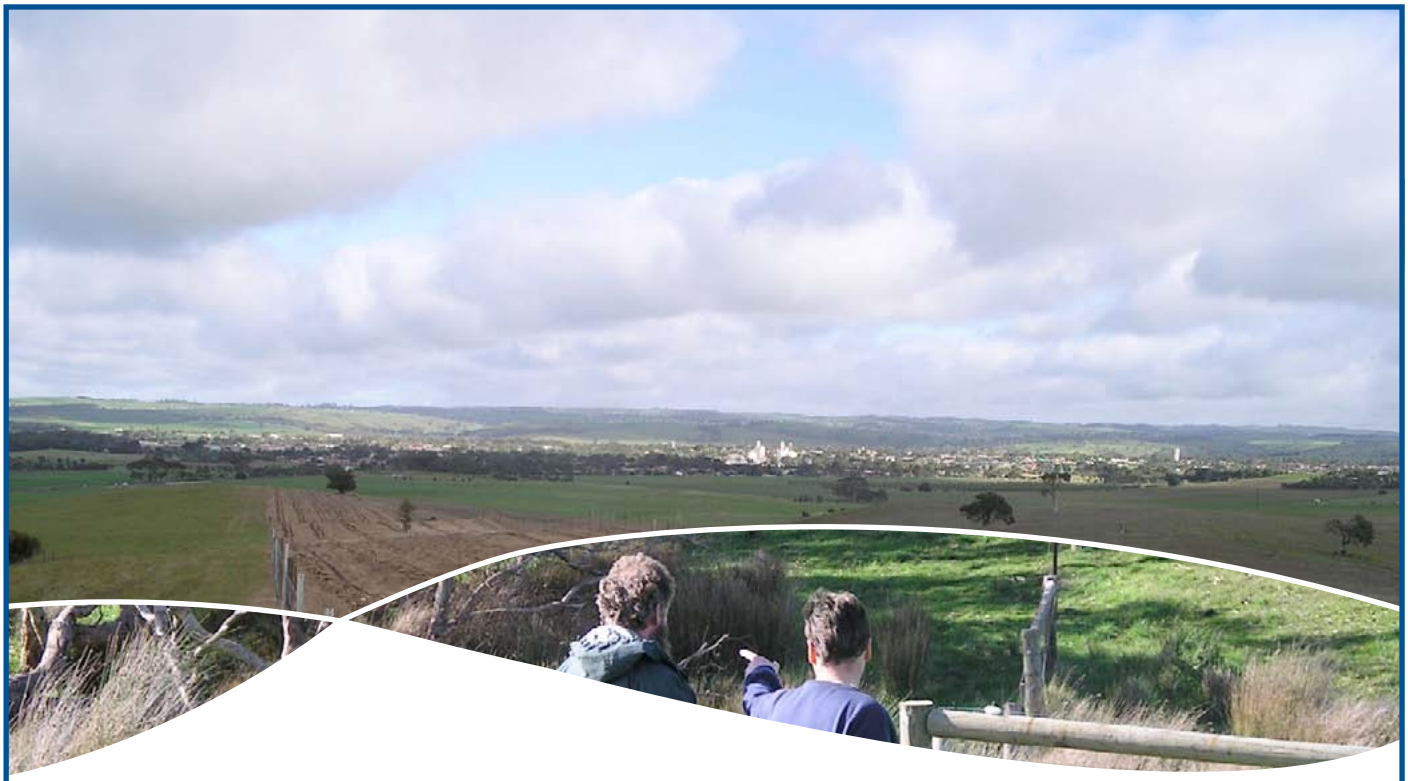
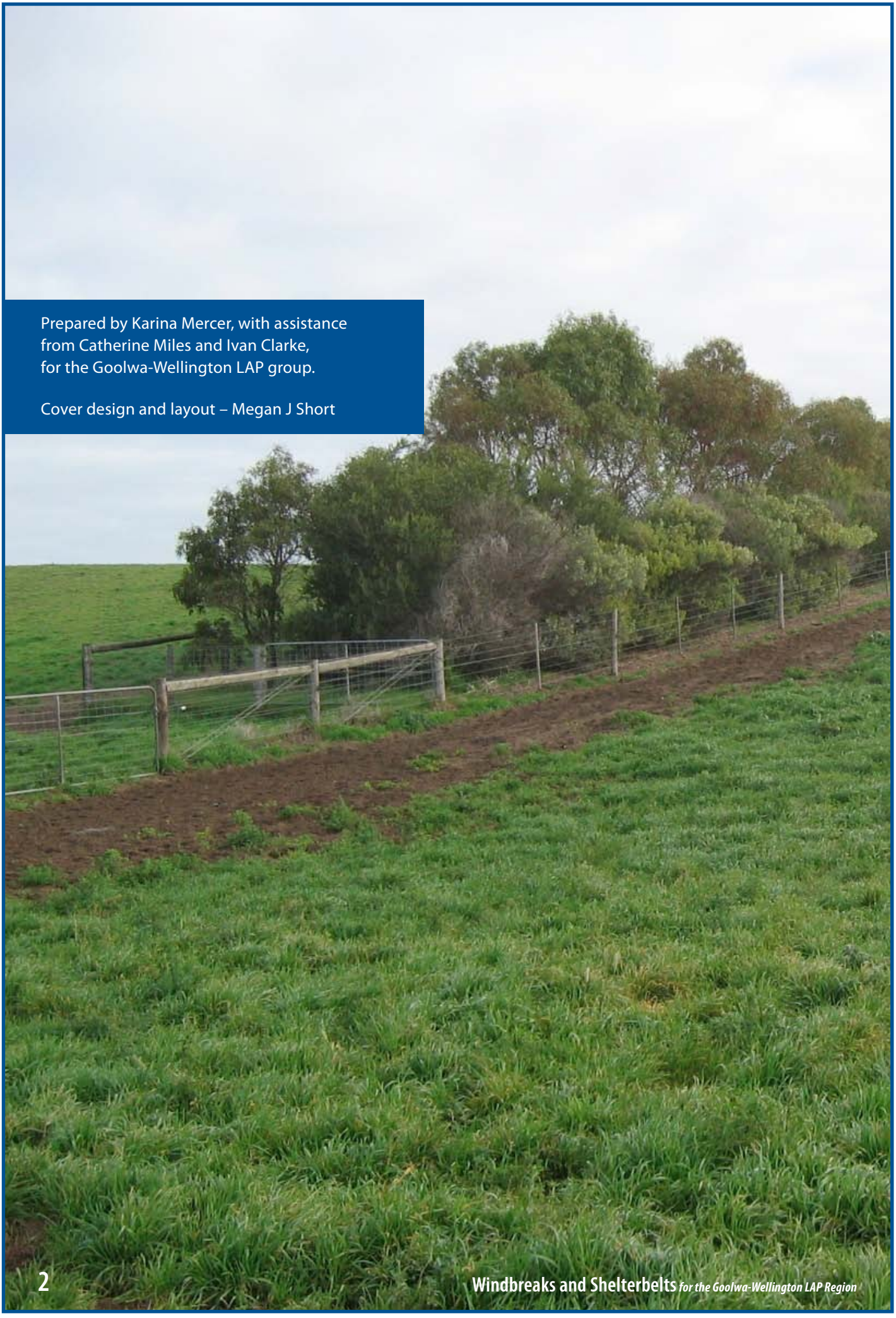


