



# DIVERSIFIED SPECIES TECHNICAL NOTE

Number: DSTN-032  
Date: November 2012

## Reducing Costs of Establishing Indigenous Forest

### Summary

Reducing the cost of seedlings and improving early growth after planting are key areas in the establishment and development of planted indigenous forests. Trials have been established that make comparisons of cost and performance of indigenous seedlings raised in containers or as open-ground (bare-root) plants in the nursery. In addition, we have evaluated a range of site preparation and weed control options. These trials have been progressively established since 2009, and are located on a hill country site in the Lake Taupo catchment.

When grown on a relatively large scale for establishing indigenous forest, the costs of nursery-raised open-ground indigenous shrub species were less than half those of container-grown seedlings. Transport, handling and planting of open-ground indigenous seedlings were more efficient than for container-grown plants, although extra care was required to ensure open-ground stock were planted within 2-3 days after lifting, as is required for open-ground exotic forestry species. Open-ground indigenous shrub species are likely to be 50% cheaper to establish than those raised in PB3 containers and marginally cheaper than Hillson root trainer stock. Preliminary results indicate that there was no significant difference in survival and growth in the first 2 years between open-ground and container-raised seedlings for many of the commonly planted species.

These preliminary results indicate an improved opportunity to reduce the cost of establishing planted indigenous forests using seedlings raised as open-ground stock. Trials confirm the need to use a cover of hardy shrub species to provide initial shelter before planting podocarp tree species on difficult hill country, in order to improve survival and early growth.

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### Introduction

Planted indigenous forestry is an option on retired pastoral hill country to improve soil stabilization and increase indigenous biodiversity, and for sustainable timber production and carbon sequestration. Compared to some production forestry species, impediments to large-scale afforestation with indigenous trees and shrubs include:

- slower establishment of indigenous species;
- high cost of nursery-raised seedlings;
- uneven quality of nursery-raised plants; and
- high cost of maintenance in early years, particularly weed control.

Nursery and planting trials in the Lake Taupo catchment began in 2009. The trials have several components aimed at reducing the costs of establishing indigenous forestry including:

- comparing performance and cost of nursery-raised indigenous seedlings in containers and as open-ground (bare-root) plants;
- monitoring performance of indigenous seedlings planted on steep hill country; and
- reducing the cost of establishing indigenous species including use of exotic nurse species and minimum site preparation and weed control options.

### Nursery Trials

In collaboration with the Taupo Native Plant Nursery, seedlings of shrub hardwoods and monocots were raised within one year in the nursery in PB3 containers (or equivalent size pots), in Hillson root trainers, and as open-ground transplants. Shoot and root development, and root collar size were dependent on the spacing of plants during propagation. On average, canopy spread, root collar diameter and size of root ball for open-ground stock were larger than for



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seedlings raised in PB3 containers which, in turn, were greater than for plants raised in root trainers.

## Establishment of Planting Trials

### Trial Site

Planting trials were located on a west Taupo farm at Waihaha, typical of steep pastoral land that is being retired from grazing (Figure 1). The 4-ha site comprises a steep north facing hill side with a low growing kanuka (*Kunzea ericoides* var. *ericoides*) stand on the mid and lower slopes. The site includes a riparian area.

### Trial Design and Treatments

Approximately 3000 plants were planted each year at the Waihaha trial in late winter over the last three years (2009, 2010, 2011), with each

block progressively retired from grazing (Figure 2).

The trial layout is a Randomised Complete Block design based on 12-tree rows and random allocation by species of nursery-stock treatments to each row. Pre-plant spot spraying used glyphosate, surfactant and marker dye at label rates. Rabbits and hares are a problem, so each trial site was rabbit fenced followed by laying of pindone poison immediately after planting. Plant spacing was 1.5 x 1.5 m (4444 stems per ha). Weeds were controlled up to 3 times per year over the first 2 years after planting, using glyphosate as above applied by knapsack sprayer.

