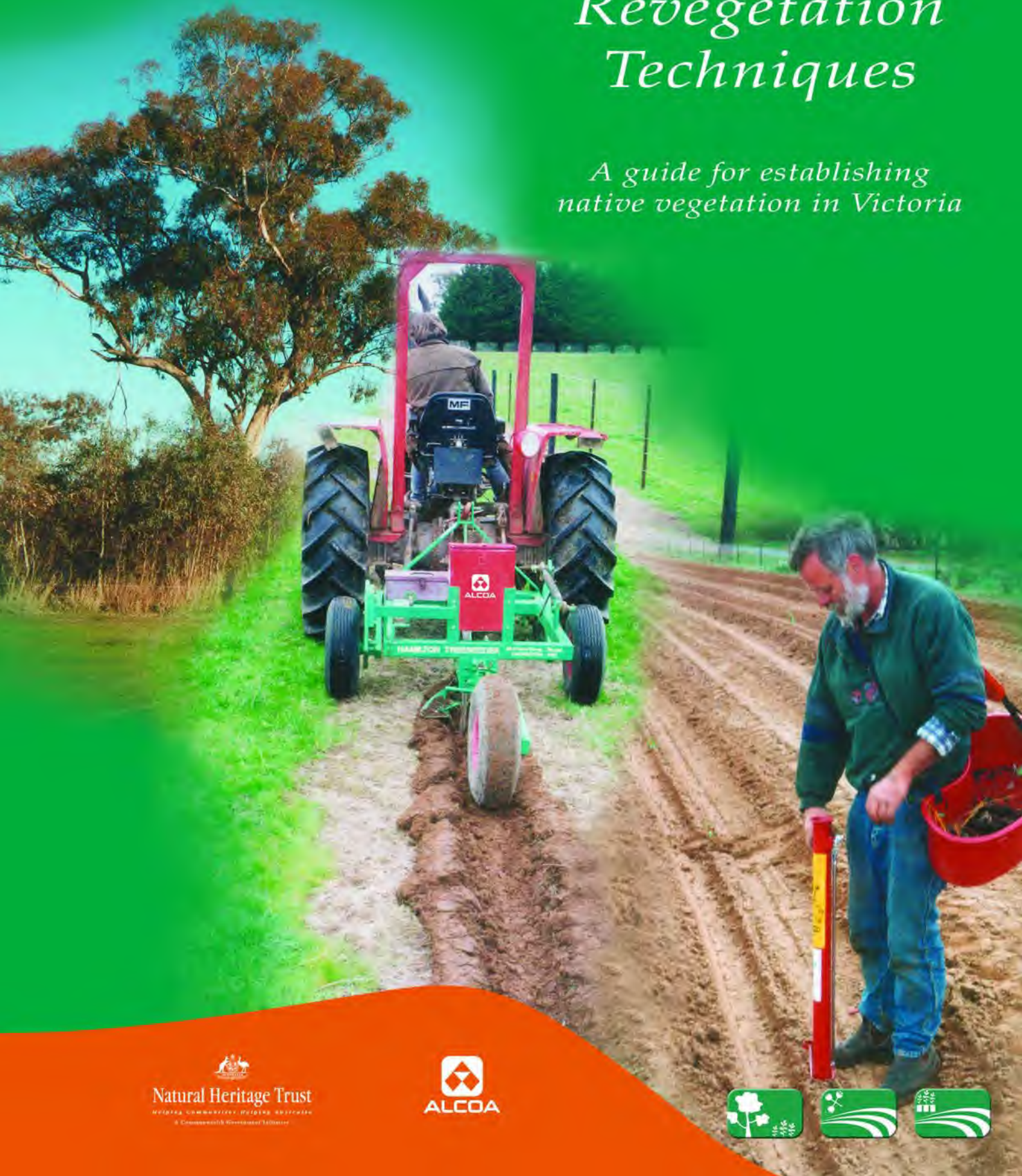
Greening Australia
Victoria Inc.

growingthefuturetogether

Revegetation Techniques

A guide for establishing native vegetation in Victoria



Natural Heritage Trust

ALCOA

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Foreword

Our capacity to conserve, enhance and re-establish native vegetation is vital to ensuring the health of Victoria's future landscape.

Native vegetation provides essential habitat for our wildlife, filters water, keeps erosion and salinity in check, has economic benefits for productivity and adds to the natural character of our environment.

Techniques to establish native vegetation have come a long way. Labour intensive and expensive means of raising trees and getting them in the ground have been replaced with highly efficient and cost effective options of direct seeding, plant propagation and planting.

Revegetation Techniques: a guide for establishing native vegetation in Victoria brings together these methods in the one publication and aims to provide the practical 'know how' to help carry out your revegetation from start to finish.

Most importantly, the information is built upon the innovations and experiences of landholders, community groups, land management agencies and our own staff at Greening Australia over many years. It's what has worked at a local level.

Underpinning these achievements is support from partner organisations. Alcoa World Alumina Australia is a major supporter of Landcare initiatives and Greening Australia Victoria acknowledges its contribution to the production of *Revegetation Techniques* and to the Alcoa Revegetation Assistance Scheme, through which much of the work highlighted in this publication has been made possible.

I am confident that you will find *Revegetation Techniques* to be a valued resource helping to guide and support on-ground action in both your catchment and across the broader landscape.

Rob Gell
President
Greening Australia Victoria

Alcoa World Alumina Australia

For more than 10 years Alcoa World Alumina Australia and Greening Australia Victoria have been partners in the Alcoa Landcare Program. The community links continue to strengthen and the knowledge learned has deepened with time.

Alcoa's Landcare program ethos is to share knowledge, to educate, and to help build stronger communities. The *Revegetation Techniques* guide is a perfect 'fit'.

Our partnership with Greening Australia Victoria has involved a number of projects that have had and are having significant effects on the landscape, including the Alcoa Revegetation Assistance Scheme in which we have built up the largest fleet of revegetation equipment in the State.

In 2002 Greening Australia Victoria calculated that the Alcoa Revegetation Assistance Scheme had contributed to the planting of more than 9,000,000 (nine million) trees and shrubs. These trees and shrubs will also lock up an estimated 2,000,000 (two million) tonnes of carbon dioxide over a 30-year period. That's an impressive outcome.

Throughout the years, members of the community and Greening Australia Victoria have worked together on revegetation projects, learning new things as they went along.

The result is this revegetation techniques guide. It contains the knowledge accumulated by thousands of people who have been our partners in revegetating this State.

Other long-term partnerships with Greening Australia Victoria include:

- the Alcoa Portland Seed Bank that services South Western Victoria's indigenous seed needs;
- the Alcoa Warrambeen Landcare Education Centre that has become a focus in the region for Landcare education and has expanded into areas such as farm safety; and,
- the pilot of Living Landscapes, a recent project that promises great things for biodiversity.

Building community links is critical to the success of projects such as these. The willingness of land managers to be our partners, for example, in the Alcoa Revegetation Assistance Scheme, has resulted in planning and action that has changed the landscape for the better.

We can now all share in the knowledge gained. We hope all who read this guide will find it invaluable for getting the best results in revegetating our State.

Joan McGovern
Community Affairs and Landcare Manager, Victorian Operations
Alcoa World Alumina Australia

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Acknowledgements

Revegetation Techniques: a guide for establishing native vegetation in Victoria is based largely on what has been learnt by landholders and others involved in revegetation at the ground level across Victoria. Thank you to the many landholders and others in giving their time and experience.

Alcoa World Alumina Australia is a major supporter of Landcare across the country. For more than a decade Alcoa has assisted a range of initiatives managed and operated by Greening Australia Victoria including the Alcoa Portland Regional Seedbank, the Alcoa Revegetation Assistance Scheme and the production of *Revegetation Techniques.*

The funding for on-ground works, from the Commonwealth Government's **Natural Heritage Trust** Bushcare Program, has enabled much of the recent work highlighted in this publication to be undertaken. The Bushcare Support Contract has enabled Greening Australia Victoria to develop and build on much of the expertise outlined in this guide. The Natural Heritage Trust's National Landcare Program, Farm Forestry Program, Coastcare and Rivercare programs have also supported revegetation work undertaken by Greening Australia.

Revegetation Techniques is based on the original direct seeding guides produced by Greening Australia in western Victoria and Greening Australia New South Wales. These guides were adapted for the North Central and the Wimmera regions of Victoria and to cover the growing and planting of cell-tray seedlings and the use of mechanical planting machines. Greening Australia Victoria also produced *The Port Phillip Guide to a Successful Community Planting Day* that provided background information. Support for these publications has come from Federal and State government departments as well as Alcoa World Alumina Australia.

Revegetation Techniques has been compiled by Katherine Corr, Project Officer, Greening Australia Victoria. The following staff of Greening Australia Victoria have assisted in the production of this guide and accompanying Footprints Fact Sheet series: Jim Robinson, Ron Dodds, Jason Horlock, Glen Terry, David Millsom, Claire Dennis, Dave Warne, Kate Walsh, David Lockwood, David Curry, Ashley Burns, Karl Dickson, James Scholfield, Doug Phillips, Rae Talbot, Kathryn Schaefer, Daryl Walters, Christine Gartlan, Andrew Pearson, Denis Martin, Vince Andreana, Bronwyn Teesdale, Nadine Slade, Jon Theobald, Glenn Mansfield, David Simondson, David Hill, Brett Spicer and Natalie Moxham. Thank you to Andrew Bennett, Senior Lecturer, School of Ecology and Environment, Deakin University, for his comments.

Thank you to the staff of the Department of Sustainability and Environment, the Department of Primary Industries, the Bushcare Facilitator network and Catchment Management Authorities for their comments. Thank you to the Victorian Indigenous Nurseries Cooperative for allowing photographs to be taken of nursery plant stock and to The Kondinin Group that provided permission for the use of diagrams from its publication *Tree Tops* and to Neville Bonney for providing permission to base the seed pre-treatment table on *Germination Pathways.*

Introduction

There are many benefits to be gained from re-establishing native vegetation in our rural and urban areas. Whether providing shelter for livestock, pastures and crops, creating habitat for native wildlife, improving our water quality, producing commercial opportunities, or improving our quality of life and natural heritage, protecting and re-establishing native vegetation is an important part of the process for achieving sustainable land management.

But there is more to it than picking out a seedling, digging a hole and putting it in the ground. Successful revegetation relies on proper planning and preparation to produce the best results, first time round, ensuring that in each location or situation the right plant goes in the right place, using the right site preparation and revegetation technique at the right time!

Revegetation need not be limited to one technique. There is a range of options available to suit establishment from seed or seedling; these will often be combined, producing a better result. Similarly, revegetation techniques will vary depending on the scale of works, the labour available and the site conditions and needs.

Often, the cheapest form of revegetation will be encouraging **natural regeneration** (germination of self-sown seedlings from existing or nearby vegetation) and should be considered as the first option for re-establishing native vegetation.

Direct seeding is a cost-effective and highly efficient technique, particularly for large-scale projects. Carried out by machine or by hand, direct seeding has many applications and advantages for plant establishment.

Planting of seedlings is another option. Today seedlings can be grown in a variety of containers, to suit the scale and purposes of works and can be planted by machine or by hand.

Retaining the existing native vegetation is of critical importance to restoring degraded landscapes. If lost, it is an expensive, lengthy process to replace many of the components of our native ecosystems. Revegetation builds on, supplements and connects these existing areas.

The selection of species for revegetation should aim to maximise opportunities to provide environmental, economic and social benefits. Local native (indigenous) species, grown from local seeds or plant material are generally the preferred choice for revegetation. They provide the greatest range of long-term benefits because they:

- are best suited to the local conditions and can still fulfill all of the functional roles required of farm trees and shrubs;
- maximise biodiversity in the local area;
- provide the best habitat for local wildlife;
- benefit the health of existing remnants;
- are well suited to regenerating without assistance;
- benefit farm productivity;
- will maintain the natural character of the local landscape.

Where indigenous species are not available, do not meet the project needs, or if the environment at the site has been so modified that local native species cannot survive, for example, highly salt affected sites, other native species may be appropriate.

A strategic approach to revegetation that results in multiple benefits and the creation of a healthy and productive environment into the future is recommended.

Revegetation action in Victoria

Much progress has been made on the ground with the development of revegetation techniques and in raising awareness of the importance of our native vegetation, particularly through programs, such as, the Commonwealth Government's Natural Heritage Trust and the National Action Plan for Salinity and Water Quality.

However, as outlined in *Victoria's Native Vegetation - A Framework for Action* and in the Draft Regional Native Vegetation Plans, more work is needed to help increase our capacity to undertake vegetation protection and revegetation. This guide is a tool to further assist and enable rural and urban communities to achieve on-ground change. By promoting the protection of existing native vegetation, its importance and priority, and the use of indigenous vegetation, this guide supports the goals and guiding principles of the above mentioned plans and policies for the long term survival of our native vegetation.

About this Guide

Revegetation Techniques is a 'how to' guide for establishing native plants from seed or seedlings. The information is based on what has worked at a practical level for landholders, project managers and research organisations.

Section A covers the steps involved in a revegetation program, from planning and preparation to monitoring.

Section B outlines the different techniques available to direct seed or plant seedlings. Natural regeneration, mechanical and hand methods are covered. Section B will also assist you to choose the technique or techniques most suitable for your site and purposes.

Section C provides contacts and resources for further advice and support.

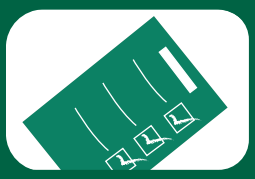
Footprints Fact Sheets is a series of case studies that describe landholder experiences with revegetation and provides on-ground examples of many of the techniques outlined in this guide. Contact Greening Australia Victoria for a copy or download the sheets from our website: http://www.greeningaustralia.org.au

Revegetation Techniques aims to complement regional guides that identify the local species and vegetation communities that should be replaced in your area. This publication should be regarded as a living document that will be updated when new information arises.

We hope you find *Revegetation Techniques* to be a helpful and practical resource.

Footprints Fact Sheet Series

SECTION A:
A revegetation program



1. PLANNING

2. PREPARING THE GROUND

3. PEST ANIMAL MANAGEMENT

4. SEEDS AND SEEDLINGS

5. REVEGETATION

6. SITE MAINTENANCE

7. MONITORING

1. Planning

Projects are successful because of good planning. Projects that involve establishing native vegetation are no exception. Careful planning helps to set objectives, identify tasks to be done, ensures that the resources are available and that activities are undertaken when needed. Planning ensures that the best possible results can be achieved.

Proper planning prevents poor performance!

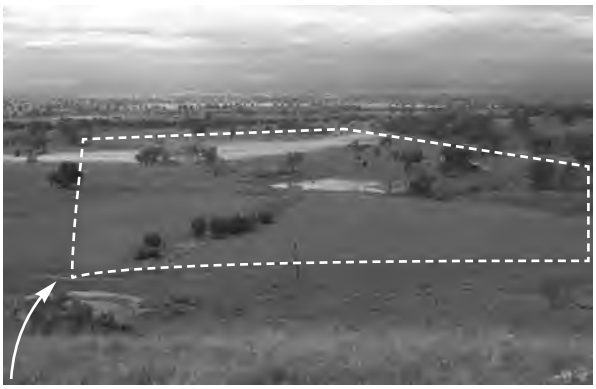
Levels of planning: site, local and landscape

Planning for revegetation occurs at a number of levels:

- the **site level**, where the seeds or plants are going into the ground;
- the **local level**, for example, when revegetation is integrated into the property or farm planning and activities;
- the **landscape level** which may encompass neighbouring farms, parklands, roadsides, rivers and catchments.

Photo: GAV

Site level



Local level

Landscape level

While the focus of this Guide is on techniques for establishing vegetation at the site level, to gain the most benefit, you need to first step back and plan your revegetation from the whole farm or property level and the landscape level.

Local level

Forward planning on a local level, such as the whole farm or property area basis, is a worthwhile undertaking. Whole farm plans or property management plans look at how land uses, such as agriculture, can best come together with infrastructure, such as buildings and fences, and the natural aspects of the land.

Local native (indigenous) vegetation, both existing remnant and planned revegetation, are an important element in planning. Strategically integrating them into the property planning process will help ensure that the time and effort involved will be most beneficial.

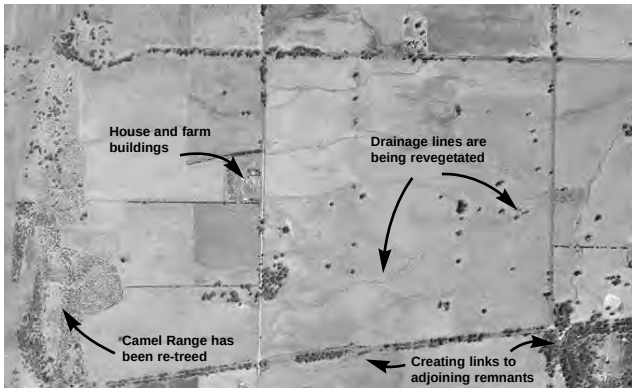


Photo: Permission of T. Hamilton

Above: Aerial view of the Hamiltons' property in the Goulburn Broken region. The family has incorporated revegetation into the planning and operation of their vineyard enterprise. Drainage lines have been fenced and are being revegetated and Camel Range has been re-treed to control salinity and improve production.

More recently Environmental Management Systems are being incorporated into farms to help improve biodiversity conservation and support clean and green production (Section C).

Landscape level

There are many benefits to be gained from linking your revegetation with the activities of others in the broader landscape. Most land management issues are not confined to property boundaries, so a cooperative approach with neighbouring landholders, community groups or other agencies will help to better target efforts and manage issues such as weeds, salinity, water quality decline and habitat loss and achieve greater gains for you and the area.

Aligning your works with the priorities outlined for revegetation in your region will increase opportunities to link to other initiatives and funding assistance.

Further information

The publication *Biodiversity Action Planning*, published by the Department of Natural Resources and Environment, is a good starting point when planning revegetation across different levels. *Biodiversity Action Planning* will help you to locate the most important biodiversity assets of your area and as a planning tool it can direct your actions for maintaining and restoring these areas.

The Native Vegetation Plan and Regional Catchment Strategy for your region is also worth referring to. Refer to Section C for full referencing and availability on the web.

Seek local advice before you begin

Before you start, talk to as many people as possible. The list of resources throughout this guide provide a great start; other sources of information include your local Landcare Groups, field days, training sessions, neighbouring landowners and advisory organisations. Refer to Section C for contacts.

Why do I want to revegetate?

Revegetation is undertaken for a variety of purposes including:

- for shade and shelter, for example, for livestock, pasture and crops;
- for fodder production;
- for timber production;
- for native products, such as cut flowers and foliage, bushfoods, biomass production and medicines;
- to control weeds, for example, Serrated Tussock;
- to stabilise soil;
- to reduce or control salinity;
- to manage pests, for example, attracting native birds to control insects;
- as habitat for native wildlife;
- to enhance rare or threatened species or plant communities;
- to enhance existing native vegetation;
- to reverse tree decline;
- to act as a sink for greenhouse gases;
- to maintain landscapes, for example, Red Gums at Dunkeld and Bulokes in the North West;
- for seed orchards or seed production areas to ensure future seed resources;
- to improve water quality;
- to improve the amenity around homes and buildings;
- for aesthetic reasons, for example, screening unwanted views;
- to create a pleasant living and working environment;
- for social and educational purposes.

An integrated approach to revegetation can achieve many of these objectives, such as, a viable farming enterprise, healthy land and water resources, social benefits and improved biodiversity outcomes.

For shade

To protect and enhance existing native vegetation

Photos: J. Robinson

For fodder, such as saltbush, for livestock

Where do I want to revegetate first?

Once the purpose of your revegetation is identified, you can then select the site where revegetation is most needed. As the examples below show, the purpose will affect site selection.

Purpose: Shelter for livestock

Locate the revegetation at right angles to the severest winds against which protection is required. Often this is along the paddock boundary in a north-south location, to provide the greatest protection from northwesterly summer and southwesterly winter winds, however, this will depend on the landscape. To maximise the benefits from the trees seek local knowledge when siting windbreaks.

Photo: J. Robinson

Stock seeking shelter on the farm

Purpose: To bring back native wildlife

Consider the specific habitat requirements of the wildlife, including the size of habitat and area in which a population needs to live, and food, shelter, nesting and breeding requirements.

You should first protect existing habitats and locate your revegetation to buffer, enhance and enlarge these areas. By viewing things at the farm and landscape level, the revegetation can be used to increase connectivity of habitats both on the property and beyond, to public and private land.

For a farmer in north-west Victoria, encouraging the return of the Mallee Fowl to the farm was one motivation. Read about his story in **Footprints Fact Sheet 30.**

Purpose: Farm forestry for profitability and biodiversity

You can readily integrate farm forestry into revegetation projects on your property. This can provide multiple benefits including biodiversity and profitability, for example, by buffering existing remnants with harvestable timber or planting productive shelterbelts across a property.

Purpose: Control water erosion

Use revegetation projects to treat the source of the problem not the symptom, that is, use water where it falls. Re-establishing trees, shrubs, grasses and sedges will help stabilise erosion sites, such as active gully heads.

Purpose: Control wind erosion

Shelterbelts, particularly those in a regular sequence across farms will help control wind erosion, such as that which occurs with lighter soils in cropping areas.

Purpose: Control salinity

Interception and prevention is better than treatment. Strategically locate revegetation to achieve the greatest outcome in combating salinity, that is, in high recharge areas, for example, Camel Range in the Goulburn Broken area (pictured below). Plan revegetation works in conjunction with neighbours to gain catchment benefits beyond the farm. Revegetation of discharge sites or areas with rapidly rising watertables will require salt tolerant species.

Purpose: Aesthetics

Revegetation should be sited to screen unwanted views or to maintain an outlook. Our wonderful native flora and fauna can be used to create a pleasant living environment for ourselves and for future generations.

Look beyond your boundaries, two projects linked together can be more effective than one!

Camel Range revegetation

What should I know about the site?

No two revegetation sites are the same. The features of each site will determine the species and revegetation techniques required. The best way to get a good understanding of what is occurring at your site and to plan the works effectively is to get out into the field and undertake a **site assessment**. The table below provides a checklist of things to note when conducting your site assessment.

Site assessment checklist

Flora and fauna	✓ Native vegetation	✓ Native wildlife (or evidence of)
	✓ Weeds	✓ Introduced animals and birds (or evidence of)
Soils	✓ Type of soil/s, structure and health	
Other features	✓ Topography and contours (especially steepness and ability to use machinery. Hand revegetation methods may be exhausting).	✓ Aspect ✓ Wetlands, creeks, drainage lines, ridges, escarpments etc.
Land and water issues	✓ For example, erosion by wind or water; salinity	
Infrastructure - above and below ground	✓ Dams, bores, buildings, roads, easements, powerlines, underground cables/pipes etc.	
Access	✓ People, vehicles and machinery. The level of access available will influence the revegetation techniques chosen and the transport of materials, such as plants, across the site.	
Surrounding landscape	✓ What is surrounding the site that will have positive and negative effects on the revegetation?	
Also find out about:		
Cultural, historical and conservation values	✓ Aboriginal ✓ Historical ✓ Rare or threatened species or communities of native plants or animals	
Management of the area	✓ Past and present land uses and management practices ✓ Ownership, planning controls, boundaries etc.	

Site assessment checklist cont.

Beginning your monitoring program

An important component of revegetation is monitoring the site over time and the information collected during the site assessment provides a great starting point or baseline of information for comparison over the years (refer to the end of Section A for greater detail on monitoring).

A part of monitoring is taking photos of the site from a fixed point **(photopoint)**. Take photos at the site assessment stage - over time it will provide a great visual record and a great deal of satisfaction!

Photos: Miller/Munford

These photographs of the Archies Creek Reafforestation Group's Wildlife Corridor project show the value of taking photos over time. The top photo was taken in 1977 and the photo above in 2000, twenty-three years after the revegetation.

Further information

A useful website for information on the natural resource features of Victoria is the Victorian Resources Online website:
http://www.nre.vic.gov.au/vro

Aboriginal cultural heritage

Contacts for more information on traditional Aboriginal Owners and people responsible for cultural heritage include the Mirimbiak Nations Aboriginal Corporation, the National Native Title Tribunal, Aboriginal cultural and heritage organisations and Aboriginal Affairs Victoria. There are also numerous Aboriginal co-operatives and land management businesses based in regional locations throughout Victoria.