Windbreaks and Shelterbelts

for the Goolwa-Wellington LAP Region

GOOLWA TO WELLINGTON LOCAL
ACTION PLANNING ASSOCIATION INC

Government of South Australia
South Australian Murray-Darling Basin
Natural Resources Management Board



Prepared by Karina Mercer, with assistance from Catherine Miles and Ivan Clarke, for the Goolwa-Wellington LAP group.

Cover design and layout – Megan J Short

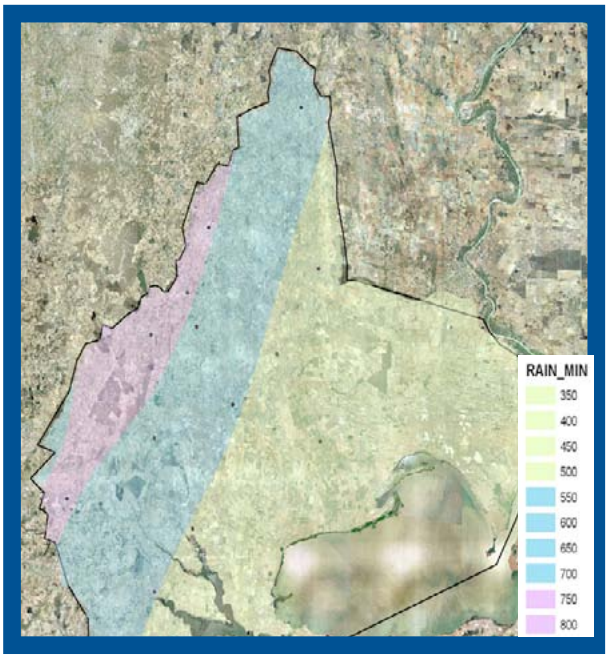
Windbreaks and Shelterbelts *for the Goolwa-Wellington LAP Region*

1 Introduction

1.1 Purpose of fact sheets

This fact sheet is intended as a guide to assist in designing, managing, and maintaining corridors and buffers on your property. It uses broad rainfall zones to suggest appropriate species for each zone. Rainfall will vary across zones, as will soils, which will determine the most suitable species to plant. Looking at any remnant vegetation on your property, or in the vicinity such as along roadsides, can help you to select the best species to suit the conditions on your site.