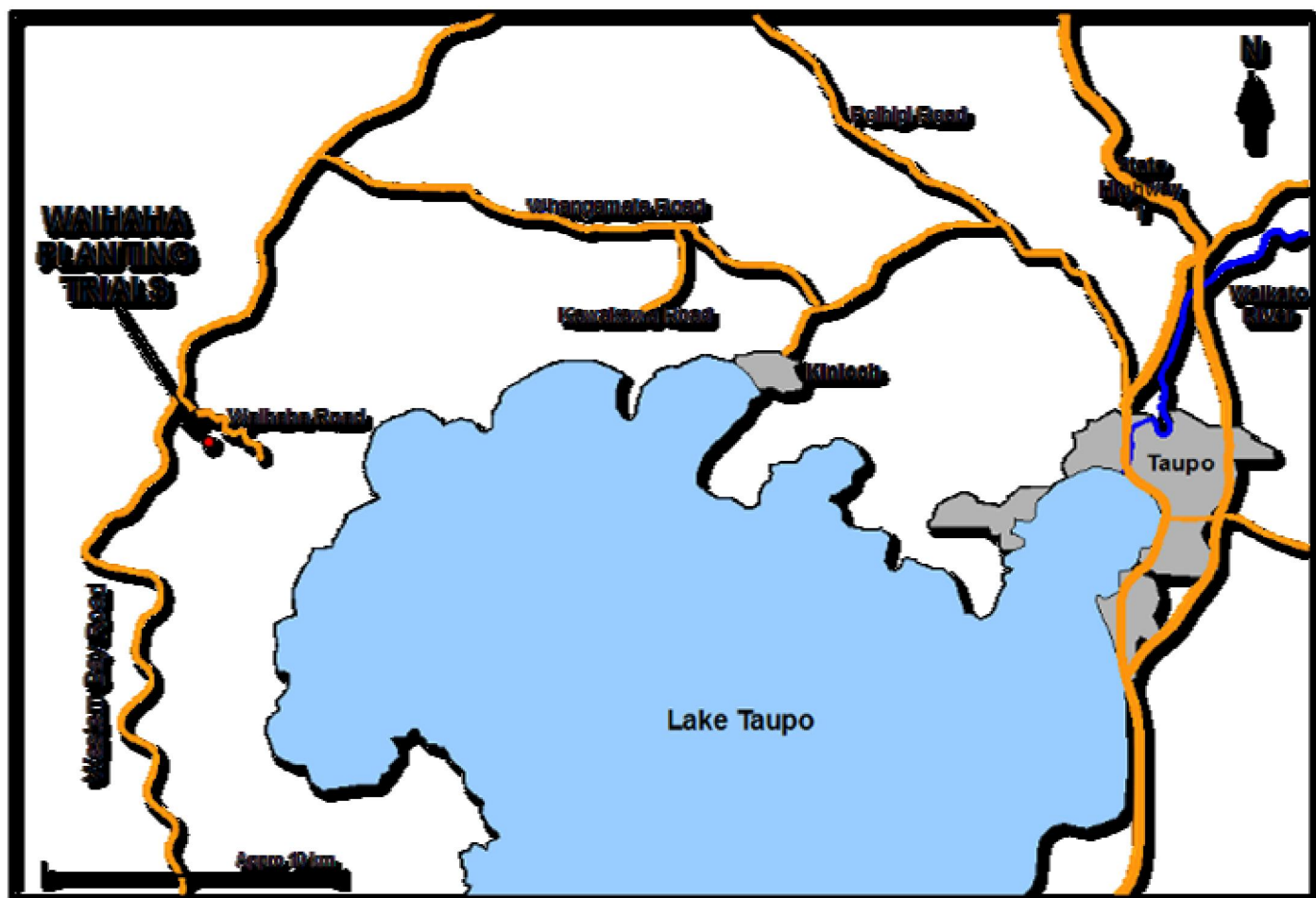


Figure 1: Location of the indigenous species planting trial site, Waihaha, west Taupo.