Aboriginal Affairs Victoria can arrange site inspections for those planning to undertake large areas of soil disturbance or those wishing to report a possible Aboriginal Heritage Site. Further details and reporting forms are available on the Aboriginal Affairs Victoria (Department for Victorian Communities) website
http://www.dvc.vic.gov.au/aav.htm
Refer to Section C for contact information.

Designing revegetation

The design of the revegetation, including the species chosen, their placement, densities, the shape and size of the works should reflect the objectives of the revegetation.

If multiple outcomes are intended, there are likely to be different requirements to consider in the design of the works. For example, if the primary goal is to create shelter in a paddock for livestock, the plant species, their arrangement and the width and length of the revegetation will be quite different to establishing a block of timber for harvesting or creating habitat for a particular species of bird.

Revegetation design for biodiversity is the focus of the following section. Recommended reading for the design of revegetation for commercial activities, such as farm forestry can be found in Section C.

Designing revegetation for biodiversity

Biodiversity is the variety of life - the different plants, animals and micro-organisms, the genes they contain and the ecosystems of which they form a part. Where all the components are able to interact and function, a healthy environment - from the soil below, to the land and water and air above - can be achieved.

Tips for maximising biodiversity in revegetation

Before considering what to seed or plant, first protect and enhance the existing remnant native vegetation

When it comes to recreating a 'natural' biodiverse landscape, the protection, enhancement and management of existing remnant native vegetation is the highest priority.

Remnant vegetation on properties will contain the remaining biodiversity and the elements of functioning ecosystems that are often the hardest to recreate through revegetation: the fungi and soil microorganisms, lichens, mosses, herbs and ground covers.

Remnants, whether in good condition or degraded, are in most cases much easier and cheaper to restore than recreating new areas from scratch. Even a single dead tree or a patch of native grasses provides some 'building blocks'. So take a closer look at what is left and protect and enhance that first. Remember, the visible vegetation is probably just the tip of the iceberg!

River Red Gums, such as this one north - west of Melbourne, are a rare find and are a priority for protection.

Protect hollow-bearing trees and include these species in your revegetation

Many paddock trees may be 200 years old or even older. Their hollows, crevices, twisted bark and branches attract a great diversity of wildlife; they are particularly important for hollow-dependent animals. It can take about 100 years for hollows to form in Eucalypts to a stage where they are useful for wildlife (Ambrose 1982, Land for Wildlife 1990; Mackowskil as in Robinson 1992). Protecting paddock trees and others so that they can mature and bear hollows is vital. Including species that will form hollows in the future should also be part of revegetation activities.

Hollows provide valuable habitat

Select indigenous species - they offer multiple benefits

The basic criteria for the selection of species are that the plants:

- are suitable for the site conditions;
- will achieve the objectives of the planting;
- will last on the site.

The use of **indigenous** species which are native to the local area and that are grown from local seed or cuttings are recommended as the first choice for revegetation. Indigenous plants, rather than species from other areas, regions, states or countries have many advantages for the landholder and environment.

These advantages include that they:

- are best suited to the local conditions, for example, they are adapted to the soils, rainfall patterns and frosts and can survive droughts, flood and fire whilst still performing the functional roles of farm trees and shrubs;
- maximise biodiversity of the local area;
- provide the best habitat for local wildlife;
- benefit the health of existing remnants;
- are well suited to regenerating without assistance;
- benefit farm productivity by, for example, providing shade and shelter for stock, habitat for insect eating birds for pest control, and filtering runoff;
- will maintain the natural character of the local landscape.

Protecting and enhancing our existing native vegetation and supplementing these areas with indigenous species in revegetation is important. Our native vegetation plays a vital role in the sustainable use of land and water including: preventing erosion and filtering runoff, supporting our economy and providing benefits for agricultural enterprises, and assisting the survival of our native flora and fauna.

Other considerations

Some local native species will be better suited than others in helping you meet your revegetation objectives. On some sites, where conditions have been substantially modified, for example, by salinisation or waterlogging, the benefits of indigenous plants may be reduced and non-local native plants may be preferable.

Refer to Section C for a listing of information notes for further information.

Developing a species list for your site

There are a number of avenues that may assist you in the development of a species list.

- Identifying the existing native vegetation (remnant) that is growing on or near a site is a good starting point. Seek assistance from your regional Greening Australia officer to help identify what is growing on your property.
- Vegetation mapping across the state has been undertaken by the Department of Sustainability and Environment and has produced what are known as **Ecological Vegetation Classes**. This information can point you in the right direction for finding out what species may naturally occur in your area. Contact your local Department of Primary Industries or Catchment Management Authority office for help in identifying the vegetation types that occur (or were likely to have occurred) on your property and their constituent species suitable for revegetation.
- Consulting local species guides for your area is recommended. In most catchment management regions of Victoria, indigenous plant guides have been produced that can assist with the selection of species. These usually list plants by locality and land system or soil type as well as by their location in the landscape, for example, along creeks or gullies or on dry ridge tops. Local publications are listed in Section C.

Photo: J. Robinson

This photo illustrates the value of using local plants from local material. The background vegetation is regenerating Swamp Paperbark (*Melaleuca ericifolia*), near Foster (South Gippsland).
The small tree in the foreground is a planted Swamp Paperbark from a NSW source. Same age, very different performance!

Establish the right species in the right place for the best results

Aim to put species where they would have naturally grown. This means matching species with soil type, aspect and where they occur in the landscape. For example, plant local species that favour wet sites in gullies or along creeks; plant species that tolerate dry conditions on slopes and ridge tops. Regional revegetation guides are helpful references for this, as is the Ecological Vegetation Class information for your area.

Consider the ratio and densities of different plants being established

The ratio of trees to shrubs and ground cover plants, and their densities will depend on the type of vegetation community being created. As a general rule, for what were originally forest environments, a 20% overstorey of trees and an 80% understorey of shrubs and ground covers is suggested. For grasslands or grassy woodlands, the ground layer would be an even greater percentage.

It is best to seek local advice to determine the most appropriate spacing of plants for the vegetation community that you are creating. The Department of Sustainability and Environment is developing guidelines for revegetation. These will provide a guide to the minimum plant density and structural diversity required for revegetation proposals based on a defined Ecological Vegetation Class benchmark. More information can be obtained from the Department of Sustainability and Environment website, http://www.dse.vic.gov.au or by contacting your local Department of Primary Industries or Catchment Management Authority office.

Find out the ratio of trees to shrubs and grasses for the vegetation community you are establishing - a grassland will be very different to a forest.

Maximise the diversity of your revegetation

Structural diversity

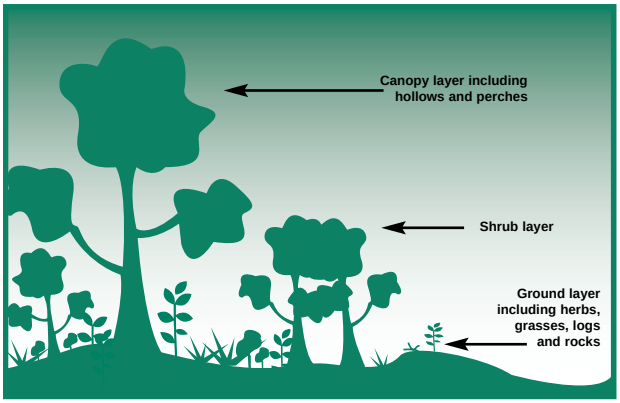
To achieve structural diversity use vegetation of different heights (canopy, shrubs and ground layer), growth forms (bushes, trees, climbers, grasses) and foliage (for example, prickly species) **that would have once occurred at the site**, including those that provide nesting opportunities and future hollows for wildlife.

Species diversity

To achieve species diversity include as broad a range as possible of the original species **(Ecological Vegetation Class)** that would have occurred on the site. This should maximise the diversity of fauna habitats created.

Include non-living elements

Leave existing rocks, logs, fallen fence posts and leaf litter for wildlife to forage in, and dead trees to provide hollows and perches.



Structural diversity in revegetation

Maximise the structure and foliage diversity and include the non-living elements such as fallen branches and logs.

Maximise vegetation connectivity

Many of the remaining patches of bush, now occur as fragments across the landscape. As a result, many species of native wildlife are unable to travel between remnants. Healthy ecosystems are more likely to exist where there are effective linkages to other areas of vegetation allowing the movement of birds and other animals and facilitating the pollination of native plants.

Revegetation efforts which seek to provide connectivity need to consider the requirements of different fauna. Different animals will prefer different levels of connectivity, from unbroken links (corridors) to scattered trees (mosaics) (Bennett, Kimber & Ryan 2000). A single line of trees will have little benefit as a corridor for most species, however, a linear corridor at least 20 to 50 metres wide will have greater benefits (Bennett, Kimber & Ryan 2000).

Connectivity should be considered at the property and landscape level. Creating links to remnants on neighbouring properties, roadsides, grasslands, streams or public land greatly enhances the network of habitat.

Photo: GAV

This landholder in Victoria's Wimmera is using direct seeding and hand planting to link Black Box (*Eucalyptus largiflorens*), Buloke (*Allocasuarina leuhmannii)* and Yellow Gum (*Eucalyptus leucoxylon)* remnants within the property and to road reserves beyond his boundary. **Read Footprints Fact Sheet 26 for the full story.**

Consider the size and shape of the revegetated area

Protecting and creating larger vegetation blocks and areas should support more of an individual species and often a greater diversity of species too (Johnson & Don 1990). Alternatively, a combination of smaller, different habitat types, such as a creek gully and nearby rocky rises will support a greater range of species than a single type of habitat (Johnson & Don 1990).

Focal Species Approach

The Focal Species Approach is a tool for landscape planning in rural areas. This approach, developed by Rob Lambeck from the CSIRO, identifies the needs of the most sensitive species of native animals in a local area in terms of habitat and space requirements: the focal species. It then identifies what needs to be done to ensure their long term survival, for example, the minimum habitat size required. By meeting the needs of the most sensitive species, the requirements of many others will be met at the same time. This helps ensure that revegetation efforts are strategic and beneficial to biodiversity (Collis 2002; Bennett, Kimber & Ryan 2000).

Further information

Further information on the Focal Species Approach in action can be obtained through Greening Australia staff based in south-west Victoria. Also refer to the references in Section C.

Biodiversity Action Planning and Landscape Plans, that identify fauna species with more demanding requirements, thereby making good focal species, are helpful references. Refer to Section C.

Promote a patchy design

If the purpose of the revegetation does not require ordered rows or spacings of plants, create a natural effect with clumps of vegetation, small clearings, different heights and ages of vegetation. This will provide greater opportunities for wildlife (Bennett, Kimber & Ryan 2000).

Consider staged revegetation and succession

Rather than reinstating a wide range of overstorey and understorey species at once, revegetation projects may opt for staged revegetation. Staged revegetation may be the best way to outcompete weeds. For example, it may be preferable to get the overstorey established first to shade out an exotic understorey and then come back and in-fill with understorey species. With a grassy woodland, efforts might concentrate on weed control to encourage the native grass understorey to return and then follow up with overstorey planting later.

Pioneer or **colonising species** play an important role early on in the development of vegetation communities and ecosystems. Wattles (*Acacia* spp.), Cassinias (*Cassinia* spp.), Fireweeds (*Senecio* spp.) and Kangaroo Apples (*Solanum* spp.) are all colonisers useful in the early stages of succession of vegetation. They establish easily after disturbance, for example, fire, and grow quickly under sunny conditions, often providing the ideal protection and environment to aid the establishment of longer-lived, slower-growing species.

Further information

Revegetation and Wildlife - A guide to enhancing revegetated habitats for wildlife conservation in rural environments by Bennett, Kimber and Ryan is recommended.

Pioneer species include Kangaroo Apple (*Solanum laciniatum*) above and Golden Wattle (*Acacia pycnantha*) below

Golden Wattle (*Acacia pycnantha*)

Value of wetlands and grasslands

Wetlands

A wetland refers to areas of marsh or water that are permanently or temporarily inundated, fresh, brackish or salt and can be artificial or natural (Ramsar Convention in Cameron 1994). On a farm, wetlands may include the farm dam, a swamp, bog, lake or billabong.

From both a conservation and economic point of view, wetlands have many benefits. They attract and support a wide variety of wildlife including birds, frogs, fish and invertebrates as well as water plants and some trees. They help with water filtration and improve water quality, improve water flow and support many birds, including insect eaters, that feed on crop pests.

Wetlands have numerous benefits - for wildlife, water filtration, water quality and aesthetics

Further information

To create or enhance an existing wetland, refer to the contact points and further information listed in Section C. Find out how a farmer recreated a wetland habitat on his property, in south-west Victoria in **Footprints Fact Sheet 17.**

Grasslands

Native grasslands and grassy woodlands are our most threatened vegetation communities. Landholders are encouraged to appropriately manage what is remaining to protect and enhance their conservation values.

Apart from providing habitat for native plants and wildlife, grasslands also have economic benefits. They are drought-resistant, they can be incorporated into farm production systems as native pasture, they are able to cope with low-nutrient, acidic and saline soils, they provide cover to prevent erosion and they provide habitat for pest controlling wildlife.

If reasonably intact grassland plants or ground flora are still present, any revegetation should ideally involve minimal disturbance. Techniques are still developing to re-establish native grasses on a broad scale. Methods for successful sowing that can apply to particular species are still needed.

Photo: J. Robinson

Grasslands are a precious resource

Further information

For further information on native grasslands, their protection and re-establishment, refer to the contact points and information listed in Section C. *Grassy Guidelines: How to manage native grasslands and grassy woodlands on your property* by Tim Barlow is recommended.

Also, read about the re-establishment of native grasses on a Corangamite property in **Footprints Fact Sheet 15.**

When is the best time?

Timing is a key consideration throughout the whole process of establishing vegetation. Identifying the appropriate timing in your area for seed collection, site preparation, seeding and planting for the species and site conditions involved is essential.

The timing of seeding and planting is site specific and heavily dependent on thorough weed control and soil moisture conservation. Ideally, seeding or planting is undertaken when the ground is still moist and soil temperatures are starting to rise. Thorough weed control will often widen the 'window-of-opportunity' for planting or seeding. The general principle to follow, given good weed control, is the lower the rainfall, the earlier the direct seeding or planting. As seasons can be variable, having preparation completed well in advance enables revegetation to occur when the conditions are most favourable.

Individual species may also have their own requirements for germination, for example Sweet Bursaria (*Bursaria spinosa*), Prickly Currant Bush (*Coprosma quadrifida*), Tree Violet (*Hymenanthera dentata*) and Cypress-pine (*Callitris* spp.) amongst others are known to germinate during the short, cold days of winter and therefore should be sown in early winter, not spring, to be certain they receive the required environmental triggers for germination.

The following table is a guide for the timing of activities in areas of medium to high rainfall and semi-arid environments. The timing of the activities should still be tailored to the local environmental conditions. At the site level, it is recommended that planning, and in some cases preparatory on-ground works, such as seed collection, plant orders and weed control, begin more than a year before seeding or planting.

Guide to timing of revegetation activities

Activity	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
1. Planning*									
2. Preparing the ground									
Soil preparation									
Weed control*									
3. Pest animal management									
Pest control									
Fencing									
4. Seeds and seedlings									
Seed collection, cleaning and ordering*									
Plant orders and propagation*									
5. Revegetation									
Natural regeneration									
Direct seeding and planting									
6. Maintenance									
7. Monitoring									

Refers to the timing of activities for both semi-arid and medium to high rainfall environments

Refers to medium to high rainfall (500mm plus p.a.) areas only

Refers to semi-arid (250-500mm rainfall p.a.) areas only

*These activities should commence in advance of the seasons shown. Ideally:
- begin planning two or more years ahead of seeding or planting;
- start weed control at least twelve months prior to seeding or planting or earlier depending on the site;
- order seed two years before seeding or planting;
- order plants at least twelve months prior to planting.

What resources are needed?

An important part of planning your revegetation is determining what resources are required, how you can source them and their cost.

Factors will include:

- **time** - planning, preparation, revegetation, follow up maintenance and recording;
- **budget**;
- **materials** - seedlings, seed, stakes and guards and fencing;
- **equipment** - seeding or planting machinery and planting tools;
- **knowledge and skills** - fencing, seed collection, plant identification, site preparation, direct seeding and weed control;
- **labour** - fencing, seed collection, site preparation, direct seeding and planting.

There is help available!

There are a number of avenues that you can explore that may assist with resourcing your revegetation.

Funding initiatives, grants and incentives are available to assist landholders and groups with revegetation. Contact your local Catchment Management Authority.

Regular **training** days are run by organisations in regional and urban areas, including Greening Australia Victoria and Landcare, and cover a wide range of topics from native plant identification to planning your revegetation project to seed collection and direct seeding. Contact Greening Australia Victoria for details.

Linking in with local Green Corps activities (teams of young people participating in environmental and cultural heritage projects across the country) may assist you with **labour support** for your project. Also, community events that attract volunteer support from the local area, such as the Spring Planting Festival in Greater Melbourne and planting weekends in rural Victoria, may also be able to facilitate community support for your planting.

Equipment and machinery can be sourced through the Alcoa Revegetation Assistance Scheme and Community Equipment Support Scheme managed by Greening Australia Victoria.

Further information

Refer to Section C for contact information and resources to support your project.

2. Preparing the ground

The successful establishment of vegetation is dependent on two key activities:

- site preparation leading up to seeding or planting;
- site maintenance following seed germination or planting.

A well prepared site will provide the best conditions for plant germination, survival and growth. This means early weed control and choosing the type of soil preparation which best suits the site and revegetation technique.

Ideally, site preparation should begin at least twelve months before seeding or planting, even earlier depending on the condition of the site. It is worth the effort to get the preparation right because the degree of site maintenance afterwards will largely reflect how good the site preparation was at the start.

Options for weed control, including chemical and mechanical methods, and soil preparation methods such as ripping and mounding are outlined below. The appropriateness of each method will depend on the site itself and the ground preparation required for each revegetation technique.

An important consideration will also be the level of invasiveness or disturbance created by the preparation. For example, in a sensitive area such as a site with some relatively intact native ground covers/grasses, the lowest form of disturbance should be chosen if revegetation is necessary.

Note: The techniques promoted in this guide are those that are the most efficient and cost effective to achieve success. The aim is to make revegetation as cost effective and easy as possible for landholders and to stretch any funding dollars as far as possible.

Photo: K. Walsh

A well prepared site ready for mouldboard ploughing in South Gippsland (above) and for mechanical planting in Corangamite (below)

Photo: J. Robinson

Weed control

Weed control is usually the most important factor for the successful establishment of vegetation. Weeds compete for and use up the soil moisture and nutrients that would otherwise be available to the native seedlings. The survival of plants can be expected to increase from nothing to 100% and growth rates to increase by 70% with adequate weed control. All weed control must be approached professionally and be timely.

Step by step guide to weed control

Step 1: Assess the problem

In order to target the control effectively, it is vital to:

- identify the weeds present;
- understand their habits and life cycles, for example, when do they grow, flower and seed? Are they annuals or perennials, grasses or broad-leaved weeds? How do they spread?;
- determine the scale of the problem (Dreher & McPhee 1994).

Step 2: Consider the control options

There is a range of weed control options available for small and large-scale revegetation, including chemical, mechanical, manual and biological methods. Reviewing land management practices and using them as part of your weed control strategy is a very effective, cost effective option, for example, grazing to reduce weed seed set. Similarly, the process of revegetation itself can also be effective in controlling weeds, for example, using competitive indigenous species to outcompete the weeds following initial weed control.

This guide does not recommend one treatment over another but does advocate taking the 'softest' approach possible, that is, use chemicals only if other treatments are less practical or effective for the job.

Photo: J. Horlock

Scalping as part of the direct seeding operation (below left), hand cultivation (above) and chemical use (below) are three methods of weed control

Handheld Rope Wick Applicator being used to target weeds in an urban revegetation bed comprised of Spiny-headed Mat Rush (*Lomandra longifolia*)

Step 3: Undertake the weed control

Whatever treatment or treatments chosen, the long-term success of weed management relies upon:

- timeliness (control prior to weed seed set);
- minimising disturbance during the weed treatment;
- replacing the space occupied by weed species with desirable plants;
- follow up monitoring and treatments (Horlock 1998).

Ideally:

- a minimum of two weed control activities should be undertaken prior to vegetation establishment and weed control should be continued until the desirable plants can adequately compete against the weeds;
- weed control should commence at least twelve months prior to sowing or planting or even earlier depending on the weeds present, for example, Phalaris (*Phalaris aquatica*), Fog Grass (*Holcus lanatus*), Blackberry (*Rubus fruticosus*) and Gorse (*Ulex europaeus*).

The importance of thorough weed control prior to seeding or planting can not be over stressed.

Chemical control

One of the main reasons why herbicides are used for the preparation of large-scale revegetation areas is that they are a cost-effective and efficient option compared with mechanical or manual methods. Herbicides can also be used selectively, with precision, in difficult topography and are often the only effective method for weeds that are difficult to control.

There are a range of chemicals, formulations and equipment available to match different, specific requirements of weed control. For example, low volumes can be applied in droplet applications, small areas can be sprayed using a knapsack sprayer and in larger accessible areas, a boom or hose line can be used.

The most commonly used herbicides for pre-planting weed control are **translocated (systemic) knockdown herbicides**, such as glyphosate (the active constituent in products such as RoundUp®). These control a broad spectrum of plants (including seedlings) and are readily absorbed and circulated throughout the plant.

Knapsack (above) and shielded boom spraying behind a four-wheel motorbike (below)

Photo: GAV

Contact herbicides are another type and are effective on those parts of the plant they touch, while **selective herbicides** will only target certain plants, for example, some will only control narrow-leaved plants such as grasses, while others will control broad-leaf weeds.

Residual or pre-emergent herbicides are absorbed by seeds and/or via the root system or leaves of young plants and prevent their establishment. Residual herbicides persist in an active form in the soil following application and can extend the period of weed control and prevent seed germination. **However, they can cause long term detrimental impacts if used inappropriately**. Experienced operators and a high level of caution are essential.

Note: Residual herbicides will affect the choice of direct seeding method chosen, for example, residuals cannot be applied as a site preparation with the mouldboard ploughing technique. The layer of soil contaminated by the residual or pre-emergent herbicide will need to be removed or scalped prior to direct seeding. However, this will not guarantee that the residual herbicide will not move through the soil bank into the scalped seedbed. Seek advice about your soil type and environment before applying residuals.

Take the softest approach possible

The use of chemicals for weed control should be approached with care and should aim to produce acceptable levels of control with the minimum use of herbicides. Similarly, it is suggested that they be used only if other forms of treatment are less practical or effective for the job.

Handle chemicals safely

- Always comply with Occupational Health and Safety Standards
- Seek expert advice
- Obtain the required permits before undertaking any works

It is strongly recommended that a Farm Chemicals Users Course be undertaken prior to chemical handling. An Agricultural Chemicals Users Permit (ACUP) is needed to use restricted chemicals, for example, dangerous poisons (Schedule 7 poisons).

Refer to Section C for more information. Contact your Regional Chemical Standards Officer from the Department of Primary Industries for chemical advice in your region.

An example of an ideal chemical weed control program using a knockdown herbicide in a spring seeding or planting program*

Spray	Timing	Purpose
Spray 1	Spring in the year before seeding or planting	Prevent seed set in the existing weeds. This may also weaken hard to manage perennials such as Phalaris.
Spray 2	Ideally after the autumn break or the first rains of the season (if there are any!)	Control seedlings that germinate after the break. Be aware that knocking out the first pasture weeds will create ideal conditions for seeds of the broadleafs to germinate.
Spray 3	6-12 weeks after spray 2	May be worth considering controlling any new seedlings that have emerged or are emerging.
Final spray at seeding or planting	A final spray may be able to take place immediately before seeding or planting, however, always adhere to the label recommendations. Also, if the revegetation technique is manual, wait for the recommended time after spraying before allowing people onto the site (adhere to the label instruction). The final spray at seeding or planting may include an insecticide, for example, for Red-legged Earth Mites; again, always adhere to label recommendations.	

