Options for Establishing Native Trees

Three main options available to the land owner interested in establishing a native forest for multiple purposes, including future timber production, are:

- Planting of nursery raised seedlings;
- Direct seeding onto the ground; and
- Encouraging growth of natural vegetation.

This article provides only a brief introduction to each of these establishment options relating to native trees and shrub species. Practical guidelines will be provided in subsequent sections in this Handbook.

CHOOSING THE APPROPRIATE OPTION

Making decisions on which option to follow requires consideration of the objectives of planting, the ecology of the species concerned, the nature of the site, the resources available and the likely scale of the exercise.

Planting of nursery-raised seedlings is the most widely used option for the establishment of native plant species throughout the country to meet many objectives (e.g., Evans 1983; Pollock 1986). It is however, an expensive and labour intensive method for establishing natives and therefore is only practical on a relatively small scale (Bergin and Gea 2007). Planting does allow control of the species mix and the intensity of planting, and with appropriate after-planting care, can be highly successful.

Direct seeding is probably a risky option in terms of outcome, but is potentially a much cheaper option than planting when it is effective. However, it is likely to be very site-specific and considerable research is required to determine if it is practical for the wide range of sites requiring reforestation in New Zealand.

Most native woody plant species used in planting programmes in New Zealand are raised from seed in containers in nurseries.

Encouraging natural regeneration is the preferred option where there is a good supply of forest tree seed and weed competition can be controlled. This is likely to be the most practical option for large-scale afforestation of native forests in New Zealand such as on marginal hillcountry farmland. While native forest will eventually regenerate in some regions, it is likely to be slow to develop. Practical methods for encouraging or enhancing large scale natural regeneration require further research.

PLANTING

By far the greatest majority of native woody plant species used in revegetation programmes and for establishing potential production forests are raised from seed. Small numbers of a limited number of species are raised from vegetative material, either as cuttings or divisions.

Nursery-raised seedlings

The usual method of establishing native species is to use plants raised from seed in containers (pots, planter bags, or rootrainers) in plant nurseries. Most native conifer and hardwood tree species can be grown from seed using standard nursery techniques. Seed production and germination rates vary and may affect the availability of some species from one year to the next. Seeding characteristics and appropriate nursery techniques have been published for kauri *(Agathis australis),* (Lloyd 1978 and Halkett 1983); for podocarps (Forest Research Institute 1980); and for hardwood trees and shrubs, (Forest Research Institute 1988 and Pardy and Bergin 1989).

Forest duff collected in winter beneath target trees contains seeds and can be used to produce seedlings of a range of native species including matai (*Prumnopitys taxifolia*) and miro (*Prumnopitys ferruginea*), which are slow to germinate (Herbert 1977). This method is best suited to small-scale operations.

Many native species have been successfully raised as bare-rooted seedlings. This method is especially suited to large-scale production and planting programmes where production costs can be reduced (e.g., Forest Research Institute 1980; Beveridge et al. 1985; Bergin and Cole 2010). Container-grown and bare-rooted plants can be planted at selected spacings to fulfil specific requirements or objectives of planting. Seedlings, depending on age and size, are likely to cost between $2 and $5 each for bulk orders from commercial nurseries, with faster-growing shrub hardwoods $2–3 and native trees, particularly conifers, $3–5.

Cuttings

Raising native timber species from cuttings is not practised on a large scale as most species are more easily raised from seed. Some native trees, such as rimu (*Dacrydium cupressinum*) (Dakin and Mearns 1974) and totara (*Podocarpus totara*) (Bergin 2003), can be raised from cuttings.

Cuttings are commonly used to raise large quantities of selected shrub hardwood species using methods widely used for cultivation of many garden plants, both exotic and native. Methods for collection and setting of cuttings are given in numerous publications, e.g., Metcalf (2007).