For assistance regarding specific species appropriate to your property, please speak with your local LAP officer.



1.2 Goolwa to Wellington LAP region and rainfall zones

The catchment area for the Goolwa-Wellington LAP covers a large area, from Victor Harbor and Hindmarsh Island in the south to Meadows, Kanmantoo and Brukunga further north. It incorporates the Alexandrina Council area, and parts of the Mt Barker, Murray Bridge, and Barossa Councils. Over such a large area there are a variety of possible site conditions. To help in suitable species selection, broad regional rainfall zones have been used to determine species selection.

1.2.1 Low rainfall: 300-500mm

This area extends west of the River Murray (eastern boundary of the GWLAP). Major towns include Wellington and parts north, and Port Elliot, Goolwa, Strathalbyn and Callington. Typical vegetation types included are grasslands and mallee.

1.2.2 Medium rainfall: 500-750mm

Predominantly the eastern flanks of the Mt Lofty Ranges. Major towns include Victor Harbor and Macclesfield. Typical vegetation types included are eastern grasslands, Blue Gum, River Red Gum, and Pink Gum grassy woodlands.

1.2.3 High rainfall: 750+mm

Major towns include Meadows, Kuitpo, Mt Compass and Mt Barker. Vegetation is predominantly stringybark forests and Red Gum, Manna Gum

2 Windbreaks and Shelterbelts

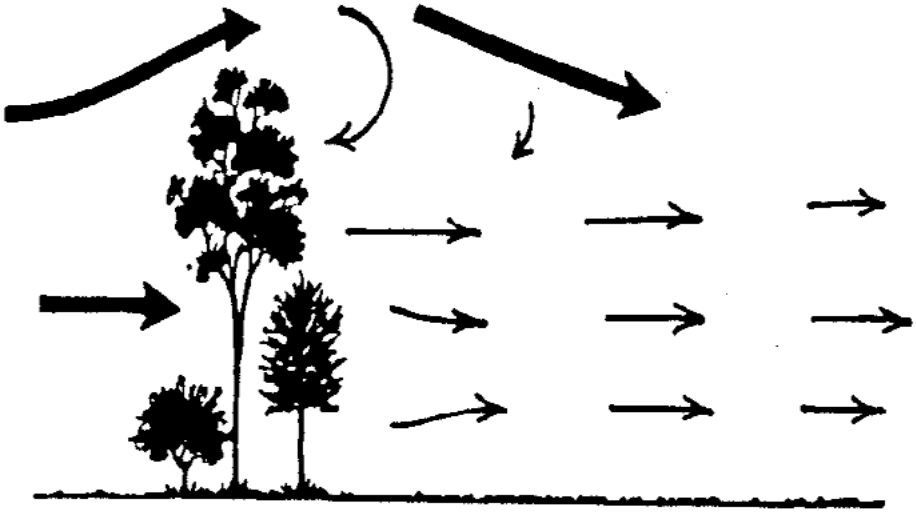
2.1 Purpose and benefits

Windbreaks and shelterbelts have numerous benefits. They can be used to:

- Protect crops and pastures from drying winds
- Protect livestock from cold or hot winds
- Help to prevent soil erosion
- Protect living and working areas from strong winds
- Provide posts, firewood, timber, fodder, honey and other products
- Provide habitat for wildlife
- Act as firebreaks

A windbreak of trees and shrubs works by filtering and breaking the force of the wind. Permeable windbreaks that allow some wind to pass through are most suitable. The slight movement of air through the windbreak forms a cushion of slow moving air on both sides of the windbreak (see diagram).

If planning windbreaks for stock, it may be worth investigating what other benefits can be obtained, for example linking remnants, protecting riparian zones, or providing protection against salinity. Research has demonstrated that in an average windbreak 3 rows wide (approximately 12m) 11 species of woodland bird can occur, but in a wider windbreak of 7 rows (approximately 25m) the number of species increased to 17[1].