*Adjust the timing to suit local conditions. The example is only a guide and will not be appropriate or practical for every situation. What it does highlight however, is the forward planning needed to control weeds prior to seeding or planting.

For spot spraying, spray circles one to two metres in diameter and for strip spraying, spray one to two metre widths.

If incorporating a residual or pre-emergent herbicide, the second spray after the autumn break is the usual timing. It is important to observe the '25 25' rule. Either 25 days or 25 millimetres of rain should intervene between spraying the residual and planting or seeding. Again, seek advice from your supplier and adhere to label recommendations.

Prevention of seed set

For annual weeds, the prevention of seed set can assist weed control. Some chemical and non-chemical methods include:

- spray topping - treating the seed heads with herbicide at low rates before seed maturity;
- pasture topping - removing seed heads mechanically before seed maturity;
- strategic grazing - stocking the area (if appropriate) heavily before seed set.

For perennial weeds, chemical control is more likely to be necessary (Dreher & McPhee 1994).

Mechanical and manual control

Do you know what's below the surface?
DIAL BEFORE YOU DIG
PHONE 1100
This service provides details of the pipes and cables for gas, water, electricity and phone lines at your site (allow at least 2 - 3 days for the information to be forwarded to you).

There are a range of mechanical and manual weed control options available and there will be one to suit the scale of weed control required and the needs of the site. A number of the options are described below.

Scalping

Scalping involves the removal of the weed seedbank in the top soil by machine or hand.

For this technique to be effective the soil must be scalped to a sufficient depth to get below the weed seedbank. The precision direct seeding machines undertake this form of weed control as part of the seeding operation. Grader blades and bulldozer blades have also been used (refer to Section B, Deep scalping of steep slopes). Scalping for spot sowing can be undertaken by hand using a rake hoe.

While an effective method of weed control, scalping is not recommended on hilly terrain that may erode. It is also important to be aware that everything is being taken away (good seeds and soil microorganisms, along with the bad). It is essential, however, if sowing and using residual or pre-emergent herbicide.

Photo: GAV

Photo: GAV

Scalping being undertaken as part of a direct seeding operation (above) and manually with a rake hoe in readiness for spot sowing (bottom left)

Cultivation

The use of a spring-tyned harrow (not a plough) can be used to maintain a weed free site. A mattock or hoe, for small scale sites may be effective to dig out weeds.

Photo: J. Horlock

Cultivation

Cultivation

Revegetation techniques that require a 'bed' situation may benefit from cultivation. However, this cultivation is not normally recommended prior to direct seeding. Cultivation will mix weed seeds through the soil profile and hence limit the benefits of the shallow scalping undertaken by precision direct seeding machines, namely, removal of the weed seed bank in the top soil.

In any event, direct seeding is an ideal technique for large-scale works. Minimising the number of passes necessary with machinery is fundamental to its usefulness, particularly if that activity, such as cultivation, is counter-productive!

Slashing

The use of a slasher or mower can be used to cut weed growth following flowering and prior to seed set.

Photo: J. Horlock

Slashing

Heat

Flame or steam weeders use high temperatures to 'cook' the top growth. The plants have no defence against the heat. Contact your local agricultural or horticultural supplier.

Smothering/Mulching

Covering weeds with mulch, newspaper or other materials. This is best suited to small-scale projects. The material must effectively block out light and/or smother the growth of weeds.

Mulching at planting can have the added benefit of assisting seedling growth by conserving soil moisture by reducing evaporation and improving water infiltration. Organic mulches, such as leaf litter, prunings, wood chips and organic jute mattings can also improve soil structure and modify soil temperatures which lead to improved plant growth.

Tips for mulching

- Ensure that the material is weed free and that the product will not cause any harm to the seedlings (aging or composting prior to use is recommended for freshly-chipped mulches that may otherwise cause nutrient deficiencies in the soil or that contain toxic phenols or resins that could harm seedlings).
- Keep the mulch clear of the seedling stem to prevent collar rot.
- Obtain good coverage and thickness (this will depend on the mulch type, however, it should last for at least a year).
- Anchor any weed mats or newspaper mulches.

Note that thick mulches will limit opportunities for natural regeneration from seed fall from revegetated plants.

Photo: J. Horlock

Smothering to control weeds

Hand removal

Weeding by hand can be a simple and effective method for small-scale projects, if carried out regularly. Care should be taken to create minimal disturbance and to remove all plant parts capable of re-growth.

This technique does not prevent growth of new weed seedlings and should be undertaken prior to the weeds flowering and producing seed (Horlock 1998). Use of gloves is recommended for poisonous or irritating plants, for example, nettles.

For more information on hand removal refer to *Bringing Back the Bush: The Bradley method of bush regeneration* by Bradley (see Section C).

Biological control

Biological control is the use of organisms to control weeds or pests. Find out if biological control options have been trialled in your area. Contact your local Department of Primary Industries Office (See Section C).

Land management and revegetation options

A change in land management may be an option to control weeds. For example, ceasing fertiliser application in a particular area may, over time, change the balance from a nutrient-rich to a nutrient-poor environment, favouring the return of indigenous species over exotic species.

Another option is suppressing weed growth with dense plantings that enable the indigenous species to outcompete exotics for sunlight, moisture and nutrients. This can link into a staged revegetation program where short-lived colonising species that grow quickly can be strategically planted to help control weeds and establish the optimum conditions for other longer-lived, slower-growing indigenous species, for example, direct seeding, at high rates, of leguminous Wattles and Pea shrub species. Similarly, in South Gippsland, Cassinia species have been used as colonisers to out-compete weeds such as Ragwort (*Senecio jacobaea*) between planted-sown rows of indigenous seedlings. In northern Victoria, timely grazing of grassy weeds has allowed the return of native pasture systems that, in turn, have outcompeted annual, broad-leaved weeds such as Paterson's Curse (*Echium plantaginuem*).

Soil preparation

In some areas, soil preparation will be required to produce loose, well drained and aerated soil ready for plant establishment. Various soil preparation techniques are described below.

Deep ripping

Ripping is recommended to assist root development by re-aerating clay-loams, clay soils, hardpans, or compacted soils. It aims to shatter dry subsoils, allowing easy and rapid root growth laterally and to depth, and to improve infiltration. Doing so, will increase plant survival, vigour and stability.

The loosened and friable soil conditions provided by ripping are also often required for the efficient use of manual planting tools and mechanical planters.

In order to optimise the shattering effect, ripping should be undertaken when the soil is relatively dry (summer or after the autumn break). Ripping in the autumn, some months prior to a spring planting will allow time for rain events and soil settling thereby minimising any large air pockets between soil clods. Similarly, driving a tractor wheel over the ripped lines is also recommended to reduce surface disturbance and help break up soil clods and produce soil 'fines'.

Proposed seeding or planting lines should be ripped to a depth of 30 to 60 centimetres where possible. Broad width and depth of soil shatter can usually be achieved with a winged, single tyne ripper. However, it may be preferred to double rip two lines 50 centimetres apart and plant-seed between the rip lines.

Equipment

Ripping is usually done with a bulldozer or three-point linkage, tractor-mounted, ripping tyne(s). For the correct use of winged ripper-tynes that produce broad width of subsoil shatter at 30 to 60 centimetres deep it is essential to have adequate horsepower. When ripping, try to avoid bringing infertile subsoil to the surface as this can inhibit seed germination.

Soil type and environment

Ripping is **not recommended** in the following soils or environments:

- waterlogged areas or wet soils;
- deep soils;
- streamsides/streambanks;
- cracking clays;
- sites where there is a high level of intact native ground flora.

In clay or sodic soils, it is best to use gypsum and chisel plough these sites. In self-mulching, cracking soils, ripping is not sufficient and can in fact be deleterious leading to subsequent problems (refer to mounding). Ripping is generally of no benefit with deep sands, however, in non-wetting sands ripping may be beneficial due to the mixing of the soils during the operation. Ripping along contours is recommended for hilly sites, particularly for highly erodible soils. It is recommended that you trial an area first to determine the worth of ripping, particularly on different soil types.

Level of disturbance

Deep ripping produces a high level of soil disturbance which may make it an inappropriate method for soil preparation on some sites.

Photo: GAV

Deep ripping using a single tyne ripper to achieve loosened and friable soil conditions

Mounding

Mounding is a soil preparation commonly used for heavy soils, waterlogged or saline soils or for farm forestry. Mounding is critical for moderate to highly saline soils.

There are four main reasons for mounding:

- to improve drainage and soil aeration, for example in waterlogged sites;
- to build up a friable soil bed to allow rapid root growth, for example, in farm forestry sites;
- to combat cracking soils - this is done by developing a rip line, mounding soil over the line and planting into the mound;
- to combat saline soils using an **m-profile** - to date in Victoria, m-profiling has mainly been used in some salinity-affected areas in North Central Victoria (refer to Section B Specialist direct seeding techniques).

Mounding does tend to facilitate faster seedling establishment and growth and therefore reduce ongoing maintenance, particularly weed control. When undertaking direct seeding ensure the mound is well formed.

Equipment

There are several specialised mounding ploughs available, for example, the Rippa Mounder and the Merbein Plough. The Rippa Mounder has a shallow ripper at the front and discs behind and the Merbein Plough has three parallel sets of discs. When using the Merbein Plough, rip then plough. Offset disc attachments on some of the direct seeding/mechanical planting machinery can also create mounds.

It is best to spray, rip and then mound. Mounds should be created at least six months in advance of any seeding or planting to enable the mound to settle and, in saline areas, to allow salts to flush out of the m-profile. Cultivation*, prior to mounding, facilitates the creation of well-formed mounds.

*Refer to note on cultivation on page 35.

Soil type and environment

Mounding is undertaken in an area where a greater volume of friable soil is required to facilitate early plant growth, for example in saline and waterlogged areas.

Level of disturbance

Mounding produces a high level of soil disturbance which may make it an inappropriate method for soil preparation on some sites.

Read about landholder experiences with ripping and mounding as methods of site preparation in Footprints Fact Sheets 1 and 18.

Photo: GAV

Merbein Plough (above) and Rippa Mounder (below) in action

Photo: C. Dennis

High pressure water injectors

An alternative to ripping is the use of high-pressure water injectors. Powered by a fire-fighter pump and water tank, this hand held injector is charged with water and blows holes into the soil, ready for planting. It also has the added benefit of loading up the soil profile with water. Once the holes are created, they can then be planted.

This method is particularly useful in hard to access sites, for planting 'long stem' seedlings in river beds or for use in dry areas. As an establishment technique it is slower than planting with manual tools (Pottiputkis or Hamilton Treeplanters) and greater time should be allowed or smaller scale works planned if this technique is to be used.

Soil type and environment and level of disturbance

High-pressure water injectors can be utilised in a wide variety of environments, from sandy to clay soils. This technique provides the benefits of ripping with a low level of disturbance.

Read about landholder experiences with high pressure water injectors in Footprints Fact Sheets 30 and 34.

Photo: GAV

High pressure water injector being used for planting along a rip line to load up the soil profile with water

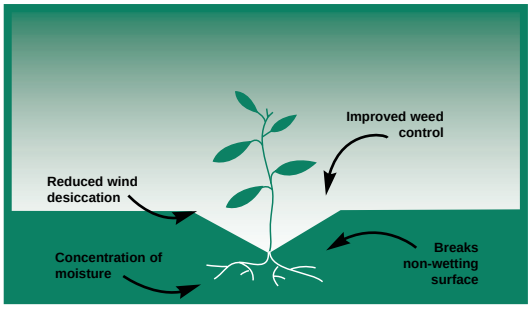
Water harvesting

In low rainfall areas, water can be harvested to enhance plant establishment. Grading the surface of the soil at an angle along the contour and pushing it into a low embankment enables water to pool behind the bank. As shown in the diagram (below), the seedlings are planted into the rip lines on the slope, at the edge of the pooled water (Casey & Chalmers 1993).

Water harvesting in low rainfall areas may be beneficial

Furrow lining

In non-wetting sands, furrow lining is a technique which can be used. The process involves deep ripping and then creating a furrow which can be 300 millimetres deep and up to one metre across. With the non-wetting sands removed from the soil surface, the rainfall can penetrate into the wettable soil below, where the seedling has been planted. To reduce erosion, create the furrow line across the direction of any potential damaging winds (Casey & Chalmers 1993).



Furrow lining in non-wetting sands may be beneficial

Diagrams reprinted from *Tree Tops: the tree planting book for farmers*, with kind permission of the publisher Kondinin Group. Phone 1800 677 761 for further information on Kondinin Group products and services.

3. Pest animal management

Have you got any of these animals on your property?

- Rabbits and hares
- Red-legged Earth Mites
- Slugs and White Snails
- Wingless Grasshoppers
- Crickets
- Ants
- Wallabies
- Kangaroos
- Deer
- Goats
- Livestock

If yes, then read on! They are likely to affect the success of your revegetation.

Control of pest animals is as important as weed control. Whether they are grazing animals or insects, revegetation efforts can be a total failure if there is inadequate pest management. The most effective pest management measures will treat the source of the problem prior to establishing vegetation.

The following advice is a guide only. Contact your local supplier and pest animal officer from the Department of Primary Industries for advice on the most appropriate pest control for your situation (see Section C).

Rabbits and hares

All rabbits and hares need to be eradicated from an area prior to seeding and planting. They have the potential to damage and destroy emerging seedlings and planted trees. Guarding will offer some protection to trees, however, seedlings from direct seeding are generally not guarded.

There are a number of control options, including harbour destruction, shooting, baiting, fumigating and warren ripping. All rabbit warrens within 300 to 400 metres of the revegetation area need to be destroyed. Hares should be constantly monitored as they have a large range; they can be very damaging as they tend to browse rather than graze.

Direct seeded plants will not be associated with fresh soil disturbance (which attracts rabbits and hares) and the plants may be tougher and less palatable than planted ones. However, they will be prone to browsing, particularly over summer-autumn when there is no other green feed available.

Contact the pest plant and animal officer of your local Department of Primary Industries office to obtain site specific advice. To be effective, co-ordinated rabbit-hare control measures with adjoining neighbours/Landcare Group members is recommended.

For some landholders, the use of car tyres as guards has been an effective method of deterring browsing by hares. Just remember to remove them when the seedlings are large enough!

Insects

Red-legged Earth Mite

Red-legged Earth Mites (RLEM) are widespread and major pests of newly emerged seedlings at the two leaf stage. Heavy infestations can rapidly destroy seedlings. If the area where the revegetation is to occur is prone to heavy infestations of RLEM, control is vital.

Approximately one millimetre in size with dark bodies and distinctive red-orange legs, RLEM hatch in autumn after cold and wet conditions and attack and suck the fluids from emerging seedlings. Signs that RLEM are feeding on plants are white spotting on the foliage.

'Chemical control is an important management strategy for RLEM' (Ground Cover 2002). Carefully timed mite control in the spring, using the appropriate insecticide prior to sowing prevents the mites producing eggs over summer and hatching swarms of mites onto emerging seedlings in the autumn. Seedlings will be susceptible, probably until they reach the four to six leaf stage so it is important to inspect plants one week after sowing and regularly thereafter.

Contact The Kondinin Group (Ph 1800 677 761) and ask for the TIMERITE™ date for RLEM control in your area to spray in spring the year before seeding.

Slugs and White Snails

Be on the lookout for slug attack if prolonged wet weather sets in. They hide under the turned over soil and then come out quickly and destroy the emerging trees. White snails are also a potential hazard on some sites.

Baits can be laid along seeding lines, or if using milk cartons in the revegetation program, place baits inside the cartons (cartons may attract snails). Non-toxic products are available.

Be aware of the possible effects on non-target species wherever chemical control measures are used.

Wingless Grasshoppers

Damage to native plants by Wingless Grasshoppers is common; recently established vegetation is particularly susceptible. Wingless Grasshoppers are smaller than a match head and almost black in colour. They have one hatching a year on bare ground when the ground becomes warmer, for example, where Capeweed (*Arctotheca calendula*) has dried off.

Early detection and control is the key. Control by insecticide sprays or baits are an option. You may have to spray a couple of times depending on the season. Even though they are called Wingless Grasshoppers, they can re-infest by coming in with the next strong wind. Before planting trees in known Wingless Grasshopper infected areas, the use of insecticides may be necessary to reduce the likelihood and extent of infestations.

Crickets

Crickets can be a problem in cracking clay areas and insecticides may need to be a control option.

Ants

In some areas ants can be a problem by taking away the seed sown in direct seeding, particularly if sowing into dry soil. If possible, time the seeding for a rapid germination so the seed is not available to be harvested by the ants.

Ant treatments, such as Magnesium Carbonate or the poison Coopex are products that can be added to the seed mix when direct seeding. Again, seek local advice.

Native animals

In some areas, native wildlife, such as wombats, wallabies, kangaroos and possums may cause damage to revegetation. However, native wildlife are protected and their destruction is prohibited without a permit.

Exclusion fencing and deterrents may be options for your area. Where native animals are damaging seedlings, one form of deterrent, for small-scale works, can be to place branches, especially of prickly species, over the revegetation area.

The use of prickly species in the seed mix used in niche seeding can be another effective deterrent to browsing animals. For example, the very prickly species, Hedge Wattle (*Acacia paradoxa*) has been sown in niches with palatable She-oaks (*Allocasuarina* spp.) and been successful at discouraging browsing.

One effective, short-term repellent for wallabies is an egg-based product developed by the Victorian Institute of Animal Science, called WR-1. An adhesive liquid, WR-1 is sprayed onto seedlings, then a calcium carbide grit is sprinkled onto them and allowed to dry overnight before planting the next day. However, the protection given by this product is limited to six to eight weeks.

The use of prickly species, such as Hedge Wattle, in niche sowing has been effective in protecting more palatable species such as She-oak.

Further information

Other ideas on wallaby control are suggested in 'What can we do about Wallabies' by Matt Armstrong, *Agroforestry News*, Autumn 2000, pg. 10.

Another good reference is *A guide to living with wildlife. How to prevent and control wildlife damage in Victoria* by Ian Temby.

Talk to your local Flora and Fauna Officer at the Department of Primary Industries for advice.

Fencing

For the vast majority of revegetation, fencing is the most cost-effective way of protecting plants from livestock and from native animals such as kangaroos.

Designs vary from prefabricated wire fencing, electric fencing and traditional post and wire fencing and will range in cost per hectare. Sloping electric fence designs have been used successfully for kangaroos, for example, at Telangatuk East. Blocking any gaps beneath the bottom wires may be needed to prevent digging under the fencelines.

Fencing can also be tailored to protect plants from the wind in exposed environments, for example, in coastal areas and are a good way to deter vehicle and pedestrian access.

Vermin proof fencing can be constructed, but is usually a very expensive option. For feral animals, it is preferable to tackle the source of the problem and use fencing as a last resort.

On the Red Gum Plains in East Gippsland, trials by the Department of Primary Industries have used fenced plots located within already fenced remnants, to exclude introduced and exotic grazers. While a more expensive option, the trials have shown promising results for the introduction of understorey species in areas where the pressure from grazing is intense.

Refer to the references on fencing listed in Section C for more information on fencing.

Rabbit proof fencing has assisted with the exclusion of rabbits from this direct seeding site in Wooragee, north-east Victoria. **Read more in Footprints Fact Sheet 20**

Tree guards

The two main functions of tree guards are to protect plants from grazing animals and to provide a beneficial microenvironment for the plant's early establishment by providing protection from drying winds and extreme temperatures. In some areas, the visual impact of tree guards can also serve the purpose of raising awareness of the revegetation activity.

However, it is important to consider:

- the cost associated with purchasing guards and stakes;
- the time and labour involved and transport of materials to the site;
- that not all guards are biodegradable and will require follow up removal;
- that tree guards are no substitute for adequate pest control;
- that some guards suit certain site conditions better than others.

If tree guards are required, choose the most cost and labour effective option for the project. A wide range of guards are available including:

- cardboard drink/milk cartons with slits cut in two opposite corners for either bamboo or bent metal wire stakes;
- rigid plastic guards (if light is a limiting factor, use a clear guard);
- plastic sleeves;
- mesh guards, either plastic or galvanised netting wire.

Choosing the guard to suit the site conditions is also important. In parts of the Wimmera for example, milk cartons are preferred to plastic sleeves not only because they are cost effective, but because they do not tend to lift in strong winds which can expose the plant stem to being burnt or killed. Also, the cartons do not tend to 'cook' the trees as the plastic sleeves can in the high temperatures of this region.

Photo: J. Horlock

Photo: J. Robinson

Photo: GAV

Cartons (top), plastic sleeves (middle) and plastic mesh guards are three types of guards available to protect seedlings

Tips for guarding

- Always ensure the guards are held securely in place with stakes or pegs as needed.
- Milk Cartons: Once the seedling is planted, place the guard over the seedling and stake. Then, heap the soil back around the base of the milk carton. This helps to keep the carton in place, channel water down and trap water in the carton for the plant rather than allowing it to escape for weed growth outside the guard.
- Order stakes and guards a minimum of two months before the planting day to allow time for delivery!

Photo: GAV

The site preparation used here was ripping and mounding. The soil was then heaped back around the milk cartons after planting.

4. Seeds and seedlings

Seed

Seed is a fundamental resource for any revegetation project and the use of locally sourced seed is recommended. This will achieve the best possible outcomes when biodiversity is an objective of the revegetation.

Whether using seed for direct seeding purposes or for raising seedlings, forward planning is critical.

- Place orders for seed preferably two years before undertaking the seeding or planting (the minimum is September in the year before a spring revegetation).
- If the seed is for propagation by nurseries allow the same amount of time to enable collection and sowing.

It is essential to provide enough lead time for collectors to obtain the quantity and diversity of desired species and allow for the fact that some species do not seed each year. It will also enable the nursery to have the plants grown, to the right stage, if you are planting seedlings.

Purchasing seed

When purchasing seed, always check its origin, its age and its viability (if known). Indigenous seed can often be purchased from local seed collectors or seedbanks. Greening Australia Victoria can provide you with a copy of the 'Seedbanks and Seed Collectors in Rural Victoria' listing.

'FloraBank Guidelines' have been developed to provide recommended standards for different aspects of collecting, extraction and storage of seed, such as keeping records and storage of seed for revegetation. A number of regional community seedbanks in Victoria have adopted these Guidelines which helps to ensure that high quality seed is available (refer to Section C). If your regional seedbank does not have suitable seed for your project, collectors will need time to plan and collect the appropriate seed.

Place orders well in advance to allow collectors time to plan and collect the seed.

Photo: GAV

Buloke seed

Collecting seed

Seed collection is an easy and often enjoyable activity. However, practitioners do need some knowledge and skills plus some basic equipment to successfully collect viable seed. To assist in gaining these skills and knowledge, you could attend a local training day; Greening Australia Victoria regularly runs seed collection training.

If collecting your own seed or propagation material you should consider the following points.

- Get to know the indigenous species that grow in your area. The key parts of plants for species identification are generally, flowers and fruits, for example, pods.

- Become familiar with the annual reproductive cycle of plants (buds, flowers, immature and ripe fruits) to ensure that collection is undertaken when fruits contain viable seeds.

  Generally, seed collection is a summer activity (80 to 90% of native plant fruits ripen over summer).

- If possible, match the environmental conditions at the planting site with those of the collection location, and work out which areas you can collect from.

- **Obtain permission** from the landowner or manager first when collecting seed whether from public or private land. The Department of Sustainability and Environment and the Department of Primary Industries manages most public land. However, other public land managers such as Vic Roads, the Public Transport Corporation and local councils should be contacted where appropriate.

- If collecting on public land you need to obtain a **permit** from the Department of Sustainability and Environment. Permits from the Department of Sustainability and Environment are free; telephone 13 61 86 to obtain the appropriate permit. In some instances a permit is also needed for collection on private land, for example, if the area is declared critical habitat.

  You should comply with all the conditions of the permit, for example, how much can be collected, from what material it can and cannot be collected and how the material can be collected. Collection from some species is restricted or not permitted at all. As a general guide, with remnant plant populations, take small amounts of seed (no more than 10% from any one plant) from a large number of plants of the same species in an area to help maintain genetic diversity and reduce inbreeding 'depression'.

- Collection from cultivated seed orchards or revegetation sites are an exception, as most or all of the seed can be removed.

- When collecting seed, collect responsibly (minimise pruning damage to plants and ideally pick fruits only), watch where you walk (minimise damage to ground flora) and generally create minimal disturbance to the collection site.