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Hardy shrubby species planted were: karamu (*Coprosma robusta*), koromiko (*Hebe stricta* var. *stricta*), manuka (*Leptospermum scoparium*), kohuhu (*Pittosporum tenuifolium*), toetoe (*Austroderia toetoe*), harakeke (*Phormium tenax*), and rautawhiri (*Pittosporum colensoi*) – with the aim of providing a cover for interplanting indigenous tree species. Three stock types were planted – PB3 polythene planter bags, open-ground and root trainers.

Site preparation and weed control treatments were:

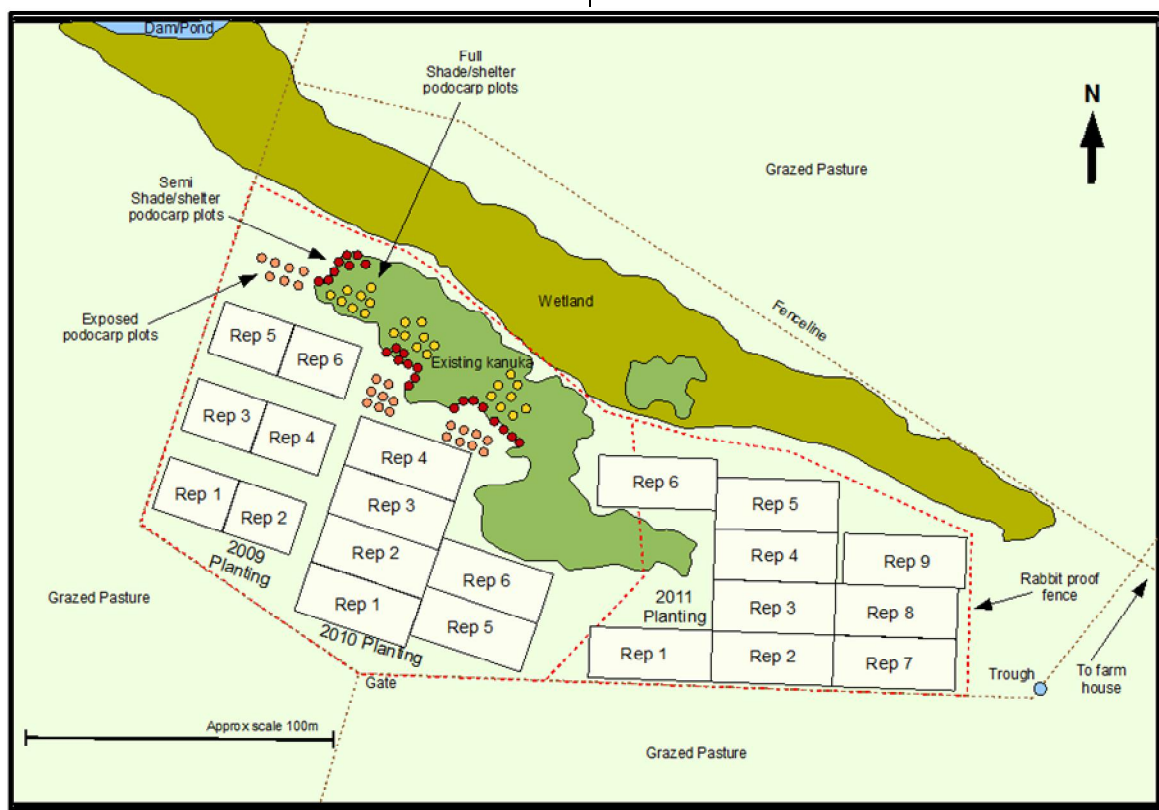
- control (no pre- or post-plant weed control);
- minimum treatment (pre-plant spray only); and
- maximum treatment (pre-plant spray and weed control).

A radiata pine (*Pinus radiata*) nurse crop treatment was also established comprising a 50/50 mix of pines and indigenous species.

Forty-five groups of podocarp tree species used widely in the past from old-growth forest for timber were established on three site types identified within the naturally regenerating kanuka, namely:

- exposed pastoral hill;
- semi-sheltered kanuka edge; and
- sheltered within-stand kanuka.

