation. In the absence of cultivation fertiliser responses were non-existent. The studies reported for here Northland however are studies where cultivation techniques were not well advanced, and this will have contributed to poor cultivation responses. As well nutrient constraints (lack of long-term balanced fertiliser applications) will have acted to minimise the pine crops' ability to take advantage of the improved soil physical properties.

The responsiveness or otherwise for the pines reported here forms part of a research programme aimed at quantifying the relationship between soil physical properties and growth. The overall aim is to establish the soil physical conditions tolerated by pines, and those soil physical conditions under which pine growth is restricted. The responses at all sites are therefore useful in determining the "envelope" of soil physical conditions required for pines to grow well. Hence the

lack of a cultivation response is as important as a cultivation effect in defining of the range of soil physical properties tolerated/not tolerated by pines.

There are of course other benefits to cultivation such as:

- improving the ease with which seedlings can be planted
- providing for soil water conservation (the minimising of the soil water evaporation during seedling establishment)
- elevating the seedlings above the frost layer at frost-prone sites
- providing a mechanism for the incorporation of slash residue after harvest to provide for better seedling nutrition

## ACKNOWLEDGEMENTS

The authors wish to thank the various local technical teams who performed the MARVL inventories and *Forest Research* staff who processed field data into stand valuations.

## REFERENCES

Hunter, I.R., and Skinner, M.F., 1986. Establishing radiata pine on the North Auckland podzols. New Zealand Forestry November 1986 pp17-23

Hunter-Smith, J.A.C., Smith, C. T., and Graham, J.D., 1996. Tree and Site Responses to Mechanical Site Preparation - An Annotated Bibliography. Report No 80, New Zealand Forest Site Management Cooperative, NZ Forest Research Institute Ltd.

Smith, C. T., Hunter-Smith, J.A.C., and Graham, J.D., 1996. A Literature Review of Mechanical Site Preparation Relevant to New Zealand. Report No 81, New Zealand Forest Site Management Cooperative, NZ Forest Research Institute Ltd.

SAS/STAT Users Guide Version 6, 4<sup>th</sup> edition 1989

Skinner, M.F., Graham, J.D., and Kimberley, M.O., 2001. The site preparation - trial revival project: The long-term effects of cultivation on the growth of pines at several sites in the North Island. Report No 122, New Zealand Forest Site Management Cooperative, NZ Forest Research Institute Ltd.