- Thoroughly dry the fruits and seed; extract seeds from fruits; label the storage container with the date of collection, collector, species and location of collection for future reference; and store seed in a cool, dry, dark place that has even temperatures throughout the year.

Further information

The seed collection permit information above was based on the Department of Primary Industries Landcare Note LC0110 *What permit do you need to collect local seed?* Further information from this note and on seed collection can be obtained from the references listed under Seeds in Section C, including the FloraBank Guidelines, website and information notes series from the Department's website.

Photo: D. Walters

Seed storage at the Mallee Seedbank, Mildura

Seed data management

The Seed Supply System is a database designed by Greening Australia Victoria to help manage the records of seedlots. A standard 'Seed Collectors Record Book' which is consistent with the Seed Supply System is also available. For further information, contact Greening Australia Victoria.

Seed collection equipment

Equipment needed for seed collection can include high pruners, secateurs, drop sheets or tarpaulins, collecting bags or containers with neck straps (for example, fruit collecting equipment, kidney trays), wool bales, buckets, envelopes and gloves (pictured on page 47).

Seed collection is generally undertaken in summer. Take appropriate precautions to minimise the potential hazards of working outdoors in the heat, for example, sunburn block-out, hat and water and watch for snakes, spiders and ants.

Photo: GAV

Seed collecting equipment

Native grass seed collection

There is a range of equipment to assist with the efficient collection of native grass seed. The Bandicoot Native Grass Seed Harvester, now available in a number of regions in Victoria, is a portable, easy-to-use brush harvester drawn behind a 4WD motor bike or utility. This harvester is a very efficient collector of clean seed and is suitable for most native grass species. Other equipment used for native grass seed harvesting includes brush harvesters mounted on 4WDs, whipper-snipper brush harvesters, sickle-bar mowers and the use of portable vacuum cleaners.

Contact Greening Australia Victoria for advice on equipment available in your region.

Photo: GAV

Harvesting native grass seed using the Bandicoot Harvester in the Wimmera (above) and vacuums to collect seed in the Mallee (below)

Photo: D. Walters

Pre-treating seed before sowing

The seed of many Australian plants needs to be treated before it will germinate to break dormancy.

To maximise the germination of species sown in revegetation, we need to understand the biology of the seed and know what pre-treatment(s) is required (if any) for each species and apply it before or at the time of sowing.

Examples of treatments that overcome seed dormancy by mimicking environmental conditions are briefly outlined below. As research into seed biology is ongoing, obtain the latest advice for the species in your area prior to revegetation.

Eight of the treatments available to overcome seed dormancy

Seed Treatment	Purpose	Method	Examples
Light exposure	Sunrays help to weaken the outside covering of the seed.	Sow seed close to or on the soil surface and lightly press in to create good seed to soil contact.	Myrtaceae family, for example, Eucalypts, Bottlebrushes (*Callistemon* spp.) and Paperbarks (*Melaleuca* spp.) and native grasses such as Kangaroo Grass (*Themeda triandra*).
Darkness	Darkness (short day lengths) and cold triggers germination for some species.	Sow seed a little deeper; sow in early to mid-winter.	Liliaceae family, for example, Flax-lilies (*Dianella* spp.).
Stratification	Cold conditions trigger germination.	Subject seed to a given period of low temperature, usually in a refrigerator.	Cypress-pines, high altitude Eucalypts and Bursaria species (*Bursaria* spp.).
Maturation or after-ripening	Allow seed to mature before sowing.	Store seed for a given period of time.	Saw-sedge (*Gahnia* spp.).
Hot water treatment	Crack or soften the outer seed skin to allow moisture into the seed's food storage and embryo.	Check for the correct temperature and duration for the given species.	Hard coated seeds, such as, Wattles, Senna (*Cassia spp.*) and Eutaxia (*Eutaxia* spp.).
Scarification	Rubbing or nicking the seed or completely removing the seed coat.	Note: pay careful attention to scarification as it can easily damage the seed's embryo. If nicking, do not nick the seed at the end with the fleshy aril attachment.	Used for hard coated seeds.
Leaching	Overcome salts, tannins etc. contained in the seed.	Place seed in running water.	The leaching of salt has been one of the major developments in being able to direct seed many varieties of Chenopod seed (small shrubs and herbs, particularly well adapted to saline areas).
Smoke	Helpful in releasing dormancy factors.	See below points for the different methods of applying smoke.	Leguminosae family (such as Wattles), Proteaceae (such as Banksia) and Myrtaceae (such as Eucalypts).

The above treatments and examples were based on *Germination Pathways* a presentation given by Neville Bonney at Greening Australia Victoria's 'Smart Seed' Native Seed Forum, 2002 and are presented with permission. The complete *Germination Pathway* chart developed by Bonney is recommended for more detailed information.

Methods for applying smoke as a pre-treatment

- Spraying the seed with smoke water as it leaves the direct seeding machine.
- Soaking the seed in diluted smoke water prior to direct seeding.
- Lightly spraying smoked water onto the seed prior to seeding. The addition of a wetting agent can also be useful to combat seed hairs that repel water.
- Broadacre spraying of smoked water onto sites where a seedbed of native species is likely to be present in the soil. This should encourage germination.

Further information

Refer to Section C for additional references on seed and refer to the latest advice and trials being facilitated by Greening Australia Victoria and the *Seed Germination Data Sheet Series*.

Priming seed

Some direct seeding techniques, mechanical and hand, such as niche sowing, use pre-germinated or 'primed' seed. Priming starts the process of germination, that is it takes the seed into the germination phase. This differs from pre-treating the seed which only effects the dormancy mechanisms of seeds.

With priming, the seed is brought to the point just before root emergence, and then sown; this encourages rapid germination of seedlings after sowing. The plant has the chance to exploit the available resources, such as moisture, before the weeds. Its chance of being eaten is also reduced!

A number of direct seeding practitioners, who use direct seeding machines, are priming seeds for twelve to twenty-four hours, then drying them to enable good seed flow through the seed box, and finally sowing. The brief drying, for a short time immediately prior to sowing, does not kill the seed.

Hints for priming seed

- Only sow primed seed into wet soil conditions as the seed will continue the germinating process after sowing but will die if there is no moisture available. Do not prime seeds if sowing 'dry', for example, in the Mallee.
- If the seed has gone 'too far', that is, fully germinated with root emerging, seedling development may be physically damaged or will risk shock when sown.
- The seed may die if the site suddenly dries out or there is an extreme event such as heat, cold or a rain downpour.

Further information

Refer to Niche sowing in Section B.

Seed quality: germination testing

Germination testing is a service that many seedbanks can offer, usually on a fee for service basis.

Germination testing of individual seedlots is useful:

- to determine the percentage of viable seeds per gram;
- to assist with understanding reasons for low germination success in the field, for example, low seed viability versus site factors.

Seed orchards

More recently, revegetation sites are being established specifically as seed orchards where plants are grown for seed harvesting. Seed orchards provide a number of benefits including:

- reducing the pressure on remnant plant populations in the wild as sources of seed;
- helping to meet the demand for seed for revegetation;
- helping to provide the quantity of seed needed (Seabrook 1994);
- providing a financial return.

Well-documented revegetation sites are playing an increasingly important role in the supply of seed as seed orchards. However, documentation of the origin of seed used in these sites is required before they can be confidently used as seed sources for future projects, particularly if biodiversity (genetic variability *within* a species) is an objective. Where the seed origin cannot be tracked from collection to revegetation, it is not recommended for use in biodiversity-focussed projects. Keeping records of the seed source also helps to ensure certain areas are not exploited.

Photo: D. Warne

Weeping Grass (*Microlaena stipoides*) being planted at Five Ways Seed Orchard, Dunkeld. The site also contains Bristly Wallaby Grass (*Danthonia setacea*) and Redleg Grass (*Bothriocloa macra*).

Photo: P. Curucan

Pallister's Reserve Understorey Seed Orchard, western Victoria.

Track the seed in your revegetation program from collection to planting to ensure that sites are useful as future seed reserves.

Further information

For more information, refer to the FloraBank Guidelines and **Footprints Fact Sheet 4**

Seedlings

A range of containers can be used to grow seedlings including:

- **Cells** - multi-celled containers arranged in trays. Cell plants can be grown in a variety of sizes and in containers with and without lateral air pruning of the roots.
- **Individual containers**, for example, forestry tubes and bare rooted seedlings.

Cell grown seedlings

Forestry tubes

Tips for working with plant stock

- Choose plant material of a high quality. A high quality plant will:
  - -have healthy foliage;
  - -have a robust root system (if a legume, check that is has nodules present);
  - -be actively growing;
  - -be well proportioned, that is, a good balance of roots to shoots;
  - -be free from pests and diseases;
  - -be clearly labelled to identify the species;
  - -not be supplied 'soft' from an igloo or shade house but will have been well hardened-up outside.

- Check with the nursery that they can guarantee the origin of the seed or alternatively provide the nursery with seed that you have collected.

- If placing a large order consider spreading the 'risk' over a number of nurseries; nursery 'disasters' can happen, for example, frost events and poor or no germination.

- Consider the length of time the plants are left in the container - too long and they may be pot bound.

- Choose plants that have been grown in conditions that help to prevent root circling or that reduce the damage to the root, for example, air pruning and ribbed pots.

- Place plant orders well in advance - a minimum of twelve months before planting. This will allow nurseries to obtain the right seed and have plants grown to the right stage.

Choosing the container

Choose the right container for the job and for the revegetation equipment that you are proposing to use. Your indigenous nursery will be able to advise you on the most appropriate container for the species that you are having grown (for example, the smallest cell sizes are unsuitable for tree seedling root development) and the type of site where they will be planted (for example, native grasses that will be planted into bare ground can be grown in the smallest sizes of cells; a larger cell is more appropriate if the grasses are to be planted into a mulched site).

Features of plants grown in cell propagation systems

For most revegetation, cell grown plants will be the most efficient and cost effective type of seedling. The reasons for this include that:

- they are low in cost (10 to 60% of the price of a forestry tube);
- they require less space, less growing medium and water compared to tubestock;
- they are efficient for planting in terms of time, transporting, effort and water use;
- their smaller size and less mature root systems increase their chance of survival (providing the site conditions are right);
- they are easy to remove from the container;
- they make possible the efficient large-scale propagation of species that are not economic when grown in individual pot systems, for example, Saltbush and native grasses and farm forestry seedlings.

Note: The potting media used in cells should have smaller size particles and greater moisture holding capacity than that used in tubestock. If the correct potting media is used cells should not dry out significantly quicker than tubes.

Cell grown seedlings

Further information

The following reference provides more information on cell propagation systems: Millsom, D (et. al). (1999). *Growing and Planting 'Cell' or 'Plug' Tray Seedlings.* (Greening Australia Victoria: Heidelberg).

Features of plants grown as tubestock

Tubestock seedlings:

- are best suited to smaller-scale projects;
- enable small quantities and a high species diversity to be grown;
- are more resilient than cell grown stock, particularly if there is going to be a considerable delay until planting;
- can be used in some mechanical planters;
- are preferred in some regions, for example, in South Gippsland where there is very strong exotic grass competition the depth of the tube can be an advantage for plant establishment.

Forestry tubes

5. Revegetation

Up to this point much time and effort has gone into the planning, preparation of the site and resourcing materials for the project. The next step is getting the seeds or seedlings in the ground at the right time and with the right method to suit the site and project size.

Natural regeneration, direct seeding and planting are the three main techniques of establishing native vegetation. In many cases, a combination of these methods may be used and a variety of equipment and machinery is available to suit the job. The choice of technique will depend on the objectives of the project, the site conditions, resources available and project size.

Revegetation techniques, their uses, advantages and factors to consider and the equipment and machinery options are followed up in detail in Section B.

However, two general issues associated with the revegetation stage of any project are watering and the use of fertiliser.

Watering

There are differing opinions on watering at the time of planting and post-planting watering. Watering at the time of planting is advantageous to help overcome any transplant shock, to help remove air pockets from the roots and establish good root to soil contact. Follow up watering after the day of planting is not usually necessary if good quality, hardened-up, indigenous plant stock, adapted to local conditions, has been planted correctly (no potting media exposed) into a well-prepared, weed free site at the appropriate time (particularly if there is a reasonable expectation of rainfall).

Direct seeding operations rely upon the build-up of moisture within the soil that results from weed control activities to support the germination and establishment of seedlings. Therefore direct seeding should be timed to coincide with predictable, follow-up rainfall. The planting of seedlings should also be timed for these conditions.

Particularly dry areas

To help guarantee success in particularly dry areas, for example, north-west Victoria, a follow-up watering may be necessary five to seven days after planting. The use of water injectors for planting in these areas can also help provide moisture to depth (refer to Section B).

Particularly wet areas

In high rainfall areas, when the timing of planting is correct, watering is not usually necessary at all.

Fertiliser

As indigenous plants are generally adapted to low nutrient soils, fertilisers are not usually necessary in revegetation programs. Fertilisers are more likely to benefit weed growth! However, for farm forestry sites where maximum growth rates are essential, fertilisers are commonly applied.

Further information

A good reference for the use of fertiliser in farm forestry is Agnote AG0788 *The use of fertiliser in farm forestry* by Bruce Sonogan, available from the Department of Sustainability and Environment's website: http://www.dse.vic.gov.au/notes (search for fertiliser)

6. Site maintenance

The table below provides some general tips for maintaining a revegetation site. The information to follow outlines the importance of plant identification when it comes to maintenance of revegetation sites and finally, weed management options for the second season are discussed. However, it is always best to seek advice about appropriate follow-up strategies for revegetation sites in your area.

Tips for maintenance of a revegetation site

Patience!	• Plants that have been direct seeded will take time to establish and the site is likely to look untidy at first (depending on how thorough your weed control was). • Don't be too impatient - even in moderate seasonal conditions the key to success is good site preparation before seeding or planting.
Inspect germination of direct seeded areas	• After direct seeding the first inspection is not usually needed for four to six weeks (depending on the season). • Different species will germinate at different times. Some will germinate many months after sowing, and others may come up more than a year later. • Identify what has germinated and keep records. It is good to be able to identify both the indigenous and exotic species coming up. The photos on pages 55 to 57 provide a guide for identifying nine indigenous species.
Pest animals	• Check the site when seedlings are at the two-leaf stage for large numbers of pest animals, particularly RLEM and, in wet years, slugs. • Implement pest control as required. • Check the seedlings for evidence of grazing/browsing and apply appropriate management if required, for example, protection from wallabies.
Post weed control	• Post-planting/seeding weed infestations will be reduced if the site preparation has been carried out thoroughly.
Fencelines	• Check, when convenient, that fencelines are stock proof, and, for electric fencing, not shorting out (ensure you include a gate to get the stock out!).
Plant losses	• If required, replace any plant losses as soon as conditions permit (except if it is a farm forestry planting that will be thinned).
Thinning	• Thinning is likely if it is a farm forestry site. However, if the purpose is to achieve a natural effect, generally leave the seedlings to sort themselves out.
Tree guards	• If tree guards have been used, maintain them and remove as needed.
Watering	• Watering at the time of planting establishes good root to soil contact and helps overcome transplant shock. Follow-up watering may be necessary if plants have been established in very dry seasons (refer to detail on watering on page 53).

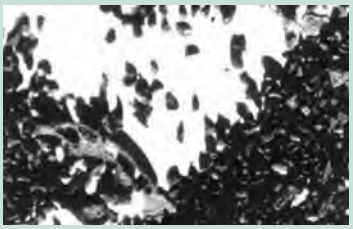
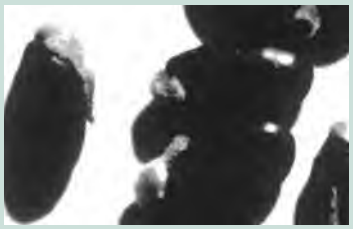
Plant identification

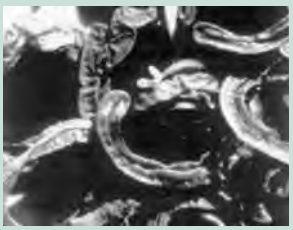
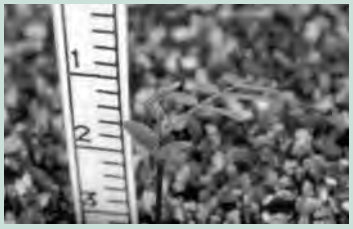
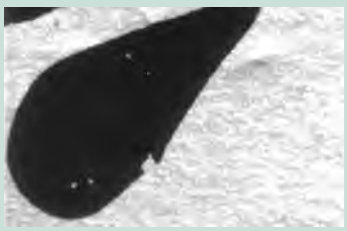
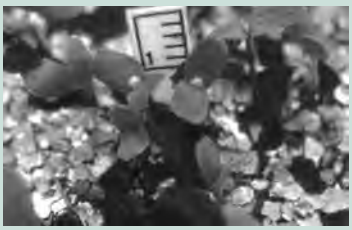
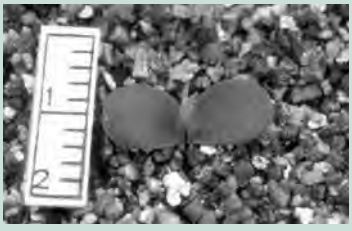
Plant identification is a very useful skill for revegetation. Knowing which are the plants to keep and which are the plants to eradicate is important. However, this does not mean you have to be a botanist. Finding out the names and main features of some of the key species that you have planted or sown will be very helpful, particularly when it comes to follow-up maintenance. Knowing what the native seedlings look like during their early stages of growth will make it much easier to identify what will need to be controlled.

There are many colour plant guides available, for indigenous plants and weeds. Refer to Section C for some of the titles. Once you get your eye in, you will quickly remember the species.

The following table provides a photograph of nine common indigenous plants from seed to different seedling stages.

Guide to the identification of nine indigenous seedlings

Seed	Early seedling stage	Late seedling stage
1. Manna Gum (*Eucalyptus viminalis*)			
2. Narrow-leaved Peppermint (*Eucalyptus radiata*)			
3. Golden Wattle (*Acacia pycnantha*)			

Seed	Early seedling stage	Late seedling stage
4. Blackwood Wattle (*Acacia melanoxylon*)			
5. Silver Wattle (*Acacia dealbata*)			
6. Coast Banksia (*Banksia integrifolia*)			
7. Yellow Hakea (*Hakea nodosa*)			

	Seed	Early seedling stage	Late seedling stage
8. Moonah (*Melaleuca lanceolata*)			
9. Prickly Tea-tree (*Leptospermum continentale*)			

Photos: Greening Australia Victoria's Melbourne Indigenous Seedbank

Weed management options for the second season

Weed management options following seeding or planting should aim to minimise weed competition for one year (ideally two years for farm forestry) and be tailored to the site conditions. In some cases, a compromise between plant growth and weed control may be necessary. For example, in saline soils where the reduction in the water table is the goal, bare ground should be avoided.

If the site has been prepared well in advance, weed infestation problems should be largely reduced. The following information outlines some of the weed management options available.

Manual weed control

Pulling weeds out by hand or digging them out with a hoe, along or beside the seeding or planting line may be an option for small scale projects. Always try to avoid disturbing the roots of the sown or planted seedlings.

Overspraying

Selective herbicides that target, for example, grassy weeds, may be used as an overspray over the seeding or planting line, particularly after summer-early autumn rain events. Overspraying is a method regularly used in direct seeding. Take due care and ensure the sprayer is accurately calibrated.

Shielded or directed spray

An alternative to overspraying is the use of a shielded or directed spray mounted on a ute, motorbike or a backpack. This technique will eliminate any natural regeneration of desirable species between the seeding and planting lines. Care must be taken to avoid spray drift. Success will depend on the accuracy of the driver and the effectiveness of the shield.

Photo: M.Dodds

Handheld shielded spray applicator (above) and a shielded spray unit mounted on a utility

Photo: R.Dodds

Rope wick weeding

A Rope Wick Applicator is one method to selectively control weeds where the weeds are considerably taller than the planted seedlings. The Applicator brushes against the tall weeds, wiping them with herbicide, while passing above the lower-growing indigenous seedlings. It can only be undertaken where the weeds are considerably taller than the indigenous seedlings (Department of Agriculture 1995). This will probably be too time consuming and tedious if you have kilometres of revegetation.

Photo: R.Dodds

Rope Wick Applicator being used for selective weed control

7. Monitoring

Why monitor?

Monitoring of revegetation sites is important. It helps to keep track of what is happening at the site and the impact of the revegetation works. It provides information that will help to improve the project at hand and improve future activities. To be of most use, monitoring should be set up from the beginning of the project, at the time of the site assessment, to provide a baseline of data with which to compare progress over time.

Inspecting the success of a mouldboard ploughed shelterbelt in the Corangamite region

Examples of monitoring activities

Taking regular photos of the site and activities from a fixed location (photopoint).

While this is often a requirement of publicly funded projects, it is worth doing for your own satisfaction. You quickly forget what the site looked like and photos provide a great visual record of what you have achieved!

When setting up a photopoint, mark it so that you know where to come back to. Also consider what the site will look like in future years and take the photo at the appropriate distance. Too close to the revegetation area and the shot will soon be blocked out by the trees. Picking a high position and a landmark to line up with can also be helpful.

Read about a monitoring program set up by a landholder in Footprints Fact Sheet 6.

Monitoring of a mouldboard ploughed site in West Gippsland

October 1997 and ready for mouldboarding

May 1998

Photos: K. Walsh

November 1999

Recording the establishment and survival of different species.

For direct seeding, if time allows, undertake basic counts of seedling establishment by species, using for example, ten metre transects every 100 to 200 metres along each seeding line. This information will help refine (and hopefully reduce) future seeding rates for different species and pinpoint species that require more research into their biology-germination requirements.

Photo: GAV

Recording vegetation establishment and survival

Keeping a list of the birds and animals observed.

Expect dramatic increases in bird species once trees and shrubs are four to five years old and have enough structure to provide some habitat. (See *Birds on Farms* report by Barrett listed under Wildlife in Section C)

Photo: R. Dodds

The use of this revegetation site by small mammals and reptiles is being monitored with pitfall lines

Read about the return of native birds to a revegetation site in Footprints Fact Sheet 17.

Checking for pest plants and animals.

Testing the water quality in creeks, dams and wetlands and monitor depth and quality of water from any bores adjoining your revegetation sites.

Contact the Waterwatch program for advice and information (refer to Section C).

Spatial and database recording of information.

Global Positioning Systems (GPS) equipment can be used to spatially record where revegetation activities take place and project information can be recorded onto databases, such as the Catchment Activity Management System (CAMS). This is a web based system that provides a spatially linked register of activities and includes information such as details of on-ground works and location of activities. For further information on CAMS phone the Department of Sustainability and Environment on 03 5833 5297.

Photo: GAV

Hand held GPS unit

SECTION B:
Revegetation techniques

1. NATURAL REGENERATION

2. DIRECT SEEDING

3. PLANTING

Introduction to the techniques

Natural regeneration, direct seeding and planting of seedlings are the three main techniques used in revegetation. In different parts of the state, a number of the techniques will have been used for many years, while in others, some of the techniques have only recently been introduced or trialled.

Each technique has advantages and factors to consider when deciding whether it is suitable. Some techniques are specialised for specific environments and purposes while others have broader uses. Often, a range of techniques are applied to the one site. Revegetation is often a 'horses for courses' situation. In reviewing the various options, match your site conditions and project size to suitable technique(s).

This section is designed to provide practical information on the use of each technique, from planning to on-ground works and aftercare. The following techniques have been included:

1. Natural regeneration: Germination of seedlings from seed fall from existing or nearby vegetation, from the soil seedbank or from seeds brought in by birds and animals.

2. Direct seeding: Sowing seeds directly onto the site on which you wish to establish them by mechanical or hand methods.

3. Planting: Planting nursery-grown seedlings such as cell or tube-grown plants by mechanical or hand methods.

A combination of the above techniques is often used to successfully establish vegetation. For example, it is suggested that seedlings should be planted to complement direct seeding (or vice versa) particularly for:

- species that are difficult to grow or known to be unreliable in direct seeding;
- rare or threatened species (usually understorey);
- species for which seed is expensive;
- species that regenerate naturally in autumn or winter, such as Sweet Bursaria, Tree Violet, Prickly Currant Bush and Cypress-pine, if direct seeding is undertaken in spring;
- narrow shelterbelts where regular plant spacing is required;
- farm forestry blocks where buffer-biodiversity strips of indigenous species are incorporated.