1. Greening Australia "Bringing Back the Birds: A Glove-box Guide"

3 Design and Placement

3.1 Choosing a location

The location that you choose for the shelterbelt will be influenced by your purpose for the shelterbelt. Consider why you are undertaking the planting. What is its main purpose? Are you looking to protect stock from wind or sun? Enhance wildlife habitat? If you haven't already done so, it may be useful to develop a Whole Farm Plan, where aerial photography and ground-truthing are used to develop a farm plan considering all site features, such as property infrastructure like fencing and gates, access, prevailing winds, soil types, 'problem' soils such as saline or sandy, and other site-specific features.

For best results, plant windbreaks at right angles to the winds from which protection is needed. These are not necessarily the prevailing winds. Crops are often worst affected by hot, drying winds from the north. Livestock are at greatest risk from cold winds and rain, which come from the south or southwest. Where practical, try and incorporate remnant paddock trees so they are protected.

To keep costs to a minimum, windbreaks may be established against existing fence lines where possible, but consider the best location to match land capability boundaries. A 'whole of farm' approach may be beneficial in determining the best location of windbreaks; in some instances this may mean additional fencing or realignment of fencing to better suit prevailing conditions.

If practical, a good location for a windbreak is high in the landscape (e.g. along a ridge line) as a greater area in the lee is protected from wind. Take care to avoid planting close to windmills and do not plant under power lines.

It is advisable to undertake a site assessment prior to any works, this may allow for an understanding of the type of vegetation association(s) that may be present as well as which on-site factors need to be considered before planting, such as soil erosion, drainage issues, weed species, or limitations to planting such as overhead power lines or other services. Native vegetation can include native grasses and understorey plants like groundcovers and lilies, and it is important that these are not affected adversely by any planting.

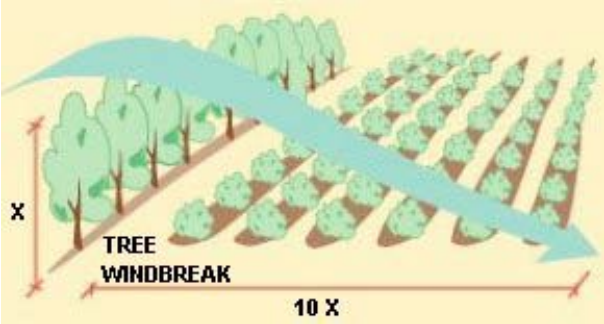
Take note of soils and topography such as dry slopes and creek lines. Match plant species to the location, i.e. don't use species from damp swampy areas along exposed ridgelines. Species should be planted that are suited to the area and the landform.

3.2 Emphasis on rows for easy maintenance

Planting in straight rows will make the site easier to maintain in the long run. Tailor the number of rows to suit your particular requirements. For example, a wide shelterbelt may provide different benefits such as biodiversity habitat for local fauna. Windbreaks incorporating both trees and shrubs in three to six rows are effective for most property situations. Multiple-row windbreaks are less affected by gaps caused by missing trees than single row windbreaks. Where land is limited, a staggered two-row design of tall trees and lower shrubs should be used for the best shelter effect. Single-row windbreaks should only be used where land is so valuable that only a small amount of space can be spared for tree planting – for example, on high-value production land. When only one row of trees can be planted, try to use trees that have foliage from the ground up if possible. Belts, with trees only, can be established for wood production, but they may be less effective in providing wind protection or habitat for native animals.

3.3 Height considerations

The windbreak height determines the size of the sheltered area. The taller the trees in the windbreak, the greater the area it protects[2]. Research suggests windbreaks are effective for a distance of 12 to 15 times the height of the tallest stratum, though protection of crops has been observed at up to 25 times the height.



The use of a sloping shelterbelt has been shown to work against protection, by actually decreasing the distance over which protection is provided. A steep-sided belt shelters a larger area because the wind is deflected to a greater height. It is better to plant a centre line of tall trees, and then use lower growing shrubs on either side.

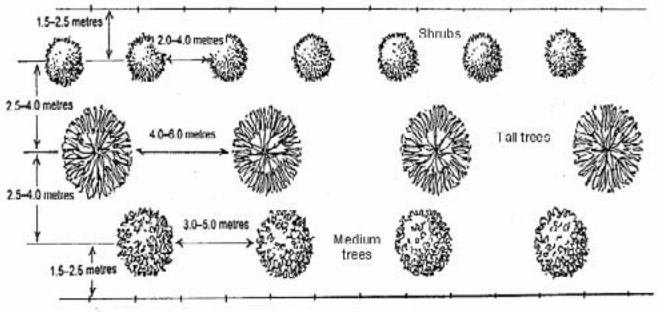
3.4 Spacing and density

The density of the windbreak will depend upon its purpose. If you are trying to provide additional habitat for native fauna, then you may wish to consider planting a couple of rows of dense shrubs that will provide protection. This dense shrub layer plays an important part in also preventing wind from funnelling under the taller tree layer.