In the horticulture industry, particular traits such as distinctively coloured foliage or plant form that are highly sought-after can be based on a limited genetic base. Cuttings are taken from a single parent plant with desirable characteristics for propagation of plants to cater for demand for the urban and garden sectors. In the same way, the exotic forestry sector has long relied on the use of cuttings to provide plants from elite trees with particular characteristics such as good tree form, fast growth or specific wood properties. Seed orchard technology for radiata pine (*Pinus radiata*) is reliant on use of cuttings to quickly bulk up family lines with preferred traits. In the future, it is likely the same technology will be of benefit to those wanting to grow improved lines of selected native trees.

For large scale revegetation of native forest, it is recommended that cuttings are taken from a wide genetic base within local populations to ensure at least some genetic diversity in nursery-raised plants. As is recommended for seed collection from native trees, cuttings should be taken from a minimum of 10 plants throughout a local population with at least 100 m between parent plants. Native seedlings raised on a large scale for revegetation from cuttings include for instance koromiko (*Hebe stricta*).

Transplanting of wildings

The removal of small seedlings from forest and scrub sites, often termed "wildings", is labour-intensive and mortality of transplants can be high. Transplanting wildings of species where seed is difficult to obtain each year and in which germination is poor, such as matai and miro, has been successful on a small scale. In addition, there can be benefits from transplanting wildings of some species (e.g. the beech species – *Nothofagus* spp.) where beneficial mycorohiza (refer to Handbook section 6.1) that are required for good performance can be introduced to the nursery propagating beds or containers, along with the seedlings.

For most species, best survival and growth has been with wildings less than 15 cm tall. Larger seedlings invariably have dispersed woody root systems that inevitably are chopped off during lifting from the forest floor. Because removal of wildings involves loss of a significant amount of root mass, survival of the transplant can be improved by cutting back up to half of the leaf area to match the root loss, keeping plants moist and transplanting quickly.

Sourcing of regenerating native seedlings from forest and scrub sites can create issues including disturbance and loss of potential regeneration of source areas. Although digging up small seedlings from the forest floor or from scrub areas will result in localised disturbance, there are many instances where vast quantities of small seedlings, usually only up to 1-2 years old, occur beneath seeding trees, under bird roosting sites or along bush edges where there is increased light and greater species diversity. Recently disturbed sites where mineral soil has been exposed within or along edges of native forest can become covered in dense carpets of a range of newly germinated seedlings of a wide range of native tree and shrub species.

Only a small fraction of newly germinated seedlings of native trees and shrubs are likely to survive as forest succession proceeds and canopy gaps open up to allow one or two plants to eventually develop. The vast majority will often die within a year or two of germination due to summer droughts and low light levels. Careful lifting of small seedlings scattered over such areas is unlikely to impact at all on forest succession.

Permission is required from the landowner or manager for removal of wildings. A permit is required from the Department of Conservation to collect any plant material from the conservation estate.

Divisions

For most grasses, sedges and other monocots such as harakeke (*Phormium tenax*) and toetoe (*Cortaderia toetoe*), plants can be separated into divisions. These species can be raised from seed or from divisions to planting size in the nursery, and divided to increase numbers for continuing to grow-on in the nursery. Alternatively, where divisions are of sufficient size, they can be planted directly in the field. This method is labour-intensive and like raising plants from cuttings, it restricts genetic diversity to that of the parent material. On the other hand, as with cuttings, divisions may give the opportunity to bulk up plant material from elite plants that have been identified with superior growth or other preferred characteristics. As with transplanting wildings it is advisable to cut back leaf area of the divided plants.

DIRECT SEEDING

Broadcasting seed as a method of establishing tree species has seldom been successful and it is rarely practised on a large scale. An overview of the key issues with direct seeding by Douglas et al. (2007) indicates there are several factors determining the success and practicality of this method for establishing native woody species. These include:

- Successful direct seeding usually requires the removal of competing vegetation and/or exposure of mineral soil. Most woody native species are unable to compete with dense grass or herbaceous weeds on open sites when direct seeded;
- Depending on site conditions and species, small newly-germinated seedlings are more prone to mortality caused by desiccation, and by fungal and insect attack, than larger planted seedlings;
- Collection of large amounts of seed for broadcast sowing on to prepared sites can be difficult and labour-intensive for many native species;
- Viability of seed can vary from one year to the next and between species;
- High initial seeding densities are required to allow for poor germination and early mortality; and
- Continuing control of competing invading exotic species, especially grasses, is required.