Guide to selection of revegetation techniques

SITE INFORMATION AND PURPOSE(S) OF REVEGETATION	REVEGETATION TECHNIQUE				
	Natural regene-ration	Direct seeding by machine	Direct seeding by hand	Planting by machine	Planting by hand
Soil type					
Sands	●	●	●	●	●
Non wetting sands	●	With spray mulches, Rodden Scalping Seeder, Rippa Seeder			
Light soils	●	●	●	●	●
Heavy clays	●	Burford or Eco Seeder with gypsum	●		●
Sticky clays	●	●			●
Cracking clays	●	●			●
Heavy wet soils in high rainfall	●	Mouldboard Plough & Rippa Seeder	Mouldboard Plough		●
Saline	●	M-Profile mounding			
Environment					
Flats	●	●	●	●	●
Light granitic hills	●	●	●		●
Rocky or stony country	●	Burford / Hamilton Tree Seeder	●		●
Waterlogged	●	M-Profile mounding			
Hard to access rocky hill tops	●		●		●
Steep hills	●	Burford Tree Seeder, Rippa Seeder, Dozer Terracing	●		●
Intact remnants and ground flora (i.e. low degree of disturbance desired)	●		●		●
Riparian	●		●		●
Isolated dead trees	●	●	●		●
Scale of works					
Broadscale	●	●		●	
Medium (e.g. belts)	●	●	●	●	●
Small scale or spots	●		●		●
Desired end result					
Random or natural	●	●	●		●
Uniform spacings			●	●	●
Input level					
Time efficient	●	●			
Labour efficient	●	●			
Low cost	●	●			
Low equipment input	●	●			
High community involvement					
			●		●
Low machinery access					
	●		●		●
Types of species being used					
Rare	●				●
Understorey	●				●
Readily available	●	●	●	●	●

● = technique is relevant / appropriate

Guide to cost comparison of techniques

One factor that will influence which technique or combination of techniques you will choose, is the cost.

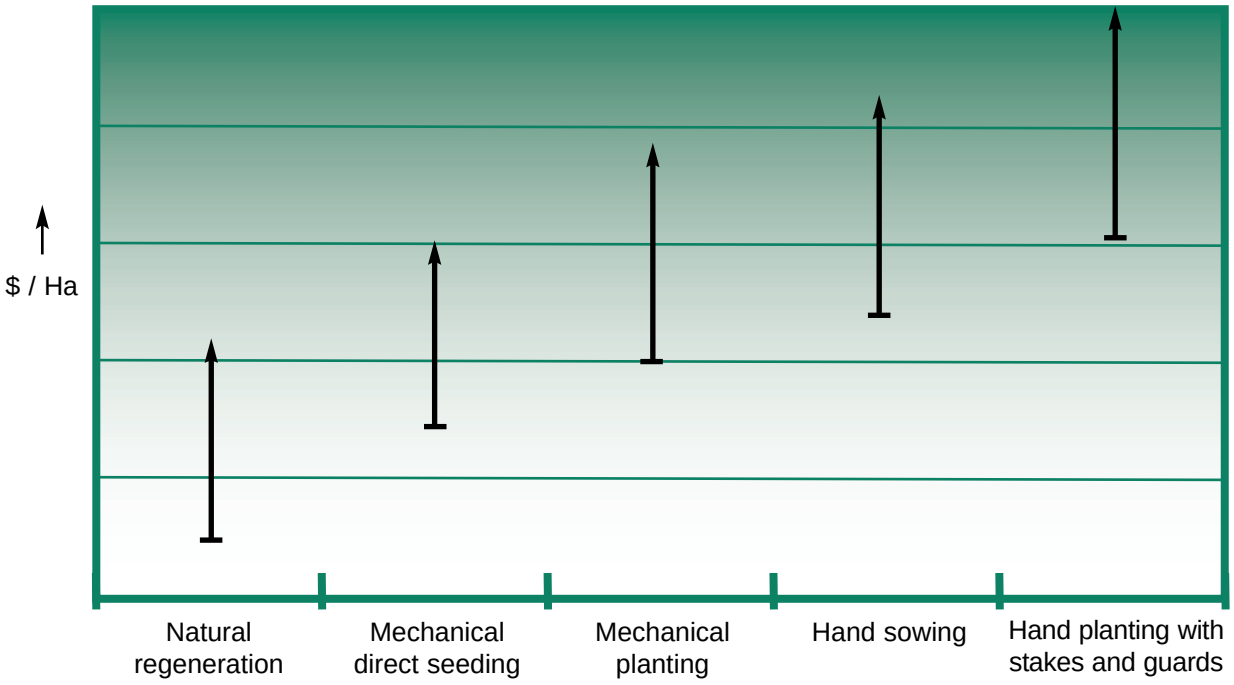
The graph below provides an indication of the most cost-effective options through to the most expensive. Natural regeneration is usually the most cost-effective, followed by the mechanical methods of seeding then planting and finally the hand options. However, the costs can increase for each technique depending on the site conditions, such as difficulty of the terrain and accessibility.

Many revegetation projects will involve a combination of techniques, and this is likely to add to the expense of the works.

Funding assistance

Speak to Greening Australia Victoria or your local Catchment Management Authority about current funding that may be available to support your revegetation project. Fencing often makes up about 80 to 90% of the total costs of revegetation in regional areas. Grant funding commonly assists with the cost of purchasing fencing materials.

Indication of cost per hectare of each revegetation technique



1. Natural regeneration

Natural regeneration is nature's technique for growing plants; it has been going on for about the last 400 million years. Whether canopy trees or understorey species, regeneration is usually the germination of seedlings from seed fall of existing or nearby vegetation. Some species, such as Eucalypts, have several mechanisms of regeneration apart from seeds including lignotubers or from coppice regrowth after felling (Oates & Clarke 1987).

Natural regeneration should be considered the first option for bringing back native vegetation.

Red Gum regeneration on a property in north east Victoria.
Read Footprints Fact Sheet 21 to find out more.

If remnant vegetation is present, whether as isolated trees in a paddock or grassland along a roadside, it is often the ideal starting point to encourage natural regeneration. For nature conservation on farmland, the priority is to fence off and manage these areas first, including encouraging natural regeneration events.

Natural regeneration is an effective, cheap method of establishing large numbers of plants in a random design. It is an important part of the succession and ecology of vegetation. Below is a summary of uses, advantages and factors to consider when deciding whether natural regeneration is appropriate for your site.

Uses

- Establishment of the original vegetation at a site on a small to large scale.

Advantages

- Genetics are appropriate for the site (except for isolated trees with no out-crossing potential).
- Low cost in terms of labour and dollars.
- Specialised equipment is not usually necessary.
- Can be adapted for large and small scale projects.
- A large number of plants can be produced (they will self-thin over time or can be actively managed for products, such as, firewood).
- Ensures indigenous species are established rather than weeds.
- Plants develop deep, strong root systems which help them establish quickly and withstand drought and wind.
- The random spacing of established plants enables the re-creation of a 'natural' self-sustaining habitat.
- Usually used with remnant vegetation areas and provides further protection for these areas.

Considerations

- Natural regeneration does not occur every year and may require specific events, for example, flooding.
- Trees may not grow exactly where they are needed.
- The final result may be a monoculture of species, perhaps just the canopy layer, and enhancement with understorey species may be required.

Requirements for natural regeneration

Natural regeneration requires:
- a heavy seedfall;
- a good seedbed with high soil moisture;
- the appropriate temperatures for germination (Venning as in Lawrence et. al. 1998).

Seed source

The seed source for natural regeneration can be from:
- parent trees;
- residual native plant seed within the soil, especially those of hard-coated species;
- wind-blown seed, for example, the light, fluffy seeds from daisies such as Dogwood (*Cassinia aculeata* spp.), Wallaby Grasses (*Danthonia* spp.) or Fireweed (*Senecio* spp.) or winged seeds (samara) from plants such as She-oaks, Banksias and Hakeas;
- birds that deposit seeds in an area, for example, from Tree Violets.

Seedbed

A good seedbed can be prepared which will increase the probabilities of a regeneration event occurring (refer to section below, on stimulating regeneration).

Episodic events

Natural regeneration does not occur every year. Many species require a particular climatic event to occur to initiate germination, such as a flood (River Red Gums *Eucalyptus camaldulensis*); a significant rainfall event in summer or a fire (Heathland communities); or some combination of high rainfall and fire. In nature, high rainfall events are often infrequent and if the site is well stocked with trees, the extra soil moisture is used by these standing trees.

Encouraging natural regeneration

Identify areas to try natural regeneration

Opportunities for natural regeneration may exist around isolated old trees in a paddock, along a waterway, in a bushland remnant or roadside reserve. Focus efforts in areas where you are more likely to have success, such as around species that are good regenerators, for example River Red Gums and Manna Gums (*Eucalyptus viminalis*), or in areas where there are fewer or no exotic pastures (Venning as in Lawrence et. al. 1998).

Photo: GAV

Identify areas to try natural regeneration such as the drainage line, above

Fence off groups of existing indigenous trees and/or understorey to reduce grazing pressure

Without fencing to exclude livestock, new seedlings will not be established. Livestock will eat young seedlings, particularly when there is no other food available, for example, during the autumn feed gap.

Seek advice as to whether a periodic grazing program once the regeneration has established within the fenced area will be detrimental to the vegetation. Certain vegetation types, such as grassy woodlands, are best left ungrazed.

Mature trees will compete with any new seedlings for sunlight, soil moisture and nutrients. Most new plants will grow outside the area shaded and dominated by the mature tree. The fence line should be well beyond the canopy or drip-line of such trees, probably to the south-east (this assumes seed fall in summer, during hot days with a north-westerly wind). The prevailing winds tend to blow the seed out from the base of the parent tree.

Fencing should be well away from the canopy or drip line of the trees as this landholder has done on his property on the urban-rural fringe of Melbourne. **Read about his story in Footprints Fact Sheet 24.**

Extend the fence line out to the lee side of the trees so that the seeds fall inside the fenced area but beyond the tree canopy or 'drip-line'.

Techniques to stimulate the regeneration of species

Reduce weed competition

It may be necessary, after fencing and before expected seedfall, to spray with a knockdown herbicide within the fenced area, but at some distance from the remnant trees, to reduce weed competition. This will minimise competition by weeds for soil moisture and increase the probability of the natural regeneration of tree seedlings.

Improving the seedbed

The seedbed can be improved in different ways to suit different species. Light cultivation, scalping, fire and the removal of weeds to increase light and soil moisture may be appropriate options.

Blackwood Wattles (*Acacia melanoxylon*) for example, are known to sucker prolifically when the soil beneath the tree is disturbed by light cultivation. Other species, such as heathland plants and the seed of all hard coated species (Wattles, Sennas, and all Pea flower species) respond well to fire. Spraying of smoked water products may, therefore, help stimulate regeneration of hard-coated seed species. The seedbed, of sites with a Eucalypt overstorey and Fog Grass understorey may benefit from removing the weed layer and opening up the ground layer. This will improve the seedbed and encourage natural regeneration of species such as Wattles.

Be careful to avoid damaging the roots of trees when disturbing the soil.

Many mature trees such as Eucalypts and She-oaks, actually prevent the regeneration of seedlings in the area surrounding the existing trees through a process called allelopathy. Allelopathy is where the leaves on the trees and on the ground exude chemicals that inhibit seedling germination.

It is only after the removal of these chemical exudates, by scalping the top layer of soil or by a flood event, that the seedlings are able to germinate.

Timing these stimulation techniques with good rainfall years and soil moisture, and good flowering-seed set and seedfall is recommended to increase the probability of regeneration.

Fire may assist regeneration on some sites:

Photo and above: Friends of Balcombe Park

Coast Tea-tree and Coastal Wattles dominated the vegetation in this urban parkland (top). Following the undertaking of an ecological burn (centre) and post-burn weed control, the diversity of heathland species has increased significantly (right).

Manage the regenerating area for pest animals and weeds

As with any form of plant establishment, pest animals and weeds should be monitored and controlled as needed. For example, it may be necessary to control grazing pressure from rabbits and hares and damage from insect attack.

Incorporate 'non living' elements into the regeneration area

Dead trees, fallen logs, rocks and leaf litter are all important components of functioning habitats - forming shelter, nesting sites, perches and food sources for an array of wildlife species including birds, lizards and insects. They also create environments for non-vascular plants to grow on, or in, such as mosses, lichens and fungi.

Photo: D. McBeath

Photo: C. Dennis

McBeath's grassy woodland remnant prior to fencing to exclude livestock (top) and following fencing. Note the build up of logs and leaf litter just over 12 months later.

Read about landholder experiences with natural regeneration in Footprints Fact Sheets 6, 7, 21, 23 and 24.

2. Direct seeding

Direct seeding involves the sowing of treated seeds directly onto a site to achieve germination and establishment and can be carried out mechanically or by hand.

Direct seeding as a regeneration method has been naturally occurring for millions of years by Australian flora and has been used, from as early as the 1870s for shelterbelt and woodlot plantations in south-west Victoria. In other parts of the state, direct seeding by landholders is a relatively new technique. Below is a summary of uses, advantages and some the factors to consider in deciding whether the direct seeding technique is appropriate for your situation and site.

Uses

- Direct seeding has many applications, both for broadscale vegetation establishment and for spot sowing by hand.

Advantages

- This technique involves a plant growing from seed rather than propagated material. Direct seeded trees and shrubs develop deep, strong root systems that help them establish quickly and withstand drought and wind.
- The patchy spacing of established plants enables the re-creation of a 'natural' self-sustaining habitat.
- If conditions are not favourable for seeding, for example, too dry, the seed can be stored for future sowing. Seedlings are harder to look after until the next season.
- Mechanical direct seeding is the most efficient technique for broad scale revegetation.
- Mechanical direct seeding is cost effective and labour efficient. Assuming the appropriate site preparation is completed, it is possible, with current technology, for one person to revegetate 10 to 15 hectares in one day (approximately 30 to 45 kilometres of seed line).

Direct seeding on a broadscale in central Victoria using the Burford Tree Seeder

Considerations

- Mechanical direct seeding relies on a greater amount of seed than techniques based on nursery grown seedlings. Commonly, about 1 to 1.2 kilograms of mixed seed is required per hectare to establish approximately 3,000 seedlings, whereas you need 100 grams of seed to grow 3,000 seedlings in a nursery (shortage of seed can be an issue).
- At this stage, not all species can be successfully direct seeded in the field.
- Whilst the labour requirement at the time of seeding is low, the seed collection process does require considerable labour, particularly if collecting seed yourself. A purchased seed mix for direct seeding would currently cost about $150 to $200 per kilogram.

There are many ways to direct seed native vegetation. The section below will outline some of the methods of direct seeding both by various machines and by hand. The first part will look at direct seeding by machine and will include steps for successful direct seeding by machine, some of the different machines available and their features and specialist direct seeding techniques, including m-profile mounding, mouldboard ploughing, deep scalping of steep slopes, applications to assist mechanical direct seeding in difficult soils, hydro-seeding and aerial seeding.

Direct seeding by machine

Steps for successful direct seeding by machine

1 PLANNING

- Determine purpose/s of revegetation
- Prioritise site selection
- Assess the site
- Select species
- Develop seeding design
- Select machinery for seeding
- Acquire the resources

Photo: R. Dodds

2 PREPARING THE GROUND

Weed control

Ensure all weeds are controlled before seeding and ideally sow into bare ground. Good weed control creates a reservoir of moisture which is available for newly germinated seedlings.

Photo: K. Walsh

Soil preparation

Different sites and direct seeding machines may require different site preparation, for example, mound if required in saline or waterlogged sites.

Above all, a weed-free site with good soil moisture to depth is needed for successful sowing.

Photo: C. Dennis

3 PEST ANIMAL MANAGEMENT

Prior to sowing, fence sites to protect them from grazing by livestock and undertake pest management to eradicate vermin such as rabbits and hares.

Photo: R. Dodds

4 SEED

Sourcing seed

Plan ahead for seed collection, which usually occurs in summer. However, some native plant fruits are not ripe in summer, for example, Sweet Bursaria, Red Gum and Manna Gum. Monitor local species populations to determine the ripeness of the fruits, for example, gum nuts or capsules. There can be seasonal variations in fruit ripening, for example during a drought year compared to an average rainfall year.

Use seedbanks for species which may not set seed that year or if you are unable to collect your own.

Photo: D. Walters

Species mix

Aim to utilise as many as possible of the indigenous species that would have naturally occurred on your site. This will maximise the re-creation of as much of the structural and floristic diversity present in the original vegetation. You may prefer to exclude rare or difficult to grow plant species from your mix and instead plant nursery-grown seedlings of these species. This will ensure that valuable seed is not wasted and that such species will establish more reliably on your site.

Include greater proportions of large-seeded legumes (colonisers) in the mix. The colonisers play an important role early on in the development of vegetation communities and ecosystems - they grow quickly under sunny conditions, often providing the ideal protection and environment to aid the establishment of longer-lived, slower-growing species.

Calculating seed quantities

As a general rule:

In low rainfall (semi-arid) areas up to 500 grams of mixed viable seed per kilometre of seedline is used, with the aim of establishing 1,000 plants per kilometre.

In higher rainfall areas up to 300 grams of mixed viable seed per kilometre of seedline is used with the aim of establishing 1,000 plants per kilometre.

When direct seeding on saline soils, 600 to 700 grams of mixed viable seed per kilometre of seedline is used due to the soil conditions and the lower germination rate of species.

Rigorous research was undertaken in south-west Victoria in the late 1980s to work out the quantities of seed required for a range of species, based on seed viability and establishment success (refer to Bird 1992 under Shelterbelts in Section C). Where such information is known, the following formula can be used to determine how many grams of seed for each species is needed per kilometre of seedline (g/km).

Calculating seeding rates

$$g/km = \frac{plants/km}{viable\ seeds/g \times \%\ field\ survival}$$

Plant density can be referred to as plants per kilometre or plants per hectare, commonly densities are 1,000 seedlings per kilometre or 3,000 seedlings per hectare. Seek local advice on the planting design, this may determine the densities to aim for.

To work out the number of plants per hectare use the following formula:

Seeding rows:

$$Plants/ha = \frac{plants/km \times 10}{row\ spacing\ (metre)}$$

To work out the number of plants per kilometre use the following formula:

Seeding belts:

$$Plants/km = \frac{plants/ha \times width\ of\ belt}{10}$$

(Formulas above from Dalton 1993)

Photo: GAV

Seed treatment

Maximise successful germination by treating seed appropriately, if required at all. Direct seeding machinery can be set up to deliver smoke water, wetting agents or mulches and gypsum.

Germination testing of individual seedlots is useful (contact your local seedbank). Always sow fresh, viable (living) seed.

Photo: GAV

Leaching seed

5 SEEDING

Timing of seeding

Photo: J. Robinson

Sow into moist soil (as pictured above) if possible. Below is a general guide of when to sow:
Medium to high rainfall areas - spring sowing
Semi-arid areas - autumn/winter sowing
Frost prone areas - spring sowing

Machinery

A variety of direct seeding machinery is available. They all use, essentially, the same process: scalping 25 to 50 millimetres of topsoil to form a weed free strip, cultivate the scalp line to create a seedbed, deposit seed in or on the seedbed and, except in sticky wet soils, use a press wheel to ensure good seed to damp soil contact.

The machinery selected should suit the site conditions (flat, rocky, hilly), soil type and the availability of 4WD ute or tractor.

Bulking agents

While not necessary for most direct seeding machines, a bulking agent may be required for seeders with large seed boxes and imprecise seeding mechanisms or for use with mouldboard plough direct seeding. This will aid seed flow and enable more even distribution of seed. Seed is 'bulked' with material such as chick crumble, sand or sawdust before sowing. The closer the bulking agent is to the size and density of the seed the better; this will avoid the two separating in distribution.

Machine calibration

A key activity in direct seeding is the calibration of seed flow to ensure that seed is sown at the right rate. To calculate the seed flow, depending on which machine you are using, this will involve either timing the seed flow for one minute or turning the seed mechanism drive wheel for a known number of revolutions (determined by the drive wheel circumference).

Calibrate direct seeding machinery after any treatments are added to the seed mix (such as Magnesium Carbonate for ants) to avoid changes to the rate of seed flow.

Sowing depth

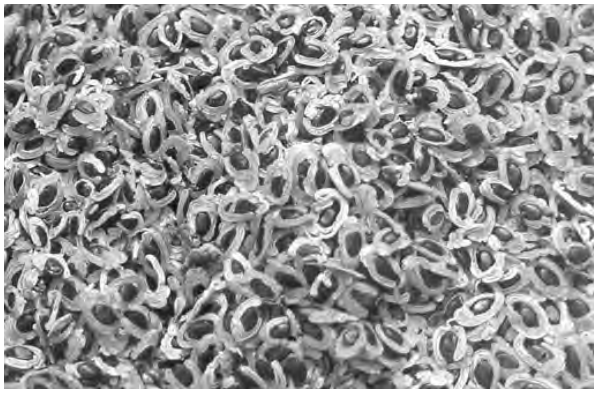


Photo: J. Horlock

For optimum results sow at the appropriate depth for the seed, this will depend on seed size (refer to Bonney 2001 *Germination Pathway*).

Photo: J. Horlock

If the direct seeding machine you are using has two or three seed boxes, which allow different depths of sowing, sow large seeds at no more than 15 millimetres deep and sow small seeds on the surface. The use of the press wheel on machines will ensure good seed to soil contact.

Direct seeding hints

Check that seed is flowing out of the seedbox at the end of each run; seedboxes do clog, so check regularly.

In steep areas where seeding on the contours is not possible, to prevent possible water erosion along scalp lines, lift the seeder out of the ground every 7 to 10 metres or so. Alternatively, have a person, on site while seeding, to push a plug of newly scalped soil back into the line to stop water movement.

Machine clean up

When using borrowed machinery or equipment, to avoid the possibility of weed or disease transfer between properties or regions, please pay particular attention to washing down the machinery or equipment upon completion of your job.

6 SITE MAINTENANCE

Inspect the seeding from about three weeks after sowing, for signs of germination (of good and bad seedlings), pests and diseases. Maintain fences. Take action against pest plants and animals as required.

7 MONITORING

Be patient. Do not write off sites as failures, it can take three years! Take a camera when visiting the site and record the change over time from a fixed point.

Document the species sown, rates and techniques used, and record germination success. This is of interest to you, but is also particularly important information to help refine direct seeding rates when sowing different species and developing strategies to promote germination.

Read about landholder experiences with direct seeding by machine in Footprints Fact Sheets 1, 2, 3, 4, 5, 8, 9, 10, 13, 15, 18, 19, 20, 26, 27, 28, 29, 30, 31, 33, 36, 38, 39, 40.

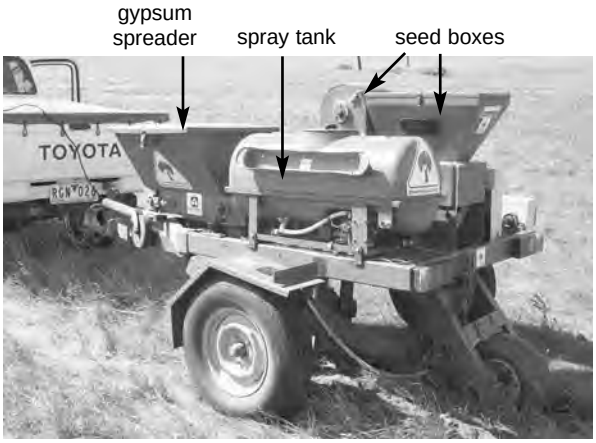
General purpose direct seeding machines

There are a range of direct seeding machines available to direct seed native vegetation. This section provides details on a number of general purpose machines and their features.

Direct seeding machines are commonly mounted on tractor linkage or drawn by 4WD vehicles. The critical issue is ensuring the machine is suited to the site conditions and that it is set up to provide the right seedbed and seed placement. Direct seeding of native vegetation has also been undertaken using existing farm machinery, including grain air seeders (refer to **Footprints Fact Sheet 38**), conventional pasture drills (refer to **Footprints Fact Sheet 15**) and rabbit bait layers (refer to **Footprints Fact Sheet 29**). The following general purpose machinery is available to landholders and the community through the Alcoa Revegetation Assistance Scheme: Burford Tree Seeder (formerly known as the Rodden Tree Seeder), Hamilton Tree Seeder, Rippa Seeder and Eco Seeder. Contact Greening Australia Victoria to hire or source the machinery listed.