It is important to remember that the denser the windbreak, the higher level of protection provided over a shorter distance. A less-dense windbreak will provide a lower level of shelter over a greater distance.

The distance between plants in windbreaks is based on the size of suitable plants for the local climate and soil. It is also important to allow access for tractors and machinery for weed control and maintenance.

Consider the effective growth rates of the species used, their space requirements, and the length of time you wish to wait for the shelterbelt to provide protection. For example it is impractical to plant eucalypt species a great distance apart as, although they may grow to a girth of several metres this would take several hundred years and the shelterbelt is unlikely to provide much protection in the meantime. In general, larger trees are planted 3-4 metres apart, with larger shrubs 2.5-4 metres. Lower shrubs can be placed 1.5-2.5 metres apart, these are also useful in providing protection for ground dwelling fauna.

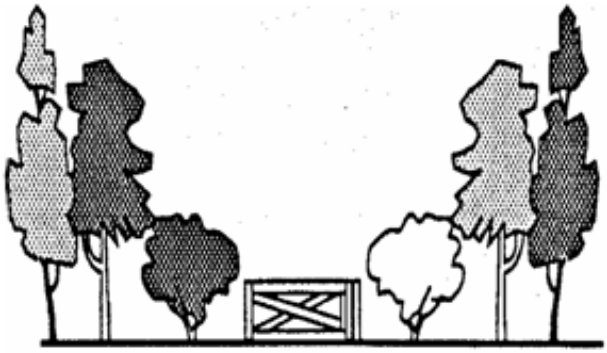


Where fewer rows are used, plants can be planted at greater densities to afford similar protection.

Talk with your local LAP officer for guidance on specific planting densities for your site, and funding conditions.

3.5 Gaps for gates etc

Windbreak and shelterbelt design and placement should take into account the need for existing or future property infrastructure. This may include items such as gates, storage sheds or livestock shelters, easy of passage through and approach to gates especially if large machinery needs to be manoeuvred.



Wind is deflected around the ends of windbreaks. The deflected wind can accelerate around the end of the belt causing localised crop damage. For this reason windbreaks should be long continuous lines of trees and shrubs to minimise any end effects. Gaps within the windbreak can have the same effect so where these are essential, the gap should be angled at 45° to prevent the wind from accelerating through the space.

4 Species Selection

Regardless of the purpose of the planting, it is important to consider that, depending on which species you wish to use, you may need to order at least 6 months if not up to 2 years in advance of planting. Some species can be difficult to propagate, or take a while to germinate, and for others seed availability may determine whether plants are available in a particular year.

4.2 Seed ratios and numbers

The number of plants to use per hectare can vary greatly depending on the particular site (such as a very rocky site with minimal topsoil), existing flora (are there trees or other plants already on-site that you need to avoid), and other factors such as cost and time, and climatic variables like low rainfall zones.

As an approximate guide for seedling planting, work on a figure of 1000 plants per ha, based on a windbreak 1km long X 10m wide, planting on average 3m apart. Seed requirements for machine direct seeding are based on ½ kg per km, with 3km of seeding, therefore 1 ½ kg of seed per ha is needed. Ratios should be based on 1/3 tall species and 2/3 shrubs.

4.3 Using provenance seed

For all revegetation work, the use of provenance or local indigenous species is highly recommended. Local species are particularly adapted to the climatic and physical conditions of a region. They are also more likely to provide appropriate resources for local native wildlife such as food, shelter, and nest material. The use of local species maximises the chance of restoring plant / animal interactions such as pollination and seed dispersal.

Collect seed from within the nearest possible remnant, or from the nearest possible remnant with a similar soil type. Consider the diversity of vegetation available, both in terms of species and structural variation. Start with dominant overstorey species (such as eucalypts) and major shrubs (such as tea-trees and wattles), and then consider understorey species (lower shrubs, groundcovers and grasses). Suppliers of seeds or seedlings can help prepare a species list for your site.

4.4 'Colonising' species

Identify which species to use in the initial phase and second phase. Undertake planting over several years to encourage the development of different age classes. Planting different species in successive years can mimic natural succession; many species do not thrive if planted outside of their natural succession time, or will simply not germinate until conditions are appropriate. Some species require extensive 'weathering' before germination will occur, and may not appear for 2-3 years after sowing.