Specific trials and practices

There have been a range of trials and larger-scale establishment programmes involving direct seeding of selected native forest species using different practices. Davis et al. (2009) provides a comprehensive review of direct seeding programmes undertaken with a range of natives, most of which have been only on an experimental scale. A selection of these is summarised.

Manuka seeding

Manuka (*Leptospermum scoparium*) has often been used and gives a rapid cover of woody native species on cleared sites. Key requirements include removing competing vegetation and the existing weed seed bank within the upper layer of topsoil. This can be achieved by cultivation, preferably turning over the topsoil using discs or similar machinery. For instance, the Waipoua Forest Trust aims to extend kauri forest to the south of the Waipoua Forest Sanctuary using manuka seed to establish a shrub cover on grassed sites to shelter inter-planted kauri (Bergin and Steward 2004). Manuka seed was scattered by hand along furrows made 4-5 m apart by tractor-drawn discs. Within 3 years, dense bands of manuka had established up to 1 m high and provided shelter for inter-planting of kauri seedlings.

Laying manuka brush

Laying of manuka brush containing ripe seed capsules on the ground has been used for revegetation of relatively small areas of recently disturbed forest and scrub areas

(Evans 1983; Porteus 1993). It is particularly successful if the brush is laid over cultivated ground in several layers that provide a degree of shelter, but avoid dense shade for newly germinating manuka. As the cut brush dries out, the semi-mature seed capsules split open and release large quantities of seed.

Canterbury trials

In a trial on bare ground under a burnt beech forest on a north-facing slope in Canterbury, a six-species seed mix comprising assorted shrub and tree species was sown with and without pasture species as a cover crop, and fertiliser (Ledgard and Davis 2004). Out of the species trialled, they found that mountain beech (*Nothofagus solandri* var. *cliffortioides*) and manuka were the most successful. The effect of fertiliser was short-lived. The window for achieving good establishment may be no more than 2 years, after which exotic grass is likely to dominate.

In other trials established on a range of sites in North Canterbury and Banks Peninsula, Ledgard et al. (2008) found low impact manipulation seeding is an option for restoring native species in ex-pastoral lands. Particular emphasis was placed on site preparation, via management of the grass cover (grazing or mowing), soil disturbance, and the use of herbicides to control competition. After 1 year, almost without exception, native seedlings were only found where seed had been sown. Over all of the sites, 23 native trees and shrubs were identified as having emerged from the sowing of seed or litter. They found that existing vegetation, particularly exotic grasses, provided intense competition.

At most sites there was a definite trend for increased seedling numbers where herbicides were applied prior to sowing, particularly where the grass was short, but the greatest increases occurred where ground disturbance had created a bare soil surface. The only situations where there were more seedlings in herbicide treated plots than in disturbed plots were where the grass was naturally short or had been mown.

Ledgard et al. (2008) concluded that the establishment of native species by direct seeding has potential as a cheaper technique for restoring an indigenous woody cover in ex-pasture grassland environments, particularly where large areas have to be treated. However, the results of seeding will vary between sites and seasons, and weed control after seedling emergence remains a critical factor.

Further research

The comprehensive review of establishment practices for native species by Davis et al. (2009) indicates that while direct seeding may be a potentially useful method

Seeding site - ploughed and lightly harrowed (not smooth, needs plenty of nooks and crannies).

Mixing seed in with fine sand prior to sowing.