Burford Tree Seeder

Designed by Rod Burford from South Australia.



The Rodden III Tree Seeder is out of production and is now known as the Burford Tree Seeder

Soil type and environment
Developed for use on a variety of soil types and climatic conditions. Not preferred for very rocky environments or confined spaces, for example, in narrow belts you need to sow before fences are erected.

Ground preparation required
Weed control to retain soil moisture to depth.

Features
- Up to four seed boxes enabling a wide range of seed to be sown to the right depths.
- Fitted with gypsum spreaders, and spray tanks to apply herbicides, smoke water and liquid mulches while operating.
- Self contained hydraulics for height adjustment.
- High precision placement of seed.

Hydraulics operated from cabin using battery powered motor

Method of sowing
Lightly scalp soil using disc to remove weed seed and create a microenvironment suitable for germination. Large seeds are sown behind a drill boot to ten millimetres deep. Fine seeds are surface sown behind two finger tynes. A press wheel follows to establish seed-to-soil contact. The wheel can be pinned up in sticky soil conditions.

Operation
Towed by a 4WD vehicle. Hydraulics operated from cabin using a battery-powered motor.

Transport
Easily transported from site to site.

Hamilton Tree Seeder

Designed by Keith Cumming from Hamilton, Victoria.

Photos: GAV

The Hamilton Tree Seeder scalps the soil and sows the seed in one pass. Inset: Germination of direct seeding using the Hamilton Tree Seeder at Stawell

Soil type and environment
Most soil types and light, heavy or rocky and steep terrain. Works best in high rainfall areas.

Ground preparation required
Weed control to retain soil moisture to depth.

Features
- Single seedbox can disperse very small to large seeds, single species or in mixes.
- Three point linkage provides manouverability and the ability to lift over rocks or rocky barriers.
- Ability to easily sow discontinuous lines.
- The flow rate of the seed box is controlled by a variable speed gear box which allows fine tuning of the rate of seed sowing.
- Moderate to high precision placement of seed.

Method of sowing
Lightly scalp soil with mouldboard action to remove weed seed, cultivate scalp line with twin offset tynes and create a microenvironment suitable for germination. A press wheel follows to establish seed to soil contact. The wheel can be pinned up in sticky soil conditions.

Operation
Used with a three point linkage tractor. Seeder can attach to either category one or two linkage arms.

Transport
Transported on a light made-to-fit box trailer.

Comments
Light-weight machine making transport easier; with the ability to easily lift over rocks using linkage it is excellent for rocky areas.

Rippa Seeder

Built by Barry Stirling from South Australia.

Photo: GAV

The Rippa Seeder in action in West Gippsland

Soil type and environment
Built to cope with steep, rough environments and able to rip and sow in stony ground (Casey & Chalmers 1993).

Ground preparation required
Weed control to retain soil moisture to depth. The V-shaped scalping blade at the front removes weeds and the seed is then dropped on the ground behind, followed by a spring loaded press wheel. The spring loaded downward pressure of the press wheel assists germination by pressing the seed in firmly.

Features
- Revolving drum seedbox with split bin which allows poorly cleaned seed to be used as well as sowing different sized seed at the same time.
- Three point linkage and design provides excellent manouverability.
- Seeder is multipurpose - it can become a self-centring ripper that does not require lifting out of the ground to turn corners.
- Broad scalping means it is suitable for sites with non-herbicide weed control.
- Moderate to high precision placement of seed.

Method of sowing
800 millimetre wide V-blade scalps soil to remove weed seed; large seeds are sown behind shallow ripper shank in centre, fine seeds are surface sown from second hose. A press wheel follows to establish seed-to-soil contact.

Operation
Used with a three point linkage tractor, bulldozer.

Transport
Transported on a custom built trailer.

Photo: GAV

Eco Tree Seeder

Eco Tree Seeder

Designed by Richard Weatherly, Mortlake, Victoria.

Soil type and environment
Machine operates in a wide variety of soil types.

Ground preparation required
Weed control to retain soil moisture to depth.

Features
- Front scalping disc, cultivating discs, mouldboarding and mounding option.
- Single seed box.
- There is a precision disc that can be fitted if exact seed placement is needed.

Bulking agent
Seed delivery on this machine requires a bulking agent, commonly chick crumbles.

Method of sowing
Lightly scalp soil to remove weed seed using disc; cultivation of scalp line using offset small discs to create a microenvironment suitable for germination. A press wheel follows to establish seed-to-soil contact. The wheel can be pinned up in sticky soil conditions.

Operation
Used with a three point linkage tractor.

Transport
Transported on a custom built trailer.

Comments
No ripper function available.

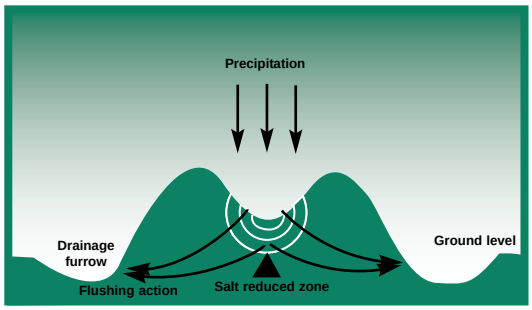
Specialist direct seeding techniques

There are a number of direct seeding techniques suited to particular environments or purposes. This section outlines six of these specialist techniques; m-profile mounding, mouldboard ploughing, deep scalping of steep slopes, applications to assist mechanical direct seeding in difficult soils, hydro-seeding and aerial seeding.

Specialist machinery available under the Alcoa Revegetation Assistance Scheme includes the Saltbush Seeder and Rodden III Scalping Seeder. Machinery for the other four techniques is not available under the Scheme, as this work is usually contracted out.

M-profile mounding

M-shaped profiles are a form of mounding for mechanical direct seeding in saline or waterlogged sites. The dish or dip in the mound allows rain to accumulate and as the water drains into the mound the salt is carried with it. This 'freshens' the soil (Casey & Chalmers 1993) diluting the salts where the seed or seedling is to be established. Specialist direct seeders such as the Saltbush Seeder are available for this technique, see below.



M-profile mound

The following information is a summary of the uses, advantages and factors to consider when using this technique.

Uses

- In saline or waterlogged sites.

Advantages

M-shaped seedbeds are advantageous as they:

- keep the seed above the natural surface thereby avoiding water logging;
- increase the catchment area for rainfall, thereby increasing the amount of moisture available to the seedling;
- leach salt from the mound resulting in a seedbed of lower salinity than the surrounding soils.

Considerations

- Use the specialist direct seeding equipment built for this purpose.
- Follow the step by step checklist for mechanical direct seeding on page 70.

M-profile mounding direct seeding machinery: Saltbush Seeder

Designed by David Millsom, Greening Australia Victoria, Lindsay Ezard, Department of Natural Resources and Environment and farmers from Kerang with experience in direct seeding of saltbush. Kerang Engineering constructed the machines.

Photo: D. Millsom

The Saltbush Seeder creates the m-profile for sowing in heavy soils in semi-arid areas and saline depressions

Soil type and environment
Seeding of saltbush in heavy soils in semi-arid areas and saline depressions.

Ground preparation required
Weed control to retain soil moisture to depth.

Features
- Single pass for seedbed preparation and seeding; accuracy adequate for broadacre use.

Method of sowing
Creates an 'm' profile mound onto which seeds are sown.

Operation
Requires a tractor with remote hydraulics.

Transport
Ten minutes to convert to road towing position.

Comments
Must be adjusted to suit the site. The saltier and wetter the site, the higher the mound formation needed.

Read about landholder experiences with m-profiling in Footprints Fact Sheet 38.

Photo: GAV

Mouldboard ploughing involves completely turning over the soil sod

Mouldboard ploughing

In the high rainfall areas of Victoria (800 to 1000 millimetres per year), in particular South Gippsland and the Otways - Heytesbury area (south west Victoria), direct seeding using mouldboard ploughs is a reliable, efficient, low cost way to establish native vegetation.

Mouldboarding involves using two to three curved ploughs, in sequence, to completely invert or turn over the soil in sods about ten centimetres thick, burying existing grasses and weed seeds. As there is an art to getting the soil to invert properly, contractors are usually used to carry out the ploughing. It results in a rough, weed free surface ready for broadcasting seed. Below is a summary of the uses, advantages and factors to consider when using this technique.

Uses

- For the establishment of native vegetation in areas of high rainfall and heavy wet soils.

Advantages

- Mouldboarding combats high rainfall by creating a variety of niches so that the seedlines do not fill up with water.
- The uppermost layer of soil is buried with its load of weed seed which assists with weed control.
- The technique creates a variety of niches, which in turn creates favourable conditions for a range of germinating seeds.
- Broadcasting of seed can be random, sown in rows for a more uniform effect or in specific spots along the seed line.
- Mouldboarding can stimulate natural regeneration, for example, of Wattles.
- If native vegetation is nearby the ploughed site can provide a seedbed for wind blown seed.

Considerations

- You need specialist equipment and environments to use this method.
- There is a high level of disturbance created by completely inverting the soil.

Steps for successful mouldboard ploughing

1 PLANNING

Photo: K. Walsh

- Determine purpose/s of revegetation
- Prioritise site selection
- Assess the site
- Select species
- Develop seeding design
- Source contractor for mouldboard ploughing
- Acquire the resources

2 PREPARING THE GROUND

Weed control

Photo: K. Walsh

Ideally, commence weed control at least twelve months before sowing.

Jan-Feb: Ensure the grass is short by grazing or slashing
Autumn: First spray of knockdown herbicide
Spring: Second spray of knockdown herbicide one week before sowing

Residual herbicides should not be used as site preparation for this technique as seed may come into contact with the herbicide and be killed.

Soil preparation

No pre-sowing soil preparation required. The soil is prepared by the mouldboard ploughing process itself.

3 PEST ANIMAL MANAGEMENT

Photo: K. Walsh

Prior to sowing fence sites to protect them from grazing by livestock and undertake pest management to eradicate vermin such as rabbits and hares.

4 SEED

Sourcing seed

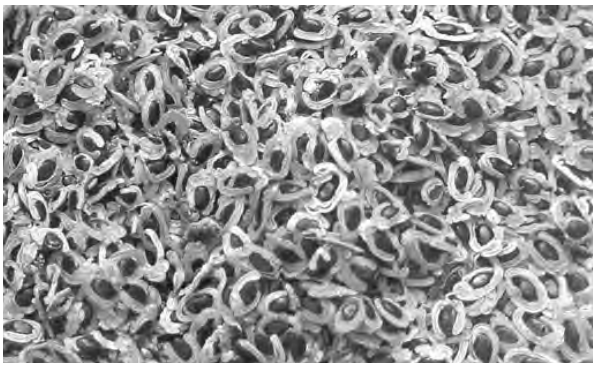


Photo: J. Horlock

Plan ahead for seed collection, which usually occurs in summer. However, some native plant fruits are not ripe in summer, for example, Sweet Bursaria, Red Gum and Manna Gum. Monitor local species populations to determine the ripeness of the fruits, for example, gum nuts or capsules.

There can be seasonal variations in fruit ripening, for example during a drought year compared to an average rainfall year.

Use seedbanks for species which may not set seed that year or if you are unable to collect your own.

Species mix

Aim to utilise as many as possible of the **indigenous** species that would have naturally occurred on your site. This will maximise the re-creation of as much of the structural and floristic diversity present in the original vegetation.

Include greater proportions of large-seeded legumes (colonisers) in the mix. A good mix of seeds would be 15% Eucalypts, 40% Wattles and 40% others, for example, She-oaks, Tea-tree (*Leptospermum* spp.), Dogwood, Paperbarks, rushes and Kangaroo Apple.

Calculating seed quantities

The amount of seed needed can be calculated using a seeding rate of two to three kilograms per hectare, that is, two to three kilograms per 10,000m3.

Seed treatment

Maximise successful germination by treating seed appropriately, if required at all.

Germination testing of individual seedlots is useful (contact your local seedbank). Always sow fresh, viable (living) seed.

Timing of seeding

Most mouldboard plough sowing is undertaken in spring, however, machinery access to the site will usually dictate the timing.

5 MOULDBOARD PLOUGHING

The next 4 steps should be carried out on the same day.

Plough

Photo: K. Walsh

There is an art to inverting the soil properly. Use a skilled contractor to undertake the mouldboard ploughing.

A single pass with a mouldboard plough will invert the soil with sods about ten centimetres thick and create a rough weed free surface. The seeds from pasture weeds are buried.

Roll

Photo: K. Walsh

Mouldboard ploughing creates air gaps. Roll at this stage to eliminate air pockets and leave the surface rough to provide niches for the germinating seeds.

Use tractor wheels, a four wheeled motor bike, paddock rollers (pictured) or drag branches over the site.

Sow

Photo: GAV

Sowing takes place as soon as the site is ploughed. Ensure soil is still moist and friable for sowing and does not have a glazed crust.

Mix seed with a bulking agent, such as coarse damp sand, to assist with coverage (ten parts sand to one part seed).

Broadcast the seed by hand or using a lawn seed spreader in the furrows and selvage (refer to Direct seeding by hand section). It is necessary to come back and sow the edges of the site.

Natural results can be achieved by broadcasting across the entire area or more uniform results can be achieved by ploughing and seeding in rows.

Roll (as required)

Roll the site to provide good seed to soil contact.

6 SITE MAINTENANCE

Inspect the seeding from about three weeks after sowing, for signs of germination (of good and bad seedlings), pests and diseases. Maintain fences. Take action against pest plants and animals as required.

Photo: K. Walsh

7 MONITORING

Photo: GAV

Be patient. Do not write off sites as failures, it can take three years! Take a camera when visiting the site and record the change over time from a fixed point.

Document the species sown, rates and techniques used, and record germination success. This is of interest to you, but is also particularly important information to help refine direct seeding rates when sowing different species and developing strategies to promote germination.

Further information

Contact the Gippsland or South West staff of Greening Australia Victoria (via the Head Office Ph 03 9450 5300) or contact the Department of Primary Industries Office in Gippsland on Ph 03 5662 9920.

Read about landholder experiences with mouldboard ploughing in Footprints Fact Sheets 9, 11 and 14.

Deep scalping of steep slopes

Steep and high rainfall areas, like the agricultural land in the Strzeleckis Ranges of West Gippsland, pose a challenge for revegetation. The reasons include:

- the steep terrain limits machinery access, both for site preparation and carrying out mechanical direct seeding;
- hand planting (which still requires site preparation) is labour intensive and tiring!;
- machinery must cope with heavy soils and the slope;
- there is a considerable weed seedbank in the soil to tackle;
- the deep, fertile soils and high rainfall means that weeds, as well as native species, grow quickly.

Photo: B. Teesdale

Steep slopes of the Strzelecki Range in Gippsland.

Deep scalping using bulldozers

Photo: B. Teesdale

Bulldozers have been used to deep scalp the slopes for hand sowing.

Deep scalping with a bulldozer has been used with success in the Strzelecki Ranges. However, because of the high level of disturbance to the site, it is critical that a thorough investigation is undertaken of other revegetation options and an assessment of the existing features of the site that may be compromised by such a technique. This technique may have applicability in other steep slope areas of Victoria, for example, the Otways. Below is a summary of the uses, advantages and factors to consider when using this technique.

Uses

- For former pasture land on steep slopes in a high rainfall and heavy soil environment (currently being trialled in the Strzelecki Ranges).

Advantages

- One pass weed control and seedbed preparation (the bulldozer blade removes the weed layer and creates the surface for sowing).
- Covers large areas in a short time.
- Thick band of seeds can be sown.
- Early indications show that direct seeding is a very cost-effective method of revegetation for the steep slopes country.

Considerations

- **CAUTION**: This is a skilled operation that requires highly experienced operators of the machinery, who are familiar with the terrain.
- Work along the contours to reduce the erosion potential.
- Avoid drainage lines and gullies.
- Access for machinery onto the site will play a large part in determining the seeding time.
- There is a high level of disturbance.
- Continued monitoring of the bulldozing sites is occurring and the potential use of the Rippa Seeder is being considered. This seeder works on the same principle of scalping but will distribute the seed at the same time. Other machines, such as the Delva Plough or a grader blade may be options.

Department of Primary Industries staff, involved in revegetation in the Tambo Valley, have found excavators just as useful as bulldozers in their steep and/or rocky country. Costing approximately the same amount, preparation of the seedbed using excavators has the advantage of not leaving a continuous line in which water can travel.

Steps for successful deep scalping of steep slopes

Follow the steps for successful direct seeding by machine on page 70 and note the following:

PREPARING THE GROUND

Weed control

The bulldozer blade prepares the seedbed and provides the weed control in the same pass. No other form of weed control is needed prior to bulldozer works.

Soil preparation

Seedbed preparation: The key to the deep scalping technique is to remove the top layer of weeds and soil.

Photo: B. Teesdale

Scalping depth and angle: The site should be scalped ten centimetres (four inches) in depth to effectively remove the weed roots. The blade should be driven at a slight angle to push the weed heap to the side of the sowing 'row' and create a terracing effect **along the contours** of the hillside.

Terracing effect: Approximately one metre intervals are made in between the scalped rows and are heaped with the weed and soil. The principle of the terracing effect is that the rain hits the slope and soaks down into the heaped area and underneath; the weed roots remain intact helping to bind the soil together. By scalping with the contours of the land, the natural slope is maintained and excessive water is soaked into the pile. Drainage lines are NOT terraced and are hand planted instead.

Photo: B. Teesdale

SEEDING

Timing

Photo: B. Teesdale

Timing will be dictated largely by access of machinery onto the site.

Sowing of the seed takes place as soon as possible after scalping. Two kilograms of mixed seed are sown per hectare.

A bulking agent or filler, such as chick crumble or sawdust, is mixed with the seed to assist with seed coverage across the site. The mixture is then broadcast by hand walking along the contours.

On average, two hectares per day, per person can be undertaken when broadcasting seed (refer to Direct seeding by hand section).

MONITORING

Also monitor for erosion and turbidity in nearby waterways.

Further information

Contact the Gippsland staff of Greening Australia Victoria (via the Head Office Ph 03 9450 5300).

Read about landholder experiences with deep scalping in Footprints Fact Sheet 12.

Applications to assist mechanical direct seeding in difficult soils

Some soils pose a challenge for direct seeding. Their properties and the environment that they are in, have, in the past, resulted in low rates of seedling establishment. Two products, soil wetting agents and spray mulches that may be applied to the site whilst direct seeding to overcome these problems are outlined below.

It is best to trial the use of such applications by seeding an area, with and without the application, to determine if there is a marked difference and whether it is worthwhile for the particular conditions at hand.

Soil wetting agents

Soil wetting agents can be beneficial in different soil types, such as non-wetting sands. The objective of the agents is to break down water repellants and allow the soil to 'wet up' from the surface down, following rainfall events. Soil wetting agents can be easily applied using a single spray nozzle and standard 'tray-mate' spraying unit. Sprayers can be mounted to direct seeding machines or the towing vehicle. Some direct seeding machines, such as the Burford Tree Seeder, already have a spray tank facility. Soil wetting agents have been extensively used in south-eastern South Australia and, in recent years with good results, in the Wimmera.

Contact your local agricultural product supplier to obtain soil wetting agents.

Spray mulches

In some soils, such as non-wetting sands which are prone to wind erosion, the application of spray mulch may be advantageous. The mulch improves the establishment of vegetation by stabilising soil and conserving moisture and reducing evaporation and protecting the seed from insect predation (for example, ants).

The mulch is applied over the seeded row as a spray and dries forming a crust. The material remains intact but is thin enough for the seedlings to emerge through (Dalton 1993).

Water-based bitumen is one product that has been used with success, particularly for fine seeded species such as Eucalypts (Dalton 1993). Be aware that if bitumen is used, it is very messy to work with, sets rapidly, it may block hoses, is usually only available in large quantities and will require effort to transport.

Machinery used for spray mulches

Some direct seeding machinery can be set up with a bitumen spray tank to apply bitumen in the same pass as the seeding.

Rodden III Scalping Seeder

Photo: J. Robinson

The Rodden III Scalping Seeder applying bitumen mulch in the Wimmera

Three-point linkage seeder designed for low rainfall areas and non-wetting sands.

Soil type and environment
Low rainfall areas and non-wetting sands.

Ground preparation
The machine's heavy blade forms a metre wide weed-free scalp line and water harvesting.

Features
- Water-based bitumen mulch overspray system can be attached.

Method of sowing
The machine scalps very radically, therefore take great care to manage the erosion potential. Also, if used with care, this technique can be part of a non herbicide vegetation establishment regime.

Operation
Medium sized three point linkage tractor.

Transport
Transported on its own custom built trailer.

Comments
Accuracy is dependent on maintaining an even ground speed.

Further information

Contact the Wimmera staff of Greening Australia Victoria (via the Head Office Ph 03 9450 5300).

Read about landholder experiences with spray mulches in Footprints Fact Sheet 28.

Hydro-seeding

Photo: GAV

Hydro-seeding to establish grass coverage

Hydro-seeding is a system of establishing vegetation in a quick and uniform manner. It is particularly useful for the even coverage of areas that are hard to access with other machinery, for example, steep road batters. The technique involves mixing the material to be sown with water in the hydro-seeding machine and applying it to the soil surface using a high pressure jet. There are two main processes used, hydro-mulching and hydro-seeding and mulching.

Hydro-mulching

The seed is mixed with a cellulose fibre mulch and water to form a slurry which is then applied to the site.

Application

- Open areas, parks, reserves etc.
- Slopes less than one in three when mulch binders are not being used. Binders can be added to hydro-mulch in steeper areas.

Advantages

The cellulose gives initial surface erosion control, helps to hold in moisture and insulates the soil which moderates soil temperature and promotes germination (Pearce 1986 and BWD Hydraulic Seeding Pty. Ltd. 1).

Hydro-seeding and straw or bitumen mulch

This process has two steps. First the hydro-seeder applies the seed and water mix to the site. A separate machine then, either applies a hay or straw mulch or a straw/bitumen mulch over the hydro-seeded area.

Application

- Roadside batters, embankments, river banks, restoration after engineering works.
- Straw/Bitumen Mulch is more often used on slopes up to a maximum of 1½ to 1 as long as the surface is fairly uneven (not cut smooth by a grader).

Advantages

This mix reduces the impact of rain on the site, provides a longer period of erosion control, holds moisture in and moderates the soil temperature. It remains intact while the roots of the plants develop and also helps to protect the soil and seeds from erosion and predation by birds and insects. (Pearce 1986 and BWD Hydraulic Seeding Pty. Ltd. 2).

Further information

Hydro-mulching and *Hydro-seeding and Straw/Bitumen Mulch* fact sheets produced by BWD Hydraulic Seeding are recommended.

Aerial seeding

'Aerial sowing is the spreading of seed from an aircraft on to a prepared seedbed in order to regenerate the site after timber harvesting' (Fagg 2001 p.8).

While this technique can cover large areas in a short amount of time, it is a specialised and expensive operation compared to the other techniques mentioned in this document. It may be the best option for large-scale revegetation in rocky, hilly areas that are not trafficable by machinery and difficult for walking, for example, the escarpment country in the Rowsley Valley near Bacchus Marsh.

Further information

Eucalypt Sowing and Seedfall, Native Forest Silviculture Guideline No. 8 by Fagg is recommended. Contact the Department of Primary Industries, Forestry Section
Ph 13 61 86.

Direct seeding by hand

Direct seeding by hand is another option for native vegetation establishment and can be used for a range of purposes and in many different situations. This section looks at a number of the options of hand sowing available: broadcast sowing, spot sowing, niche seeding, brush matting and 'lay and spray'. In general, the principles for all are similar in that each method prepares a germination bed and the seed is then applied to the area. Below is a general summary of the uses, advantages and factors to consider when deciding whether to direct seed by hand.

Uses

- Suits revegetation projects from a small to large scale, particularly those that are inaccessible by machine or require minimal disturbance.

