MECHANIZATION IN A FOREST NURSERY

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SYNOPSIS

This paper describes the mechanical aspects of raising 1/0 Pinus radiata at the Tasman Pulp and Paper Company's tree nursery at Te Teko. It explains how the special needs of a large-scale planting programme have provided the opportunity to establish "production-line" techniques in a nursery, with an improvement in tree quality and a reduction in unit costs.

Mention is made of the limits of the existing methods and equipment, and how the problems of an annual production in excess of seven million 1/0 P. radiata seedlings may be handled.

INTRODUCTION

Organizationally, forest nursery operations can be grouped under the following three headings: Land preparation; sowing and cultivation of the crop; and lifting and despatch.

Land preparation includes all work necessary in getting the ground ready for the making up of the seedbeds. Included in this work is the growing of green crops, and any topdressing that might be necessary before sowing.

Sowing and cultivation include the making up and sowing of the seedbeds, the chemical control of weeds, fungi and insects, further application of fertilizers, mechanical weeding, irrigation and, finally, root wrenching.

Lifting and despatch include the lifting of the crop, its sorting, counting and packing, subsequent storage, and transport of the trees to the planting site.

Several factors influence the choice of machinery to be used on the above work, and one of the most important is the nursery's objectives, which in turn will define its size and layout.

At the heart of the nursery mechanization is the tractor, and it is around this piece of machinery that so much of the other equipment is designed. In essence, the desirable qualities of a nursery tractor are:

(1) Sufficient ground clearance to allow for free travel over nursery beds when the trees are at their tallest. (At Te Teko an initial ground clearance of 21 in. is considered optimal.)

(2) Provision for mid-mounted hydraulically operated equipment, as well as the three-point linkage at the rear.

(3) At the power take-off, sufficient horsepower to operate heavy cultivating equipment. A two-speed or multi-speed power take-off is very useful.

Most tractors in the 56 h.p. class meet these essentials, but some may require modifications to give the necessary ground clearance. Such a tractor is a requirement that all large nurseries have in

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common but, beyond this point, the choice of further equipment is dependent upon many factors.

The following describes how one nursery, that of Tasman Pulp and Paper Co. Ltd. at Te Teko, has mechanized some nursery operations, and indicates the benefits obtained.

### NURSERY DESCRIPTION AND OBJECTIVES

The Tasman nursery is situated alongside the Rotorua-Whakatane State highway, near Te Teko, and is 15 to 20 miles north-east of the Company's afforestation area in the Tarawera Valley. The soil (described as Otakiri loamy sand) is recent alluvium derived from volcanic ash, and is moderately drained and easily worked.

Total area of the nursery is 34 acres. It comprises four 7½-acre blocks, the remainder of the area being taken up with roadway, buildings and gardens. Nursery beds are approximately 21 chains long and there are 47 beds per block. The depth of fertile soil varies from 12 to 18 in., beneath which lies a considerable depth of pumice. Little or no trouble is experienced in very wet weather, although it has been necessary to lay field tiles in one part of the nursery.

The objects of the nursery are to provide sufficient planting stock per annum to meet the Company's afforestation programme. At present, the nursery is producing 6 million 1/0 *Pinus radiata* seedlings and approximately 1 million of other species, which include Douglas fir, *P. taeda* and hybrid poplars. It is around the

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**Fig. 1: A block of *P. radiata* seedlings six months old at Tasman Pulp and Paper Company's Tree Nursery, Te Teko.**

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requirements of the 1/0 P. radiata that existing equipment and methods have evolved. Future expansion will undoubtedly bring other improvements.

NURSERY OPERATIONS

(1) Land Preparation

Following the complete removal of the previous crop, the area is scarified with tines mounted on a Fordson multi-purpose tool bar. These tines penetrate to a depth of 12 in. or more and break up the consolidation that has occurred during the previous season. Ploughing is also done on occasion, but care is needed not to bring to the surface any of the pumice layer.

Following scarification or ploughing the area is coarsely cultivated with a 50 in. Howard rotary hoe mounted on the rear of the tractor. Such work is normally completed by mid-August and may be undertaken by agricultural contractors.