Fast growing species such as Wattle Acacia sp. and Hop Bush Dodonaea sp. can help the establishment of the slower growing species like eucalypts.

5. Site preparation

5.1 Weed control

To be successful with revegetation, you must control existing pasture and weeds well in advance of planting seedlings or direct seeding. The development of a weed management plan provides some structure for control, schedule for follow-up, and monitoring of success. It should be developed in conjunction with a professional, particular if the use of chemicals is involved.

Weed control programs should be put into place at least 18 months prior to planting, especially for perennial weed species or those that are likely to have built up a significant seed bank. Particular attention should be given, where appropriate, to perennials such as sorrel, veldt grass, primrose, couch grass, kikuyu, lucerne, and phalaris. Control for perennial weeds should be done the year before planting. Weed competition is a great inhibitor of plant growth, and some species such as sour sob are known to alter soil pH thereby affecting germination and growth of seedlings.

Most sites will require weeds to be controlled approximately two weeks before planting.

Follow-up control after planting should be undertaken selectively and only if the weed burden would inhibit plant growth. This can be done with shielded sprays but special over-spray mixtures can also be used. Most native species have an unknown tolerance for herbicide, and many herbicides will affect young seedlings adversely.

Different techniques exist for controlling different weed species, including hand-pulling, cutting, grazing, competition, biological control, and use of herbicides. Professional advice should be sought when choosing to use herbicides for weed control. Various techniques have been created to treat different types of plants with herbicide, such as spraying,

cut 'n swab, stem injection, stem and leaf swabbing. It is important to understand the plant you are dealing with so that the right technique can be applied at the right time.

More detailed explanation of each of these steps can be found in the CRC for Australian Weed Management "Developing and Implementing a weed management plan" available from NRM staff / CRC Weeds / Australian Govt.

Contact your local control authority for advice on chemical use. It is important that herbicides are used by appropriately license operators. Seek advice prior to using residual chemicals or over-sprays.

5.2 Ripping

Ripping the site prior to planting can help the establishment of tubestock by promoting strong root growth and increasing infiltration of water. Ripping has been found to be effective on heavy soils, particularly those that have been compacted, but has little impact on lighter soils. Ripping often stimulates weeds to germinate so may require additional weed control. Ripping should be undertaken well before planting to allow the soil to settle and help avoid the formation of air pockets, which may affect the successful establishment of windbreak species.

5.3 Pest control

Vertebrate pest control should be run in conjunction with weed control activities, and is essential in the establishment phase but also through the life of the project. Control of browsing herbivores such as kangaroos, rabbits and hares, and other pests such as insect pests like red-legged earth-mite, caterpillars and grasshoppers may need control. A variety of methods including non-destructive options such as fencing, tree guards, using prickly plants, distractions and change are available.

Rabbit control may need to be undertaken up to 2 years in advance, and should be ongoing. It should form part of a regional control program for most effectiveness. Control of kangaroos should be done in conjunction with NPWS. A destruction permit will be required for culling of kangaroos. Red-legged Earth-mites can be particularly damaging for direct seeded sites and these may require miticide application.

Preferential plants that are selectively grazed can be planted or sown with species that can provide innate protection. For example, species such as Drooping Sheoaks (Allocasuarina verticillata) that are often grazed heavily by kangaroos can be sown with species that are less palatable such as Kangaroo Thorn (Acacia paradoxa).

5.4 Fencing

Fencing may be required to exclude stock from revegetation areas, or to minimise the impact of grazing herbivores such as rabbits, hares and kangaroos. Electric fencing may be a consideration until seedlings reach a stage of maturity where light grazing by herbivores is not detrimental to the plants survival.

A 'hot wire' top and bottom has been used to minimise kangaroo access to revegetation areas. A 'hot' bottom wire can entangle and harm fauna such as Echidnas, so fencing designs should enable ground fauna, which predate agricultural pests, to move through the site freely.

It is usually best to keep windbreaks fenced permanently to prevent gaps being created by livestock browsing on the lower limbs of established trees and shrubs. Fencing may not be required in situations of continuous cropping; in timber belts with trees only, which are not likely to suffer bark damage from stock; or in some alley farming situations with fodder shrubs where stock grazing of the windbreak is expected.

6 Establishment Techniques

Establishment techniques will depend upon the particular species being planted, site-specific features such as rocky or steep terrain, available resources including budget and people, and other factors including environmental conditions. Often a combination of techniques can be used to take advantage of prevailing environmental conditions of a particular season.