Advantages

- Low-cost technique for establishing native vegetation.
- Suitable for small and remote areas.
- Equipment is simple, portable and inexpensive.
- Useful where machinery is unsuitable, for example, rocky, steep hills.
- Involves little in the way of soil disturbance and allows for more controlled placement of plants within a site.
- Can be used to complement other methods of establishment such as regeneration, direct seeding or planting.
- Useful for the establishment of understorey plants.
- Depending on the technique and seasonal conditions, the seed can be sown while the seedbed is being produced.

Considerations

- More labour intensive.
- Be aware of potential health and safety concerns, for example the constant bending and straightening of the back required by some techniques.

Seed coating and bulking agents

For some hand sowing methods, seed may be coated with a 'sticker' (e.g. egg-white based sticker) to increase its size and weight thereby increasing the distance of spread (Fagg 2001).

If a seed coating is not available, or suited to the method of hand sowing, a bulking agent may be used to enable more even distribution of seed, by diluting the seed lot. Bulking agents can also help control the rate of seed being sown, either by hand or hand operated equipment. Chick crumble, sand or sawdust can be used. However, the closer the bulking agent is to the size and density of the seed the better; this will avoid the two separating during distribution (Fagg 2001).

The following section will outline selected hand sowing methods.

Broadcast sowing

Hand broadcasting

Photo: GAV

Hand broadcasting seed across a mouldboard ploughed site

Hand broadcasting involves casting seed by hand across the prepared seedbed, sometimes called 'feeding the chooks'.

A seed coating or bulking agent can be used to assist distribution. If neither are used, make a small cup and use that to help ensure the same weight of seed is being broadcast across the revegetation site. While a simple technique, be aware that it will take longer and seed distribution will be less even than using a spinner (described below) and the results can be patchy.

Read about landholder experiences with hand broadcasting in Footprints Fact Sheet 14.

Spinner

Photo: GAV

Using a spinner to direct seed by hand

Hand cranked spinners can be used to sow seed evenly across larger revegetation sites. The speed of sowing depends on the walking and cranking pace and the size of the opening from the hopper, while the width of sowing will depend on whether the seed is coated or not and how fast it is cranked (Fagg 2001). Some calibration will be required and fluffy seeds, like Daisy-bushes (*Olearia* spp.) and Cassinia that may block up the spinners should be sown by hand.

Contact your local agricultural product supplier to obtain a seed spreader; it is an adaptation of a hand fertiliser spreader.

Read about landholder experiences with spinners in Footprints Fact Sheet 11.

Spot sowing

Spot sowing refers to using a measured amount of seed and sowing that in specific spots within a revegetation site. In other words, sowing discrete spots rather than spreading the seed across the whole site.

Ideal for small areas or for sowing seed that is expensive or not available in large quantities, spot sowing can have a higher establishment rate than broadcasting because the spot has been particularly selected or prepared (Fagg 2001). However, to reduce competition avoid areas of well-established vegetation. Methods for spot sowing include: rake hoe, Doyle Seeder, seed-a-metre and hand held seed dispensers.

Rake hoe

The rake hoe method involves the hand scalping of the top soil with weed seeds from a spot, light cultivation and the sowing of seed into that spot. A rake hoe, a tool normally used to make fire trails, can be used to create the clearing; they are available from hardware stores.

Photo: GAV

Scrape the seedbed

Photo: GAV

...and then rake to prepare the soil

Steps involved when using a rake hoe

- Control weeds in a 1 to 2 metre diameter circle and conserve moisture by chemical or manual means.
- One to three weeks after weed control, scrape/scalp the area using the hoe side of the rake hoe to remove dead weeds and trash.
- Use the rake side to lightly cultivate the surface soil.
- Apply a measured amount of seed to each spot (always sow into a moist seedbed).
- For fine seed, such as Eucalypts and Tea-tree, use the flat end of the rake hoe to tamp the soil and firm in the seed.
- For larger seeds, such as Wattles and She-oaks, rake the area again and then tamp down with the flat end of the rake hoe. Ideally, bury larger seeds to a depth of about twice their size.

(Steps adapted from the State Tree Centre *Tree Facts* 1991).

Doyle Seeder

The Doyle Seeder, developed by Denis Doyle in Alexandra, is a modification of a long-handled, three pronged garden hoe. The hoe has a lidded, plastic, pipe cylinder attached and a small seed-release slide operated by a hand lever. The pronged hoe cultivates the seedbed and the hand lever releases the desired amount of seed from the pipe onto the seedbed (Fagg 2001).

Contact Greening Australia Victoria for details of suppliers.

Seed-a-metre (marketed as the Weed-a-Metre)

Originally developed for dispensing granules of herbicide, this tool has been used for surface sowing of fine seeds, such as Eucalypts, in forestry situations. The cone shape facilitates the spreading of seeds over a circle diameter of 1.5 metres (Fagg 2001). This method requires a pre-prepared seedbed and is probably unsuitable for large-seeded species, such as Wattles.

Contact Greening Australia Victoria for details of suppliers.

Hand held seed dispensers

Hand held seed dispensers that apply measured quantities of seed onto the prepared seedbed, are available. Contact Greening Australia Victoria for details of suppliers.

Read about the use of a seed dispenser for revegetation in Footprints Fact Sheets 19.

Niche seeding

Successful niche sowing in south-west Victoria

Niche seeding is a hand, direct seeding technique whereby a small hole is created in the soil into which pre-germinated (primed) seed is sown.

The huge advantage of this technique comes from the priming. The seed is brought to the point just before root emergence and then sown; this encourages rapid germination of the seeds and gives the plant the chance to exploit the available resources before the weeds. Its chance of being eaten is also reduced! There are a number of considerations to take into account when using primed seed. Refer to Section A, under Seed for more information.

The other advantage of this technique is that the hole into which the seed is sown provides a microenvironment for the seed; weeds have been removed from the immediate germination area and highly fertile media can be placed into the area ready for sowing seed.

Successful species for niche seeding

Silver Wattle (*Acacia dealbata*), Black Wattle (*Acacia mearnsii*) Golden Wattle (*Acacia pycnantha*), Yellow Gum (*Eucalyptus leucoxylon*), Mountain Ash (*Eucalyptus regnans*), Tea-trees (*Melaleuca* spp.), Bottlebrushes (*Callistemon* spp.), She-oaks (*Allocasuarina spp.*), Hop Bush (*Dodonea viscosa*), Hemp Bush (*Gynatrix pulchella*), Golden-tip (*Goodia lotifolia*), Austral Indigo (*Indigofera australis*) and grasses such as, Wallaby Grass (*Danthonia* spp.), Tussock Grasses (*Poa* spp.), Weeping Grass (*Microlaena stipoides*) and Spear Grasses (*Stipa* spp.). All have been tried with success.

Further trialling across a range of soil and climatic conditions is encouraged.

Equipment needed for niche seeding

- Plastic resealable bags/sealed plastic bins.
- Perlite or similar germination medium (finer grain sizes preferable).
- Guards (as needed); milk cartons or cardboard tubing is ideal.
- Fresh viable seed.

Steps for successful niche seeding

1 PLANNING

- Determine purpose/s of revegetation
- Prioritise site selection
- Assess the site
- Select species
- Develop seeding design
- Acquire the equipment and resources

2 PREPARING THE GROUND

Weed control and soil preparation

Ensure all weeds are controlled before seeding and ideally that you are sowing into bare ground. Good weed control creates a reservoir of moisture which is available for newly germinated seedlings.

Usually about one metre diameter circles are adequate or prepare larger areas if closer sowing is required.

3 PEST ANIMAL MANAGEMENT

Prior to sowing fence sites to protect them from grazing by livestock and undertake pest management to eradicate vermin such as rabbits and hares.

4 SEED

Sourcing seed

Plan ahead for seed collection, which usually occurs in summer. However, some native plant fruits are not ripe in summer, for example, Sweet Bursaria, Red Gum and Manna Gum. Monitor local species populations to determine the ripeness of the fruits, for example, gum nuts or capsules. There can be seasonal variations in fruit ripening, for example during a drought year compared to an average rainfall year.

Use seedbanks for species which may not set seed that year or if you are unable to collect your own.

Species mix

Aim to utilise as many as possible of the **indigenous** species that would have naturally occurred on your site. This will maximise the re-creation of as much of the structural and floristic diversity present in the original vegetation. You may prefer to exclude rare or difficult to grow plant species from your mix and instead plant nursery-grown seedlings. This will ensure that valuable seed is not wasted and that such species will establish more reliably on your site.

Include greater proportions of large-seeded legumes (colonisers) in the mix.

Calculating seed quantities

To determine how many viable seeds there are per gram of different species consult a local species list such as Dalton (1993), Appendix 1, 'Number of Seedlings Per Gram of Seed' or in Bird (1992) *Trees and Shrubs for South-West Victoria* or the Greening Australia Victoria Seed Germination Data Sheet Series 1 - 9 (Refer to Section C).

The number of seeds required for niche direct seeding will also be dependent on the species, rainfall and local conditions.

In general, in higher rainfall areas sow larger seed such as legumes, at three to four seeds per hole and ten to fifteen seeds in drier, low rainfall areas. For fine seeds such as Eucalypts, fifty plus seeds may need to be sown per spot (again, more or less depending on the circumstances).

Seed treatment

Maximise successful germination by treating seed appropriately, if required at all.

Germination testing of individual seedlots is useful (contact your local seedbank). Always sow fresh, viable (living) seed.

Prime the seed

Use a clear resealable plastic bag or plastic container and fill with a quantity of the germination media.

Mix the seed germination medium through and seal tightly, taking care not to expel all of the air.

Store the seed for approximately five days (as a general rule, seed can be primed about five days to sowing. Wattles can be primed ten days before sowing).

Check occasionally to see that there is sufficient moisture but do not drown the seed!

Note: It is not advisable to 'push' the seed too far into the germination process. Sow the seed before the emergence of the radical (first root). If the radical has emerged, it will probably be damaged by niche seeding. The objective at this stage is to 'awaken' the seed, not create a seedling.

5 SOWING

Timing of sowing

Sow into moist soil if possible. As a guide:

Medium to high rainfall areas - spring sowing
Semi-arid areas - autumn/winter sowing
Frost prone areas - spring sowing

Prepare hole

Photo: J. Watt

Prepare a hole (niche) by taking a core of soil out, ideally using a Hamilton Treeplanter (cell size) to a depth appropriate for the soil conditions. As a guide this is usually 25 to 30 millimetres, however, the aim is for the seed to be placed in the soil profile area with the most nutrients, that is, the top layer. In poor soils, this layer may be very thin and therefore the hole may need to be shallower.

A gauge can be attached to the Treeplanter to act as a guide for hole making, this will speed up the process.

Sow

Photo: J. Watt

Place approximately two centimetres by two centimetres mix of media into the bottom of the hole.

Firm in

Photo: J. Watt

Gently firm down the media with a 'tamping stick', for example, a broom handle or stake to ensure the seed is making good soil contact, but not so hard that the seed is damaged.

Watering and guarding

Watering and guarding is optional. If guarding, the use of a tube or cylinder, such as a milk carton, enhances germination by preventing wind from drying the seedbed. It can also help prevent soil or other debris covering the seed and assist in keeping the seed in place if there is a heavy rainfall.

If light is an issue, consider using a clear guard, such as a length of coil of PVC water pipe, approximately ten millimetres in height (note this will need to be removed later on).

For small projects, a non-chemical form of weed control such as mulch mats which suppress weed growth can be used to surround the niche.

6 SITE MAINTENANCE

Inspect the seeding from about three weeks after sowing for signs of germination (of good and bad seedlings), pests and diseases. Maintain fences. Take action against pest plants and animals as required.

Prickly species, such as Hedge Wattle, have been sown with palatable species, such as She-oaks, to reduce animal browsing.

Do not be concerned if there are multiple seedlings growing in each spot as these will either self thin over time or you can selectively prune unwanted stems as required.

7 MONITORING

Be patient. Do not write off sites as failures; it may take three years! Take a camera when visiting the site and record the change over time from a fixed point.

Document the species sown, rates and techniques used, and record germination success. This is of interest to you, but is also particularly important information to help refine direct seeding rates when sowing different species and developing strategies to promote germination.

Read about niche seeding being used in revegetation in Footprints Fact Sheet 19.

Brush matting

Brush matting is another method of vegetation establishment and is commonly used for small scale, intensive strategies, in coastal environments as a way to hold the soil together, to limit beach access and to reduce erosion.

The technique involves cutting branch material, 'brush', at a time when the fruits are ripe, and laying it on a bare or prepared area. The branches are then pinned down to hold it in place. Over time, the fruits open and drop their seeds resulting in regeneration. At the same time, the erodible soils are stablised and people are deterred.

The 'brush' implies the type of plant, and commonly, in coastal areas local Tea-trees (Myrtaceae family) have been used. Where the branches are cut, the original plant is able to re-sprout.

A responsible approach to the pruning involved with brush matting is encouraged, for with no weed control the probability of success is lower than with other techniques.

'Lay and spray'

One technique that has been used, in particular, to establish Kangaroo Grass is the lay and spray method.

Immediately after harvest (when the seeds are ripe, usually in January) Kangaroo Grass hay is spread out onto a site. The seeds drop and are screwed into the soil, after rain, by their awns. The site is sprayed with herbicide in winter, after the tall perennial weeds have grown through, and the hay is then burnt at the earliest opportunity in spring. Kangaroo Grass seeds begin to grow in November.

This technique is only suitable for smaller sites. The availability of efficient, native grass seed harvesters, for example, the Bandicoot Native Grass Seed Harvester, in recent years, in a number of locations, has meant that sizeable amounts of Kangaroo Grass and other native grasses are now more readily available. Trialling of the sowing of native grass seed through conventional pasture drills is advancing and it is likely that in the immediate future, we will have the ability to re-establish native grasses on a large scale. However, our native grasslands and grassy woodlands are extremely depleted. If we are to make a serious attempt to re-instate areas of these habitats, seed production areas will be required for many of the native grassland species and the lilies, peas, daisies, orchids and sundews.

3. Planting

The planting of indigenous seedlings can be undertaken by machine or by hand. While there is an increase in labour, time and money with this technique compared to natural regeneration and direct seeding, a high level of efficiency can be achieved with the use of planting equipment and when planting is preceded by good planning and ground preparation. Importantly, there are also social and educational benefits to be gained from the hands-on involvement that this technique offers at the planting stage.

This section will include information on planting by machine or hand, steps to follow for successful planting and planting machinery and equipment.

Planting by machine

Photo: GAV

The Waikerie Planter in action

Mechanical planters work on the principle of opening the soil with a broad tyne or shank so that a plant can drop into the space. Press wheels then push the soil back around the plant as the machine travels forward. Different machines are able to plant different seedling stock, including cells, tubestock and open-rooted seedlings. Below is a summary of the uses, advantages and factors to consider when using this technique.

Uses

- Used primarily for large-scale vegetation establishment on flat to undulating country.

Advantages

- Mechanical planting provides an efficient option for large-scale revegetation in the right conditions - flat to undulating country with friable soil conditions.
- Suitable for planting plants grown from cuttings or tissue culture or open-rooted seedlings.
- It is particularly suitable for projects which require regular, known, spacings of tree seedlings, such as farm forestry or narrow shelterbelts.
- For use in planting selected, high performance, provenance seedlings which would be too wasteful of seed or too expensive to direct seed.
- Can commonly achieve planting rates of 500 to 1,000 plants per hour.
- Enables older or infirm people to participate in planting.
- Some machines water-in planted seedlings.
- Much less tiring than manual planting.

Considerations

- Good soil preparation is crucial.
- Maximum sub-soil moisture conservation is critical.
- Mechanical planting machines work extremely well where very friable soil conditions are present. If the soil has not been sufficiently cultivated and is still cloddy, some seedlings will not be correctly planted and can be left lying on the soil surface. Cultivation to achieve soil conditions, similar to rotary hoeing, is recommended.
- The site should be assessed; mechanical planters work best on relatively level sites and along long, straight runs.
- If planting less than 10,000 cells, reconsider this option as 2,000 plants can be established in one day, per person, by hand techniques, for example, using planting tools such as Pottiputkis used with kidney-shaped planting boxes.

- Health and safety issues need to be considered. For example, using the Youman Tree Planter requires the operator to bend forward and sideways. To avoid possible back ache regular changing of operators is suggested.
- Usually suitable for projects with a narrow species range.

Read about landholder experiences with mechanical planting in Footprints Fact Sheets 2, 16, 28, 30 and 32.

Planting by hand

Greening Australia Victoria's annual Spring Planting Festival encourages community involvement in revegetation (above) as do the Hindmarsh Planting Weekends in rural Victoria.

Photo: R. Dodds

Seedlings, whether bare rooted, cells or tubes can be established by hand operated tools in a wide variety of conditions. Planting by hand also provides a high level of community involvement in revegetation activities, providing an enjoyable social and educational experience. Below is a summary of the uses, advantages and factors to consider when using this technique.

Uses

- Revegetation of areas hard to access by machine.
- Small to large scale works.
- Fosters community involvement in revegetation.

Advantages

Hand planting is a technique most suited to revegetation projects that:

- require selected plants at regular spacings, for example, farm forestry;
- require species that are difficult to direct seed;
- are establishing species for which there is a limited seed supply; hand planting can be valuable in setting up seed production areas to rectify this problem for the future.
- aim to provide a high level of community education at the planting stage;
- are inaccessible by machinery;
- are of a small scale;
- use a wide range of species;
- are planting specimen trees.

Considerations

- There is greater time involved and a higher cost associated with plant production, time and equipment compared to direct seeding.
- Logistics of material and people access across the site.
- Reduced efficiency for large scale revegetation.

Read about landholder experiences with hand planting in Footprints Fact Sheets 17, 18, 19, 22, 25, 26, 30, 31, 34, 35 and 37.

Steps for successful planting by machine or by hand

1 PLANNING

- Determine purpose/s of revegetation
- Prioritise site selection
- Assess the site
- Select species
- Develop planting design
- Select machinery/equipment for planting
- Acquire the resources

2 PREPARING THE GROUND

Photo: R. Talbot

Weed control

Ensure all weeds are controlled and ideally plant into bare moist ground. Good weed control creates a reservoir of moisture in the planting area which is available for use by the seedlings.

Soil preparation

Different sites and planting machines/equipment will require different site preparation. Well-prepared weed-free soil is essential for most sites.

3 PEST ANIMAL MANAGEMENT

Photo: R. Talbot

Prior to planting fence sites to protect them from grazing by livestock and undertake pest management to eradicate vermin such as rabbits and hares.

4 SEEDLINGS

Sourcing seedlings

Choose plant material of a high quality (see Section A under Seedlings).

Place plant orders well in advance - at least twelve months before planting. This will allow nurseries to obtain the right seed and have plants grown to the right stage.

If placing a large order consider spreading the 'risk' over a number of nurseries; nursery 'disasters' can happen, for example, frost events and poor or no germination.

Consider the length of time the plants are left in the container - too long and they may be pot bound.

Choose plants that have been grown in conditions that help to prevent root circling or that reduce the damage to the root, for example, air pruning and ribbed pots.

Refer to Greening Australia Victoria's nursery listings for suppliers of seedlings in your area. 'Indigenous Nurseries of Melbourne's Port Phillip and Westernport Regions' and 'Farm Tree Nurseries and Growers in Rural Victoria'. Details are provided in Section C.

Species mix

Aim to utilise as many as possible of the **indigenous** species that would have naturally occurred on your site. This will maximise the re-creation of as much of the structural and floristic diversity present in the original vegetation. Include greater proportions of legume (colonisers) in the mix.

Calculating plant quantities

The ratio of trees to shrubs and ground cover plants, and their densities will depend on the type of vegetation community being created. As a general rule, for what were originally forest environments, a 20% overstorey of trees and an 80% understorey of shrubs and ground covers is suggested. However, for native grasslands or grassy woodlands, the diversity of species is in the ground flora alone, rather than the canopy layer.

It is best to seek local advice to determine the most appropriate spacing of plants for the vegetation community that you are creating.

As a general guide for spacings:

Canopy trees = 1 per $5m^2$
Shrub layer = 1 per $2\text{-}3m^2$
Ground covers/grasses = 4-5 per $1m^2$

5 PLANTING

Timing of planting

Plant into moist soil if possible - moist site conditions suggest that weed control measures have been taken!

Guide to Timing:
Medium - high rainfall areas - spring planting
Semi-arid areas - autumn/winter planting
Frost prone areas - spring planting

Watering and guarding

Watering at planting is advantageous to remove air pockets from the roots, to help overcome any transplant shock and to establish good root to soil contact. (**In wet sites, watering may not be necessary**). Refer to Section A under Revegetation for more information.

If guarding, ensure they are anchored securely. The diagrams on page 106 provide the correct technique for hand planting seedlings.

Machinery and equipment

Select the machine or equipment to suit the environment, soil types and to match the plant container size. Refer to the detail on machinery and hand tools available to follow.

Machine and equipment clean up

When using borrowed machinery or equipment, to avoid the possibility of weed or disease transfer between properties or regions, please pay particular attention to washing down the machinery or equipment upon completion of your job.

6 SITE MAINTENANCE

Photo: R. Dodds

Inspect the planting site and seedlings for signs of pests and diseases and take action as required. Replace and remove guards as needed and maintain fences.

In exceptionally dry years or low rainfall areas, for example, the Mallee, consider a second watering over the summer period.

7 MONITORING

Take a camera when visiting the site and record the change over time from a fixed point.

Keep records of other observations, for example, of birds and other animals that use the site. This will provide good 'bench marks' for measuring the success of future revegetation projects, particularly those that have biodiversity conservation/enhancement as an objective. This will also provide an increased sense of satisfaction from the work involved with revegetation.

Similarly, it is often useful for future reference to keep a record of the species planted, dates of activities and documents such as nursery invoices.

Mechanical planting machinery

Bushplanter

Photo: GAV

The Bushplanter is a versatile and commonly used mechanical planter that has been adapted from horticulture.

Ground preparation required
Well-worked, friable, fine tilth to a greater depth than the cell tray height.

Soil type and environment
Works in a range of soil types if the soil is well prepared and friable.

Features
- Planting mechanism uses simple 'pockets' on revolving chains for spacings thirty centimetres and up.
- Dual seating for two operators.
- Chain drive mechanism carries the plant and drops them at pre-set intervals.
- Comfortable upright planting position for operators.
- Automatic watering available.

Capacity
Capable of planting from two to thirty thousand plants per day depending on the site and plant spacings.

Plant stock
Suited to plant cell tray or plug grown plants and open rooted seedlings.

Operation
Three point linkage tractor.

Transport
Transported on custom built trailer.

Read about landholder experiences with the Bushplanter in Footprints Fact Sheets 2 and 16.

Waikerie Tree Planter

Photo: GAV

The Waikerie Tree Planter is a mechanical planter used for cell tray seedlings in specific soil types.

Ground preparation required
Bare earth. No active root systems in soil. As for direct seeding, no cultivation.

Soil type and environment
Sand or loamy soil types. Not suitable for heavy soils or for 'fluffy' soils that are cultivated.

Features
- Simple rotating-table planting mechanism.
- Twin sets of press wheels for seedling bedding-in.
- Up to 1,000 plants can be loaded on the carrying racks on the machine.
- Comfortable upright planting position for operator.

Plant stock
Cell grown at least 15 to 20 centimetres tall with well developed root systems, that is, potting media does not collapse when seedling removed from the cell.

Operation
Medium sized three point linkage tractor (reasonable three point linkage lift capacity required as this is a heavy machine).

Transport
Transporting - allow half an hour to move from transport to operation mode.

Comments
Will not work in the range of soils that the Bushplanter does. Does not work well out of a straight line.

Read about landholder experiences with the Waikerie Tree Planter in Footprints Fact Sheets 28 and 30.

Youman Tree Planter

Photo: GAV

The Youman Tree Planter is a simple to use, sturdy multi-functional planter.

Ground preparation required
Ripped and cultivated to produce friable soil conditions.

Soil type and environment
Works in rocky to swampy areas. Soil should be loose enough to easily back fill around the planted seedlings and not cloddy to allow effective firming-in by press wheels.

Features
- Depth control from tractor seat - no adjusting of depth wheels.
- Large carrying trays for large capacity of works.

Plant stock
Fifteen centimetre forestry tube and bare-rooted seedlings.

Operation
Three point linkage tractor.