Following this, and depending upon local weather conditions, the area is re-cultivated with the rotary hoe; but this time the hoe's shield is half-closed, giving a finer breakdown of the soil. This work does not proceed until the soil is relatively dry and friable. Topdressing with artificial manures is then carried out with a 14 ft wide Munro topdressing unit, mounted on the nursery trailer. With topdressing completed, the way is clear to make up the beds. This is done by making two passes over each bed area with the hoe shield in the closed position and allowing the rotary hoe to work in the top six to eight inches of soil. This procedure raises the beds some four to five inches above the depressed wheel tracks. With the beds thus formed, a water-filled roller 50 in. wide is used to consolidate the top two or three inches. Whenever possible the beds are made up five to six weeks prior to sowing, in order to allow time for weed seeds to germinate freely.

(2) Seed Sowing and Crop Cultivation

All P. radiata seed is pre-treated with Arasan and stratified in a cool store for the required period.

Seven Planet Junior seed sowers are mounted in two banks on a steel frame. The multi-holed disc controlling the flow of seed from the hopper is set at hole No. 21 on the scale, to give an even distribution of seeds at approximately 15 to 18 per foot.

The hoppers each hold approximately 5 lb of treated seed, and are topped up at the end of every 40 chain run. Previously, when the seed was treated with a mixture of Thirodust and latex, it was necessary to stop after two or three beds to remove the hoppers and clean out the excess Thirodust and latex that had shaken free from the seed. The recent change to Arasan has eliminated this and resulted in more accurate sowing.

In setting up the seed sower and in the subsequent sowing, it has been found essential to have the framework exactly level. To ensure that it is so, a spirit level is used and a constant check made that the frame is travelling horizontal to the bed. A further
essential is that all shoes are exactly level. Allowance must be made, if a new one is fitted, to compensate for its greater depth in comparison with those shoes that are slightly worn at the bottom. If these precautions are not taken some rows will be sown deeper than others, leading to delayed seed germination and consequently to smaller trees at the time of lifting.

Following the sowing of the seed, other mechanized operations carried out over the seedbeds are regular sprayings with various weedicides, fungicides and insecticides and, occasionally, liquid fertilizers. This work demands an efficient spray unit, if sprayings are to be both accurate and uninterrupted. The present spray equipment consists of a Hilo 4 pump coupled to the tractor’s power take-off, and an 80 gal hydraulically rear-mounted tank, to which is attached a three-piece articulated boom. Each boom section covers one bed and the nozzles are spaced at intervals of 14 in. Flow from the pump by-pass supplies sufficient agitation to the liquid in the tank—an important factor when dealing with the wettable powders. Coupled into the delivery line is a valve selector which allows the spray to be delivered through any combination of the three booms, allowing maximum flexibility in the spraying programme. This unit, together with the pressure control valve, is mounted on an arm attached permanently to the spray tank. When the complete spray unit is hydraulically lifted, the extended arm automatically comes into a comfortable position for control by the tractor driver. This eliminates the need to re-connect hose

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FIG. 2: Seed sowing with Planet Junior sowers. Since this photograph was taken, the frame has had a further section added and now carries seven hoppers in place of the five illustrated.
lines or valve gear on to the tractor when the spray unit is re-
quired. It is necessary only to back into the spray unit, lift it
on the hydraulic forks, and slide the pump on to the power
take-off spline. All solutions and mixes going into the tank are
passed through a nylon strainer. This and thorough pre-mixing of
chemicals eliminate many of the blockages that would otherwise
occur at the nozzles. The normal operating pressure for the spray
unit varies between 60 and 100 lb/sq.in., depending upon the
chemical being applied.

Volatile sprays are also used, particularly for post-germination
work. To help eliminate scorching of the young seedlings, a tractor-
mounted seedling guard was fabricated. The guards are individually
mounted between the spray nozzles of a five-foot boom, and the
unit is fitted to the front hydraulic lifting forks. The guards give
complete protection to the seedlings and the spray is applied
in a band between each guard. Mounted thus, the driver can easily
control the height at which the unit travels above the seedbed.
Nevertheless, great care is needed to prevent the guards crossing
over the lines of seedlings being shielded.