Up to three single-species plots comprising five trees planted at 1-1.5 m spacing were located on each site type with a minimum of 5 m spacing between plots (Figures 2 and 3). Podocarps planted were rimu (*Dacrydium cupressinum*), totara (*Podocarpus totara*), kahikatea (*Dacrycarpus dacrydioides*), matai (*Prumnopitys taxifolia*) and miro (*Prumnopitys ferruginea*).



**Figure 2: Layout of replicated blocks for the indigenous species planting trials established in 2009, 2010 and 2011 comprising mostly shrub hardwoods and the planted podocarp groups within and adjacent to the existing kanuka stand, Waihaha, western Taupo.**





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**Figure 3: View to the south of the indigenous species planting trials established on a steep north-facing slope, Waihaha, western Taupo.**

## Preliminary Results

### Shrub Hardwoods

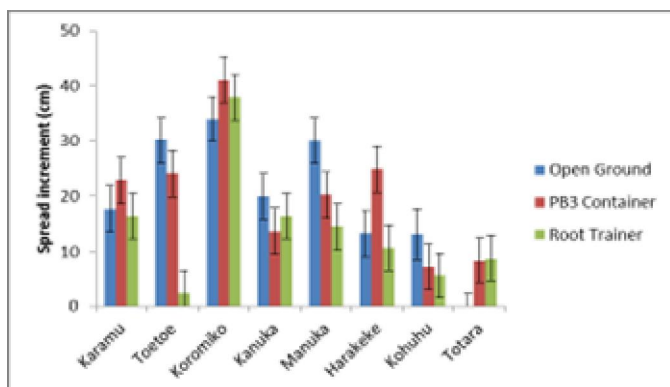
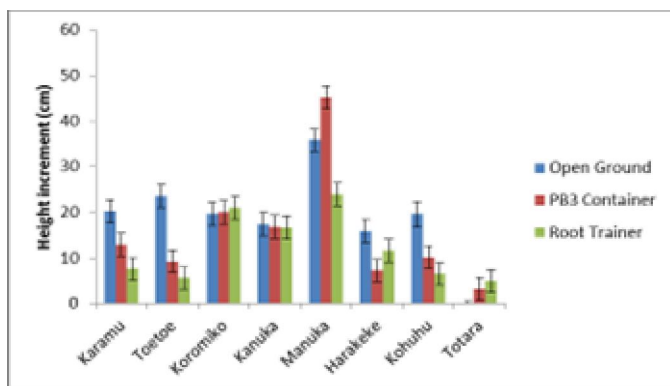
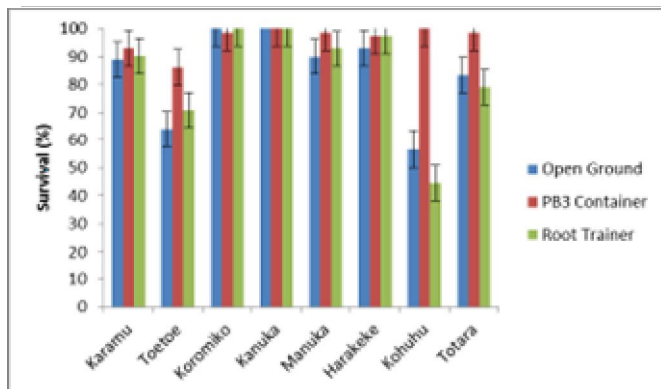
One year after planting, survival is over 80% for most species except toetoe and kohuhu, especially for PB3 and open-ground stock types (Figure 4). Mortality of open-ground and root trainer toetoe and kohuhu was significantly higher than for PB3 container stock.

There was a trend for less growth increment with root trainer stock types compared to other stock types for the shrub hardwood species (Figure 4). Manuka had the fastest height growth, with koromiko the fastest in canopy spread.