Transport
Easily transported.

Comments
- Operator required to crouch over the 'planting shoot', where the plants are placed in the plough line at the desired intervals; suggest regular changing of operator to mix up tasks.
- If plants are to be evenly spaced, the appropriate length of chain can be dragged behind the planter to indicate spacing.
- To improve efficiency and help the planter operator keep up with the machine, remove well-watered trees from the tubes and repack them, bare-rooted, into boxes

Hand planting equipment

There are a range of tools available which will increase the efficiency of planting seedlings by hand. This includes a variety of designs available to suit different sites, soil types and purposes of vegetation establishment.

Fundamental to the efficient use of most of the manual planting tools is site preparation. This generally means moist soil to depth, for ease of use of tools, as well as for plant survival and growth. Similarly, friable soil conditions, for example, produced by ripping are ideal when using most manual planting tools. If ripping is not possible or recommended, for example, for cracking clay soils, planting will be less efficient (slower), and survival and initial growth rates of seedlings will probably also be reduced.

Contact Greening Australia Victoria to hire or source the equipment listed.

Planting tubes

Pottiputki

Pottiputki and kidney tray

Photo: GAV

The Pottiputki and kidney tray is an efficient planting system

The Pottiputki has been developed by Lannen Plant Systems.

Description
- Simple, efficient hand planting tube for one person.
- Developed using the technology of the overseas forestry industry.

Features
- Requires no bending, stooping or kneeling by the operator.
- Commonly used with Lannen kidney-shaped planting box (where seedlings are pre-lifted from trays by nurseries) or Hiko bracket and belt hip carrier (where seedlings are planted direct from cell-tray containers).

Soil type and environment
- Well prepared ground, for example, pre-ripped to create loose, friable soil.
- In very high rainfall sites, the plant may be 'punched' into non-ripped soil using this implement.

Capacity
- More than 2,000 plants per day using skilled operators (Blue Gum contractors would each commonly plant 6,000 per day).

Plant stock
- Tubes are available in sizes to suit most containerised plants.
- Several thousand seedlings can be transported bare rooted and planted.

Comments
- The use of kidney trays or bracket-and-belt hip carriers with the Pottiputki enable large numbers of plants to be carried comfortably on the hip and make planting easier and faster. Bracket-and-belt hip carriers are commonly used when few species are being planted; kidney trays are preferred if a broad range of species is included in the revegetation.
- For sites where residual or pre-emergent herbicides have been used, the placement of seedlings in the soil by Pottiputkis ensures that there is no contact between seedling roots and the herbicide.

Read about landholder experiences with Pottiputkis in Footprints Fact Sheets 18, 26, 30, 31, 35 and 37.

Plug removing planters

Hamilton Treeplanter

Hamilton Treeplanter in action

The Hamilton Treeplanter has been developed by Keith Cumming, Hamilton, Victoria.

Description
- Consists of a handle, shaft, footrest and a tube or cell shaped structure at the base.

Features
- Creates hole the right shape and depth for the seedling - the depth is slightly longer than forestry tubes or cells to allow for covering of potting media with soil from the planting site which avoids capillary drying out of potting media and plant roots immediately after planting.

Soil type and environment
- Avoid using in heavy clays. There is a risk of 'glazing' the sides of the plant hole and causing boxed roots in these conditions.

Site preparation required
- Ideally intended for use in herbicide sprayed riplines. If ripping is not possible or recommended, use will be less efficient and survival and initial growth rates will probably also be reduced.

Capacity
- Four hundred trees per day, per person.

Plant stock
- Range of cells, up to tubestock.

Comments
- Ideal for community plantings as a two person operation, where one person makes the holes and another person plants.
- More labour intensive than the Pottiputki and involves bending to plant when used by a single operator.
- Care must be taken to water plants in well to remove air pockets and thoroughly cover potting media with soil. This will block the air flow down the plant and avoid capillary drying out of the potting mix. If planting into a mulched site, clear a space in the mulch first and then use the planter to create a hole in the soil.
- The Hamilton Treeplanters come in a variety of sizes to match the seedling size being used, for example, from cells to tubestock.

- For sites where residual or pre-emergent herbicides have been used, the placement of seedlings in the soil by a Hamilton Treeplanter ensures that there is no contact between seedling roots and the herbicide.

Read about landholder experiences with Hamilton Treeplanters in Footprints Fact Sheets 17, 22, 25, 26, 35 and 37.

Hand augers*

Gumbo Planter

The Gumbo Planter has been developed by Andy Marshall, Rokewood.

This mini auger is designed for use in heavy cracking or sticky clay soils where other tools, such as the Hamilton Treeplanters, glug up. Comes with small, pointed, T-shaped tools for roughing hole sides if glazed.

Hamjam Borer

Hamjam Borer

The Hamjam Borer has been developed by John Van Denham.

It consists of a handle, shaft and foot plate with spikes and rotating cutting blade/bit. Stand on the foot plate, push spikes into the ground and rotate the handles to create a rough hole with non-glazed sides. Several cutting blade/bit sizes are available.

Mechanical Augers*

Mechanical auger used to create holes for planting

A powered hole digger for use by one or two operators. A variety of bit sizes are available for different sized holes. Commonly used for planting cell-raised, native grass seedlings. Available from most major hardware stores.

*Note: Ensure the sides of the hole are not glazed - the auger should tear the sides of the hole rather than glaze the sides.

Water injector augers or jets

Photo: GAV

Water injector auger

Powered by a fire-fighter pump and water tank, this hand held 'injector' is charged up with water and blows holes into the soil, ready for planting. It also has the added benefit of loading up the soil profile with water. Once the holes are created, they can then be planted. This method is particularly useful in dry conditions, hard to access sites such as riparian environments, in lighter soils or for planting 'long-stem' seedlings in creek beds prone to flooding.

Read about landholder experiences with water injector augers in Footprints Fact Sheets 30, 31 and 34.

Mattocks

Mattock

- Mattocks can be a useful tool for small-scale hand planting projects.
- They serve a similar function to ripping when used to make planting holes considerably larger than the seedling rootball, breaking up heavy, compacted or sticky soils. This enables easy, rapid root growth, laterally and to depth.
- Mattocks are a superior choice over the Hamilton Treeplanters for use in sticky clays, particularly where mechanical ripping and cultivation is not possible. However, they should not be used on sites where residual or pre-emergent chemicals have been used as the seedling roots will come into contact with the chemical in the soil.
- Mattocks can cause back pain and, with hard pointed ends, should be used with care and away from other people.
- Available from most hardware stores.

Planting spades

Planting spades are used mainly in the forestry industry for planting open-rooted pine trees. They can also be used for open-rooted native seedlings. Check supplies with major hardware stores.

Steps for hand planting tubestock

The following example outlines the steps involved for planting tubestock into a mulched site.

Clear mulch.

Select Treeplanter to match seedling pot size and prepare the hole.

Gently squeeze container to loosen, invert and support stem to allow plant to slide out.

Plant, ensuring that the seedling is planted below the surface of the ground. Ensure plug of soil is put back around the plant, ensuring no potting mix is exposed (to avoid capillary drying out of the potting media/seedling root area, immediately after planting).

Firm in.

Bring back mulch around plant (keeping stem clear of mulch).

Water in at planting to establish good root-to-soil contact (if site requires this).

Guard as necessary.

SECTION C:

Contacts for further advice, information, resources and reading

There is a wealth of expertise and information available to assist you with your revegetation project. This section aims to help you locate local advice, equipment and further reading.

Advice and information

Organisation

Greening Australia Victoria

Greening Australia Victoria works in partnership with landholders, community groups, industry, natural resource management agencies and government to help create sustainable and productive landscapes throughout the state.

The organisation provides services in vegetation planning, supply, establishment, management and training for local and regional areas.

Contact Details

Staff are based in regional locations across Victoria and can be contacted via the **State Office** on phone **03 9450 5300.**

Website: http://www.greeningaustralia.org.au

Email: general@gavic.org.au

Greening Australia Victoria staff locations

Hire of Machinery & Equipment
Greening Australia Victoria hires revegetation machinery and equipment through the **Alcoa Revegetation Assistance Scheme**, including direct seeders, mechanical planters, hand planting tools and seed collection equipment. You need a standard fifty millimetre tow ball to transport a direct seeding machine.

The **Community Equipment Support Scheme**, operating from the Port Phillip region with support from Parks Victoria, hires Tool Trailers and/or individual tools for revegetation.

Equipment Care and Hygiene: Users must adhere to the Conditions of Use provided with the equipment. Due care should be taken to avoid the possibility of weed or disease transfer. Please wash down the machine or equipment upon completion of use.

Contact Greening Australia Victoria for booking information and hire rates.

Organisation	Contact Details	
Department of Sustainability and Environment and Department of Primary Industries	Customer Service Centre	Ph 13 61 86 http://www.dse.vic.gov.au http://www.dpi.vic.gov.au
Region offices to contact for: -Flora and fauna information -Seed collection permits -Pest plant and animal information -Regional Chemical Standards Officers -Program information e.g. the Catchment Management Activity System	Gippsland North East North West Northern Irrigation Port Phillip South West	Ph 03 5172 2111 Ph 02 6055 6111 Ph 03 5430 4444 Ph 03 5833 5222 Ph 03 9296 4400 Ph 13 61 86
BushTender Trial	Project Manager	Ph 03 9637 8360
The Living Systems Project	Education Officer Project Leader	Ph 03 5333 6825 Ph 03 9412 4585
Land for Wildlife	State Coordinator Alexandra Bairnsdale & Orbost Ballarat Benalla Bendigo Horsham Mildura Port Phillip (Greater Melbourne) Portland St Arnaud Swan Hill Wodonga Yarram Central Gippsland	Ph 03 5430 4363 Ph 03 5772 0257 Ph 03 5152 0410 Ph 03 5333 6967 or 03 5333 6928 Ph 03 5761 1526 Ph 03 5430 4368 Ph 03 5362 0765 Ph 03 5022 4324 Ph 03 9785 0134 Ph 03 5523 3232 Ph 03 5495 1700 Ph 03 5036 4824 Ph 02 6055 6173 Ph 03 5183 9103 Ph 03 5172 2111
Native Vegetation Officers	State Coordinator Corangamite East Gippsland Glenelg-Hopkins Goulburn Broken Mallee North Central North East Port Phillip & Western Port West Gippsland Wimmera	Ph 03 9412 4542 Ph 03 5233 5506 Ph 03 5152 0652 Ph 03 5573 0705 Ph 03 5784 0600 Ph 03 5051 4576 Ph 03 5422 7304 Ph 02 6056 6220 Ph 03 9296 4660 Ph 03 5662 9920 Ph 03 5362 0746
Waterwatch	State Coordinator	Ph 03 9412 4072

Organisation	Contact Details	
Landcare (Victoria)	Statewide Landcare Facilitator (at the Department of Sustainability and Environment)	Ph 03 9412 4785
	Victorian Landcare Gateway (provides links to Landcare in each region)	http://www.landcare.net.au/vic
	Regional Landcare Co-ordinators (hosted and managed by the Catchment Management Authorities)	
	Port Phillip	Ph 03 9785 0117
	Corangamite	Ph 03 5253 9131
	Glenelg-Hopkins	Ph 03 5571 2526
	Wimmera	Ph 03 5662 4555
	Mallee	Ph 03 5022 4331
	North Central	Ph 03 5440 1820
	Goulburn Broken	Ph 03 5761 1673
	North East	Ph 02 6043 7619
	East Gippsland	Ph 03 5153 0462
	West Gippsland	Ph 03 5382 1544
Catchment Management Authorities	Port Phillip & Westernport	Ph 03 9785 0183 http://www.calpboard.vic.gov.au
	Corangamite	Ph 03 5232 9100 http://www.ccma.vic.gov.au
	Glenelg-Hopkins	Ph 03 5571 2526 http://www.glenelg-hopkins.vic.gov.au
	Wimmera	Ph 03 5382 1544 http://www.wca.vic.gov.au
	Mallee	Ph 03 5051 4377 http://www.malleecma.vic.gov.au
	North Central	Ph 03 5448 7124 http://www.nccma.vic.gov.au
	Goulburn Broken	Ph 03 5822 2288 http://www.gbcma.vic.gov.au
	North East	Ph 02 6055 6133 http://www.necma.vic.gov.au
	East Gippsland	Ph 03 5153 0462 http://www.egcma.com.au
	West Gippsland	Ph 03 5175 7800 http://www.wgcma.vic.gov.au

Organisation	Contact Details	
Environment Australia	Community Info Unit	Ph 1800 671 717 http://www.ea.gov.au
Natural Heritage Trust		http://www.nht.gov.au
Bushcare	State Bushcare Coordinator	Ph 03 9412 4539
Local Government	Contact your local environment officer at the shire or council. A statewide local government contact is the MAV (see below)	
Municipal Association of Victoria (MAV)	Environment Resource Officer	Ph 03 9667 5555 http://www.mav.asn.au
Contacts for more information on traditional Aboriginal Owners and people responsible for Cultural Heritage	Mirimbiak Nations Aboriginal Corporation National Native Title Tribunal Aboriginal Cultural and Heritage Organisations Kulin Nation North West North East Gippsland South West and Wimmera Aboriginal Affairs Victoria (AAV)	Ph 03 9321 5300 Ph 03 9920 3000 Ph 03 9793 1735 Ph 03 5033 0666 Ph 03 5869 3353 Ph 03 5136 5152 Ph 03 5562 3458 Ph 03 9637 8000 http://www.dvc.vic.gov.au/aav.htm
Indigenous Land Management Facilitator for Victoria	Greening Australia Victoria	Ph 03 9450 5300
Trust For Nature		Ph 1800 99 99 33 http://www.tfn.org.au
Parks Victoria		Ph 13 19 63 http://www.parks.vic.gov.au
Field Naturalists Club of Victoria		Ph 03 9877 9860 http://www.vicnet.net.au/~fncv
Green Corps		Freecall 1800 077 700
Conservation Volunteers Australia		Ph 1800 032 501 or Ph 03 5333 1483 http://www.conservationvolunteers.com.au
Chemical Information Service		Ph 03 9210 9379

Quick find help list

Topic referred to in Section A and B	Contact point / references suppliers
1. PLANNING	**Obtaining local advice for your area** Contact Greening Australia Victoria, the Catchment Management Authority, Department of Primary Industries Office or Landcare Group. More information about your site can be obtained from: Victorian Resources Online http://www.nre.vic.gov.au/vro **Whole farm planning** Contact Greening Australia Victoria or the Department of Primary Industries for local courses, or your local TAFE College or Training Body. Video and Booklet - *On Borrowed Time: A Guide to the Potter Farm Plan*, 1990, The Ian Potter Foundation, Melbourne. Available from Trust for Nature. Ph 1800 99 99 33 or 03 9670 9933. Australian Master Tree Grower Course For course details in Victoria phone Greening Australia Victoria or the Department of Primary Industries in your area or visit: http://www.mtg.unimelb.edu.au **Aerial photographs** Contact the Department of Sustainability and Environment's Land Information Centre (Melbourne) on Ph 8636 2827, or Vic Image (South Melbourne) Ph 9682 3330, or United Photo Graphics Services (Melbourne) Ph 9877 3922, or the following website: http://www.land.vic.gov.au **Site assessments** Contact local groups and organisations, such as, Greening Australia Victoria, Field Naturalists, Land for Wildlife or local Landcare groups for details of local experts to assist with identification of flora and fauna on your property.

Topic referred to in Section A and B	Contact point / references suppliers
1. PLANNING (cont.)	**Environmental Management Systems** Environmental Management Systems in Agriculture Ph 03 9637 8463 The following websites provide background information: Rural Industries Research and Development Corporation http://www.rirdc.gov.au/ems Department of Agriculture, Fisheries and Forestry Australia http://www.affa.gov.au (search for EMS) Department of Primary Industries and Department of Sustainability and Environment http://www.dse.vic.gov.au (search for EMS) **Biodiversity Action Planning** Download or request a copy of the following publication from the Department of Sustainability and Environment: Platt, S. J. and Lowe, K. W. (2002). *Biodiversity action planning: action planning for native biodiversity at multiple scales - catchment, bioregional, landscape, local,* Department of Natural Resources and Environment, Melbourne. Available at http://www.dse.vic.gov.au (search plants and animals/native plants and animals/biodiversity/rural landscapes) This site also provides biodiversity overviews for specific bioregions; and landscape plans for specific landscape zones within each relevant bioregion. **Ecological Vegetation Classes** Contact the Parks, Flora and Fauna Division of the Department of Sustainability and Environment, Ph 13 61 86 or speak to the Native Vegetation Officer at the Department of Primary Industries for your region (see contacts). The following website provides background information: Department of Primary Industries and Department of Sustainability and Environment http://www.dse.vic.gov.au (search for Ecological Vegetation Class)

Topic referred to in Section A and B	Contact point / references suppliers
1. PLANNING (cont.)	**Resourcing a project** Budget: Contact your nearest Catchment Management Authority to find out about funding incentives and grants. Training, Skills and Knowledge: Contact Greening Australia Victoria or your local Landcare group for upcoming field days or training days. Materials: Contact Greening Australia Victoria for listings of indigenous nurseries, seed collectors and seedbanks or for information on revegetation suppliers. Labour: Link in to local programs such Landcare, Green Corps, Conservation Volunteers Australia or community planting events and regional programs that may be able to generate or assist with supporting your revegetation.
2. PREPARING THE GROUND	**Pest plant advice** Contact your local Pest Plant and Animal Officer at the Department of Primary Industries. Useful information can also be found on the Department of Primary Industries and Department of Sustainability and Environment website http://www.dse.vic.gov.au (search under Plants and Animals to Pest Plants and Animals to Pest Plants to Pest Plant Notes). **Farm Chemical Users Permit** Contact your local TAFE College or University, private providers or the Chemical Information Service on Ph 03 9210 9379. **Agricultural Chemical Users Permit** To apply for an Agricultural Chemical Users Permit you need to have completed an approved training program. For an application form contact the Department of Sustainability and Environment, Ph 13 61 86. **First aid courses** St John Ambulance Australia (Victoria) Inc. Ph 03 9696 0000 http://www.sjaa.com.au

Topic referred to in Section A and B	Contact point / references suppliers
2. PREPARING THE GROUND (cont.)	**Soil preparation** The type of soil preparation will be linked to the site conditions and revegetation technique selected. Seek local advice from Greening Australia Victoria, Department of Primary Industries, local Landcare Groups experienced with the local conditions and equipment. 'Dial Before You Dig' : Ph 1100
3. PEST ANIMAL MANAGEMENT	**Pest animal advice** Contact your local Pest Plant and Animal Officer at the Department of Primary Industries. Useful information can also be found on the Department of Primary Industries and Department of Sustainability and Environment website http://www.dse.vic.gov.au (search under Plants and Animals to Pest Plants and Animals to Pest Animals to Pest Animal Notes). **Fencing & tree guards** Contact your local Department of Primary Industries office, Greening Australia Victoria or Landcare Group about local contractors and suppliers.
4. SEEDS & SEEDLINGS	**Seedbanks and seed collectors** Contact Greening Australia Victoria for a copy of the 'Seedbanks and Seed Collectors in Rural Victoria' listing or download a copy from the website http://www.greeningaustralia.org.au (and click on the Victorian website to Vegetation Services to Nursery Lists). Contact your regional seedbank. **Guidelines and seed information** FloraBank Guidelines: Download from http://www.florabank.org.au **Seed collection permit** Permits (free) are available from the Department of Sustainability and Environment, Ph 13 61 86. **Training in seed collection** Contact Greening Australia Victoria **Seed pre-treatments** Talk to your local seedbank (contact Greening Australia Victoria for a copy of the 'Seedbanks and Seed Collectors in Rural Victoria' listing or http://www.greeningaustralia.org.au or refer to Bonney (2001) or Ralph (1997) (Details in references).

Topic referred to in Section A and B	Contact point / references suppliers
4. SEEDS & SEEDLINGS (cont.)	**Indigenous nurseries** Contact Greening Australia Victoria for a copy of the 'Farm Tree Nurseries and Growers in Rural Victoria' listing and 'Indigenous Nurseries of Greater Melbourne 2002' listing or visit http://www.greeningaustralia.org.au (click on Victoria to Vegetation Services to Nursery Listing). **Seed data management** Contact Greening Australia Victoria to purchase a copy of the 'Seed Supply System' and 'Seed Collectors Record Book'. **Seed collection equipment** Contact Greening Australia Victoria and enquire about equipment available for hire through the Alcoa Revegetation Assistance Scheme or Community Equipment Support Scheme.
5. NATURAL REGENERATION, DIRECT SEEDING AND PLANTING	**Advice** Contact Greening Australia Victoria, the local Department of Primary Industries office or Catchment Management Authority. Other organisations or programs that may be able to provide advice on remnant protection include Trust for Nature and Land for Wildlife. **Mechanical and hand tools** Contact Greening Australia Victoria and enquire about equipment available for hire through the Alcoa Revegetation Assistance Scheme or Community Equipment Support Scheme. **Labour support** Contact Greening Australia Victoria, Green Corps, Conservation Volunteers Australia, or the local Catchment Management Authority for potential support.
6. SITE MAINTENANCE	Seek local advice from the Department of Primary Industries, Greening Australia Victoria or Landcare group.
7. MONITORING	Contact your local Department of Primary Industries office, Catchment Management Authority, Landcare group, Waterwatch, Field Naturalists Club or Greening Australia Victoria about what monitoring programs you could link in to. For further information on spatial and database recording of information and the Catchment Activity Management System (CAMS) contact the Department of Sustainability and Environment on 03 5833 5297.

Helpful notes series

Greening Australia Victoria has two sets of case studies as well as other related publications available on their website:

Bushcare Demonstration Sites series numbers 1 - 28 http://www.greeningaustralia.org.au (click on Victorian link)

Footprints Fact Sheets series numbers 1 - 40 http://www.greeningaustralia.org.au (click on Victorian link)

(The Footprints Fact Sheets are also available from Greening Australia Victoria by mail)

The Department of Primary Industries and Department of Sustainability and Environment has a comprehensive Information Notes Series available from: http://www.dse.vic.gov.au/notes/

Notes include information on: Trees and Native Vegetation, Land for Wildlife, Weeds, Soil and Water, Flora and Fauna, Forests, General Farming and Landcare groups.

Notes under the heading Trees and Native Vegetation and subheading Native Vegetation and Growing Trees include:

Indigenous plants, Native vegetation, Shelterbelts, Establishment, Pests & diseases, Planning revegetation, Trees causing damage.

Land and Water Australia: National Riparian Lands Program has the following fact sheets available to download from the website below:

Riparian Management Fact Sheets 1 - 11 http://www.rivers.gov.au/publicat/factsheets.htm

References and further reading

* References referred to in text.

STATEWIDE & REGIONAL REVEGETATION INFORMATION

Statewide

Department of Natural Resources and Environment. (2002). *Victoria's Native Vegetation Management - A Framework for Action*, DNRE, Melbourne.

Regional

Contact your local Catchment Management Authority for copies of your Regional Catchment Strategy and Native Vegetation Plan.

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North Central

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Southern Riverina

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This publication is available from the following website http://www.gbcma.vic.gov.au/revegetation/

Gippsland

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Gippsland Forestcare Project. (2002). *A Landowners Guide to Managing Private Native Forests in Gippsland*, Greening Australia Victoria, Heidelberg.

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Farm forestry

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Preparing the ground

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Department for Victorian Communities	http://www.dvc.vic.gov.au
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Department of Primary Industries	http://www.dpi.vic.gov.au
"Dial Before You Dig"	http://www.dialbeforeyoudig.com.au
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Notes:

Revegetation Techniques is a ‘how to’ guide for establishing native plants from seed or seedlings. The information is based on what has worked at a practical level for landholders, community groups, land management agencies and project managers.

It covers the steps involved in a revegetation program, from planning and preparation to monitoring and then outlines the different techniques available to direct seed or plant seedlings. Natural regeneration, mechanical and hand methods of revegetation are described and a comprehensive resource section is provided.

Revegetation Techniques aims to complement regional guides that identify the local species and vegetation communities that should be replaced in an area.

Designed to accompany this guide is the *Footprints Fact Sheets* series of case studies. These describe landholder experiences with revegetation and provide on-ground examples of many of the techniques outlined in this guide.

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