Some key points to consider are:

• Select suitable plants - be aware of time requirements for seed collection, plant propagation and planting

• Establish plants when conditions are suitable, particularly soil moisture

• Consider a combination of methods – machine direct seeding for larger species, and follow-up with tubestock and / or hand direct seeding of other species. Seedlings propagated from cuttings will be hand planted. Some seed is too expensive to be used broad scale with machine direct seeding.

• Fertiliser is not needed. Most agricultural soils have an adequate fertiliser history. Fertiliser encourages weed species to grow, and the majority of native species do not respond to fertiliser or respond adversely

• Sowing at the right time (following breaking rains and once weeds have been controlled) and at the right depth (important to consider if machine direct seeding is to be undertaken with a mixture of species)

6.1 Seed collection

The collection of native plant material (seed, fruits, cutting material or bulbs) is governed by the National Parks and Wildlife Act 1972 which is administered by the Department for Environment and Heritage. If you wish to collect seed or propagation material from public land such as Forest Reserves, NPW Reserves, Crown Land, and other public land such as roadsides and local council reserves, you will need to obtain a seed collection permit from the Minister for Environment and Conservation through DEH and the permission of the landholder. .

Seed or propagation material collected from private land requires the permission of the landholder, but you do not need a permit to collect seed or take cuttings from plants on your own property. There are several conditions to this, for instance if the plant is a prescribed plant (listed in Schedules 7, 8 or 9 of the Act) a permit is required regardless of whether you have the permission of the landholder or if it is on your property. It is best to contact DEH prior to collecting seed or propagation material.

6.2 Machine direct seeding

A specialised machine is used to sow a mixture of native seed straight into the ground. This method is cheaper and easier than planting seedlings or hand-direct seeding, but time and weed control is critical. It is also not suited to all sites, for example those with existing trees or understorey species like native grasses, or steep and rocky sites. Preparation of a good seedbed is necessary to allow roots and moisture to penetrate the soil. Lifting the seeder at random intervals will help avoid straight lines and allow for variation in structure as plants mature.

6.3 Hand direct seeding

You may wish to include some more specialised species, particularly if the windbreak or shelterbelt serves the purpose of also providing resources for native fauna. These are generally species for which seed is harder to obtain or is more expensive.

Prepare the area for seeding by lightly raking a small area with a rake or hoe, scatter seed and cover. Large seed should be just buried, and fine seed should be sprinkled on top. Mixing a quick-growing hard coat seed (Dodonaea, Acacia) with finer seed (Eucalyptus, Leptospermum) can bring good results, although care should be taken not to create over-crowded conditions by sowing excessive amounts of seed. Hand-seeding spots can be sheltered with fallen branches to protect seedlings from browsing, or to minimise the potential for seeds to be washed from the soil during rain or windy events.

6.4 Tubestock planting

Seed is propagated in nursery conditions to enable advanced plants, usually 6-18 months old, to be planted directly at the site. A good knowledge of particular propagation techniques, such as methods to break seed dormancy, is needed. Numerous contractors are available to collect and propagate local native seed for planting at a site. The GWLAP is able to assist with advice in this regard. Some species are better propagated by cuttings, or by dividing clumps, due to poor germination rates or a lack of knowledge on germination techniques for that species.

Costs depend on the amount of seed to be collected / number of plants to be grown, availability of seed and difficulty of propagation, age of seedlings, and whether you choose to engage the contractor to plant the seedlings for you. Tubestock planting is undertaken following the first good break-of-season rains, usually from June until as late as September depending on the rainfall and local conditions.