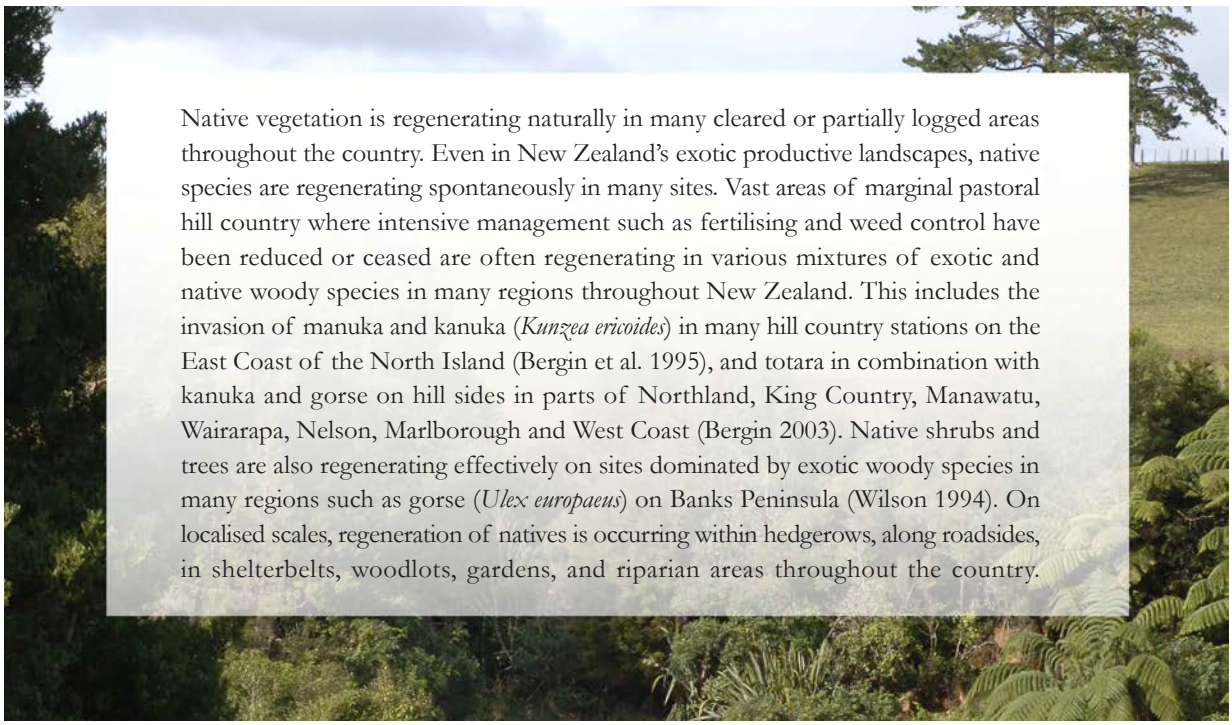
A trial in North Canterbury, showing various forms of site preparation. Straight ploughing was the best.

Several native shrub hardwoods 2 years after sowing in ploughed strips in the Canterbury trial.

for establishing indigenous forest on steep hill country grassland, it has not been tested beyond small scale trials. As most trials have focussed on pioneer or early colonising species, it will also be necessary to determine how best to introduce tall forest native species to ensure that desired climax vegetation has the potential to develop (Davis et al. 2009).

Further research is required to determine the efficacy of direct seeding of natives on a range of sites including optimum methods of site preparation, the role of selective grazing in seedling establishment, choice of native species to seed and other management considerations and the economic viability.

EXOTIC AND NATIVE REGENERATION



Native vegetation is regenerating naturally in many cleared or partially logged areas throughout the country. Even in New Zealand's exotic productive landscapes, native species are regenerating spontaneously in many sites. Vast areas of marginal pastoral hill country where intensive management such as fertilising and weed control have been reduced or ceased are often regenerating in various mixtures of exotic and native woody species in many regions throughout New Zealand. This includes the invasion of manuka and kanuka (*Kunzea ericoides*) in many hill country stations on the East Coast of the North Island (Bergin et al. 1995), and totara in combination with kanuka and gorse on hill sides in parts of Northland, King Country, Manawatu, Wairarapa, Nelson, Marlborough and West Coast (Bergin 2003). Native shrubs and trees are also regenerating effectively on sites dominated by exotic woody species in many regions such as gorse (*Ulex europaeus*) on Banks Peninsula (Wilson 1994). On localised scales, regeneration of natives is occurring within hedgerows, along roadsides, in shelterbelts, woodlots, gardens, and riparian areas throughout the country.