The next operation in the culture of *P. radiata* seedlings is
wrenching. The first wrenching is normally carried out during
February; the actual date depends upon the height of the seedlings
to be wrenched. Subsequently they are wrenched some four or
five times prior to lifting. The first root-pruning is done with a
piano wire strained between two vertical blades that travel either
side of the bed. These blades are mounted on the Fordson multi-
purpose tool bar attached to the tractor's three-point linkage.
Straining of the 16 gauge, high tensile steel wire is accomplished
by an ordinary set of wire strainers. In this operation it is the
speed of the tractor that plays an essential part; and the long
beds enable the tractor to move at speeds of up to 5 m.p.h. In
good conditions this has proved to be an ideal tool, and little
or no sign of the passing of the wire is visible on the surface.
The wire actually snaps or pulls the roots off—it does not cut
them. When working well, the sound heard is similar to that
of a well-known breakfast cereal. One drawback to this operation
is that the roots tends to build up on the wire and, if the driver
is not observant, this can cause a sudden blockage and pull the
trees down under the ground. Every now and again the wire has
to be lifted and cleared of these tree roots. Subsequent wrench-
ings are normally made with a blade of conventional type.

Whilst the light soil at Te Teko allows the easy passage of a
wire or blade, it does not always give the necessary immediate
support to tall, wrenched seedlings. Sufficient soil moisture is
required to impart the necessary firmness to the soil before tall
seedlings can be wrenched. If necessary this can be imparted by
irrigation.

(3) Lifting, Packing and Despatch

In order to achieve the maximum daily output, this operation
has received considerable attention. Most of the Company's planting
is done by crews on bonus, and much of the area is planted by
Lowther crank axle tree-planting machines. These factors, and
large-scale private sales, dictate three requirements in delivering stock:

(1) An output to meet a planting rate of up to 120,000 trees per day.

(2) An accurate count of the number of trees supplied to the crews.

(3) Trees packed in a container suitable for direct placement into the rectangular plant holders fixed to the Lowther machines.

To meet these specifications, appropriate equipment has been developed or modified, and the working routine streamlined.

The chief factor influencing these new developments was a decision to eliminate the puddling of lifted stock. Trials in the Tarawera Valley had indicated that this operation was of doubtful value to the survival and growth rate of the planted seedlings. The introduction of modified multiwall paper sacks as tree con-
FUTURE DEVELOPMENTS

So much for the present system at the Te Teko nursery, but what of the future? In order to meet an increased demand for seedlings, at a lower cost, the following changes are planned:

(1) A wider rotary hoe (either a 70 in. or 80 in. model) both to speed the task of cultivating and to allow for more seed drills per bed.

(2) An improved spray unit consisting of a trailer-mounted 300 gal tank, complete with independent motor and pump, and articulated spray booms extending over six beds.

(3) An overhead pre-mixing tank to eliminate tractor idling whilst refilling with a new mix.

(4) A modified Marsh reciprocating root-wrencher, later to be adapted to provide a mechanical means of lifting trees from the ground.

(5) An automatic sorting and packing system based on a conveyor belt, with trees being weighed instead of counted.

(6) The cool storage of tree packets in pre-packed, insulated containers, which can be wheeled on to the truck and lifted off at the planting site. Such containers will form the tree depot at the planting site and will be brought back to the nursery when empty.

DISCUSSION

In essence, the nursery methods described in this article are simple, based as they are on straightforward production of large quantities of 1/0 P. radiata for one major outlet. These requirements generally involve only one seedlot and, with the nursery in close proximity to the planting site, there is wide scope for streamlining the routine.

As mentioned at the beginning, the size and shape of the nursery are some of the most important factors in nursery mechanization. In this respect the Company's nursery site at Te Teko is excellent, with a layout ideally suited for mechanical equipment. The choice of site was not accidental, the area being selected in order that efficient production methods could be evolved to meet the requirements of an expanding forest establishment programme.

The present nursery production methods are the result of modification to existing equipment, elimination of unnecessary functions, and the introduction of some new ideas. These changes have allowed P. radiata production to increase from one million in 1962 to six million in 1967, with a steady decrease in prime costs per thousand trees produced.

These methods are now working at their optimum, and further increased production will incur an increase in prime costs per thousand seedlings. Further expansion at present or lower costs will be dependent upon the introduction of the changes proposed earlier. There is a need to re-plan some of the operations and also
to replace some equipment with new equipment of greater capacity. Such changes will lead to increased production at lower unit cost, together with further improvement in seedling and planting quality.

Mechanization, however, is complementary to the use of sound nursery techniques, and can in no way supplant them. The successful development of a nursery largely depends upon using the best cultural and tree-handling methods. Mechanization of nursery operations is the key to achieving these objectives most economically.

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