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**Figure 4: Comparison of survival, height and crown spread increment between plants raised as open-ground transplants, in PB3 containers and in Hillson root trainers for each of eight indigenous tree, shrub and monocot species 1 year after planting at the Waihaha site. Columns show means and vertical bars indicate standard errors for each species.**

## Podocarp Planting

One year after planting there was progressively poorer survival from fully sheltered to exposed sites for rimu and kahikatea and to a lesser degree

totara (Figure 5). There was generally similar survival between stock types open-ground and container, and only a minor reduction in survival for matai and miro from sheltered to exposed sites.

## Cost of Establishing Indigenous Forest Plant Costs

Estimated provisional cost per plant for each stock type was:

- Open-ground – \$1 each (based on small scale production)
- PB3 containers or equivalent – \$2.50 each
- Hillson root trainers – \$1.50 each.

Nurseries must have free draining friable soils, have expensive tractor-based equipment and have staff with experience raising indigenous plants as open-ground stock. Substantial orders (10,000 plus per species) are required for large scale production to ensure plant prices are low.

## Transport and Storage

Requirements for plant storage and transport for each stock type are:

- Open-ground – up to 800 plants per m<sup>3</sup> (3 layers of boxes)
- PB3 containers or equivalent – 120 plants per m<sup>3</sup> (2 layers of trays)
- Hillson root trainers – 720 plants per m<sup>3</sup> (2 layers of baskets).

Open-ground and the small Hillson root trainers occupied similar storage and truck space and so have similar handling and transport costs. Stock raised in PB3 containers required four times as much space for storage and transfer to the planting site.

## Handling

At the planting site, handling and planting for each stock type comprised:

- Open-ground – up to 50 in a box or bag handled at one time by planters.
- PB3 containers – only 12 seedlings at one time.
- Hillson root trainers – one basket of 48 at a time.



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Indigenous seedlings raised in PB3 containers required up to four times longer to distribute plants at the planting site.

## Planting

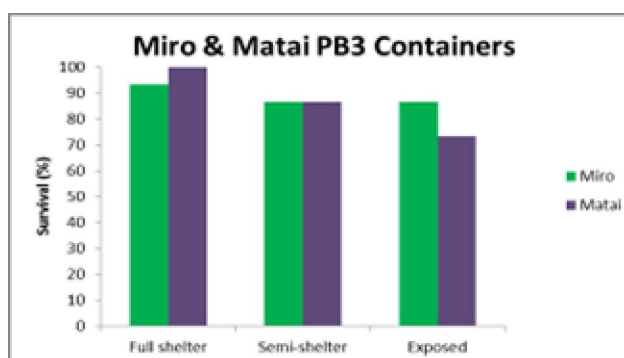
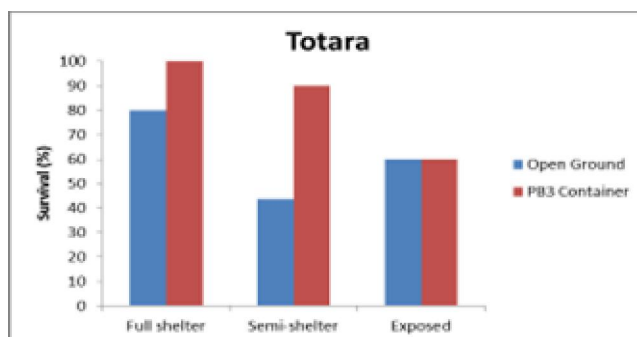
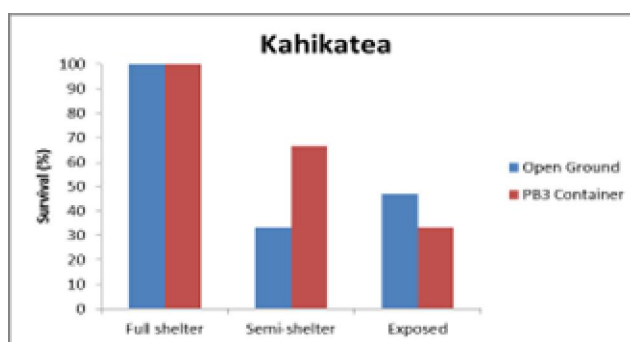
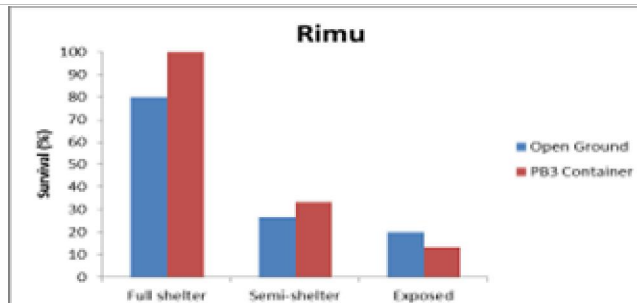
Differences were observed in both ease of planting and time taken to plant between seedling stock types. Open-ground were the easiest to plant. PB3 containers and Hillson root trainers required extra time to extract seedlings from containers and recover plastic waste.