ENHANCEMENT OF NATURAL REGENERATION

Requirements

The pace at which the process of natural regeneration of native forest occurs, and the species composition of resulting communities, will be influenced by many factors. These include:

- characteristics of the original forest and the current landscape;
- site history, e.g., intensity of logging, burning, and clearance;
- for open sites, the current condition and landuse of cleared areas;
- for scrub sites, the current predominant cover of woody species;
- presence, vigour, and persistence of weed species;
- distance from seed sources of native species;
- presence and effectiveness of seed-dispersal agents; and
- presence of browsing animals.

Davis et al. (2009) state that the requirements for successful natural regeneration are the presence of adequate local seed sources, and as with direct seeding, exclusion of grazing livestock, control of animal pests, and control of competing vegetation.

Enhancing regeneration

It is generally essential to exclude livestock (or reduce grazing intensity) and browsing animals such as deer and goats to enable satisfactory establishment and growth of indigenous species. Some species, notably kanuka, manuka and totara, are relatively unpalatable, however, and are able to establish under low livestock grazing intensities providing competition from resident species is minimal. As with establishment from direct seeding, competition from vigorous weed species, especially exotic grasses, is a major obstacle to natural regeneration of indigenous vegetation in grasslands.

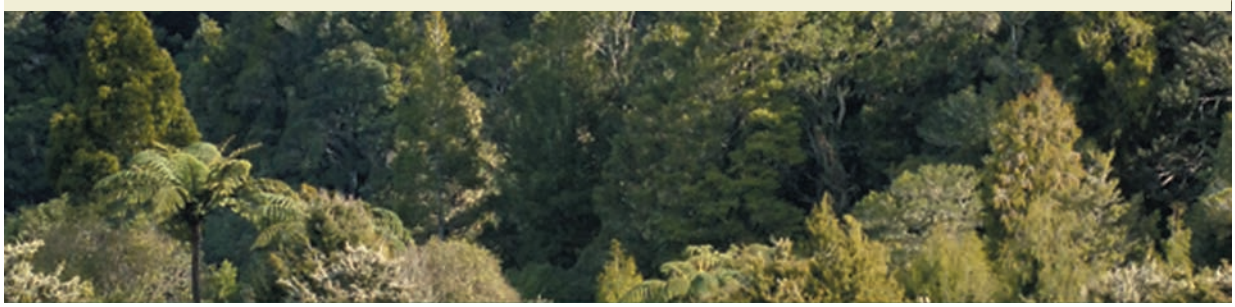
Reducing or eliminating factors that are inhibiting natural regeneration may be a more practical strategy than planting

nursery-raised seedlings. A survey of sites in which natural regeneration is taking place may show that timber species are already present. Where regeneration is occurring, thinning, weed control, and releasing of target tree species from overtopping canopy may be required to improve survival and growth. Where natural regeneration is non-existent or insufficient, planting scattered groups of native timber trees that will become a seed source may be sufficient to restock such areas.

CONCLUSIONS

While planting of nursery-raised seedlings remains the high profile option for establishing native trees, the costs are prohibitive for this to become the most practical method other than for relatively small planting programmes in key areas or for establishing local seed sources. The significant areas of New Zealand's landscape that require establishment of a permanent cover of indigenous vegetation will not be achieved through intensive planting programmes of native trees alone. Planting, certainly on a large-scale, is a last resort!

Our landscapes have a remarkable capacity to revert to forest through natural processes of seed dispersal, regeneration and succession. On many sites, the return of a native forest cover will involve a succession through early phases dominated by exotic woody species. However, in most cases, it is only a matter of time before native species will come to dominate. While there will be a continuing role for more intensive establishment options, particularly planting, restoration of native forest in many of our extensive landscapes will only be achieved by enhancing mechanisms for encouraging natural regeneration. Natural regeneration of native forest will eventually occur – it is largely a matter of time and patience!



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Author: David Bergin, Scion

Contact: Tãne's Tree Trust
Website: www.tanestrees.org.nz

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ISSN 2230-3014 April 2011. Revised May 2012.

Printed by Scion Digital Print Centre, Rotorua