## Preliminary Cost/time Comparison

Estimated costs for per plant from nursery production to planting for each stock type, based on shrub hardwoods and monocots raised within one year in the nursery, are shown in Table 1 compared with standard radiata pine. Seedling and transport estimates are from the Taupo Nursery and handling and planting estimates from time/motion studies at the Taupo planting site.

**Table 1: Estimates of costs and time for establishing indigenous shrub species. Estimates are highly variable due to size of seedling orders, distance to planting sites, access and site type.**

| Stock Type               | Cost of nursery-raised seedling     | Transport space                                  | Handling at site and planting time |
|--------------------------|-------------------------------------|--|------------------------------------|
| Open-ground              | \$1.25 - \$1.50 each<br>Bulk \$1.00 | 10 cents/plant (1000 plants per m <sup>3</sup> ) | 0.9 mins per seedling              |
| PB3 containers           | \$3 - \$3.50 each<br>Bulk \$3       | 40 cents/plant (120 plants per m <sup>3</sup> )  | 1.8 mins per seedling              |
| Hillson Root trainers    | \$1.25<br>Bulk \$1.10               | 10 cents/plant (1000 plants per m <sup>3</sup> ) | 1.6 mins per seedling              |
| Radiata pine open-ground | \$0.40 approx (bulk)                | Approx. (1200 plants per m <sup>3</sup> )        | 0.6 mins per seedling              |



**Figure 5: Comparison of survival of planted groups of podocarps in full shelter and in the semi-shelter of short kanuka shrubland, and on an adjacent exposed open site.**



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## Preliminary Conclusions

### Plant Performance

In general, there was no significant difference in survival and growth in the first two years between open-ground and container-raised seedlings for many of the commonly planted shrub hardwood and monocot species. There are exceptions – it can be difficult to form a compact fibrous root system on bare-root seedlings such as *Pittosporum* species. Trials confirm the need to establish a cover of hardy shrub species as shelter before planting podocarp tree species on these difficult hill country sites.

### Economics of Establishing Indigenous Species

The cost of nursery-raised open-ground indigenous shrub species is less than half that of container-grown seedlings. Costs of planting open-ground indigenous shrubs species are closer to the costs of establishing radiata pine than they are to planting indigenous species raised in containers.

Transport, handling and planting of open-ground indigenous trees and shrubs was easier than for container-grown plants, although extra care was required to ensure open-ground stock were planted within 2-3 days after lifting. Open-ground indigenous shrub species are likely to be 50% cheaper to establish than PB3 container stock, and marginally cheaper than Hillson root trainer stock.

Post-plant weed control is a significant cost of establishing indigenous forestry species, as some indigenous species can be slow to establish and will require two or more years of releasing, especially on weed-infested sites. Further monitoring of these trials will allow us to quantify the range of site preparation and weed control treatments that are being evaluated.

## Acknowledgements

The nursery and planting trials have been established as a collaborative project involving Tane's Tree Trust, the Lake Taupo Protection Trust, local landowners, Opus, Scion, Future Forests Research, and the Waikato Regional Council.