6 Comparison of Techniques

	COST	LABOUR	ESTABLISHMENT	MAINTENANCE	LONG-TERM VALUE	AESTHETICS
MACHINE DIRECT SEEDING	• Economic – seeds generally cost less than seedlings (note some can be expensive due to difficulty in collecting or propagating) • Plentiful seed is required – may be difficult for some species • Some seeds need special treatment prior to sowing which may increase price • Some seed is too expensive to be used broad scale which restricts the diversity of species available • Availability of seed may vary from year to year depending on climatic conditions	• Efficient – less time and labour is needed than propagating seedlings • An experienced operator can seed several hectares a day • Large areas can be revegetated relatively easily • Seed is easier to handle than seedlings (including transportation to the site) • Not effective or efficient for smaller projects, or on difficult terrain	• better suited to sites with no standing vegetation and of gentle slopes • Reduction in stress to plant roots • Reduction in damage to root hairs while planting • Likelihood of introducing new weeds or soil pathogens reduced • Direct seeded plants have better root growth, and are therefore more better suited to cope with varying climatic conditions following germination • Best suited to areas with a reliable moderate to high rainfall without extremes of temperature • Poor seedbed preparation can prevent germination. Timing of sowing, site preparation, weed control, and species selection is critical • Poor weather conditions can effect establishment - failure of seed to germinate due to environmental conditions (such as dormancy, dry conditions, wet conditions). Poor conditions may result in no direct seeding being undertaken in a season • Not suited to some sites such as those with deep, non-wetting sands or heavy soils. Generally not suited to sandy soils due to sandblasting of seeds and / or drying of sand surface • Predation of seeds by ants can reduce germination rates • Seedlings may be eaten by slugs, grasshoppers, or red-legged earth mites • Requirements of site preparation and sowing can cause damage to seed (herbicide use, soil disturbance) • Timing is more critical than for other methods •Large-scale herbicide use can impact on the environment • Machinery may not be available at optimum sowing times due to high number of requests	• May often be planted in rows, making follow up weed control easier • Infill planting may be used as a management technique to combat weed species and provide a biodiversity benefit • Weed control required – weed invasion is a major reason for failure of direct seeding • Grazing by stock or native animals requires management - inappropriate / insufficient protection enabling grazing by herbivores or damage • Appropriate management of feral pests particularly rabbits is necessary • If a mixture of species is sown, the type of herbicide than can be used for follow-up control of weeds can be limited (some native species are more susceptible to herbicide than others)	• Trees and shrubs efficiently established.	• Within-row distribution of seeds creates a less-structured as seeds are not released at a uniform distance apart along the row • May not "see" results immediately as germination and growth of seeds is not as visibly apparent as planting of tube stock • Historically the use of straight rows with little variability has resulted in monotonous revegetation

	COST	LABOUR	ESTABLISHMENT	MAINTENANCE	LONG-TERM VALUE	AESTHETICS
HAND DIRECT SEEDING	• Volunteers or working on your own property can work out very cheap • More expensive than machine direct seeding (if paying contractors) but cheaper than seedling planting. • May be limited by access to seed	• Can be a quick process with an efficient operator – estimates of 800-1500 spots per day per person • Enables sowing in amongst established species without causing damage to the plants or root systems	• Especially useful for some species such as native grasses. • Limited soil disturbance • Suitable for steep slopes, difficult terrain, or watercourses • Enables herbicide pre-treatment of smaller area only required for sowing of seed • Planting species in clumps can be undertaken to achieve more natural densities and improve the habitat value of the planting • Some particles sown may not be seed – known as decoy seed • Not all seeds that germinate will survive • Seed of some species is very small and cannot be sown separately • Knowledge of species requirements, densities, vegetation associations etc required (what to plant where and how much)	• Weed control is essential prior to and in early stages to allow establishment	• Can be used to complement other methods (machine direct seeding, tube stock planting)	• A more "natural" arrangement of species and densities may be achieved as plants grow competitively
TUBE STOCK PLANTING	• Plants may be 'grown to order' 6-8 months in advance of planting which may reduce costs as growers are able to collect specific amounts of seed • May be more costly in the short-term (factor in cost of seed, germination, watering, possibly also delivery to site, planting, tree guards and stakes)	• Use of tree planters can increase efficiency • A range of labour choices (volunteers, contractors, community planting days) – Positives and negatives associated with each such as experience, cost and reliability.	• Planting species in clumps can be undertaken to achieve more natural densities and improve the habitat value of the planting • Enables inclusion of more expensive or difficult-to-grow species • Planting can be timed according to moisture – tube stock can be held over until climatic conditions are right • Enables herbicide pre-treatment of smaller area only required for planting of tube stock • Planting of tube stock may be more successful for particular soil types resulting in better establishment. In steep and/or dry areas a bowl can be shaped around the plant to increase water infiltration. • Tree planters can create tight cylindrical holes that discourage lateral root growth • Failure to plant tube stock at the right depth can result in significant losses - skilled planters are a necessity	• Follow-up weed control usually required. • Tree guards may be required to minimise grazing by herbivores, thus increasing total cost per plant • Not all styles of tree guard are suitable for all sites – for example, windy sites may require wooden stakes to support guards, while less exposed conditions will cope well with simple bamboo stakes	• Community involvement on a project can be very beneficial • Broad range of species established.	• Opportunity to create more 'natural' looking plantings rather than straight rows may be more aesthetically appealing • May be better able to design windbreak by placement of plants depending on their height. • An unstructured 'bush look' may not be visually appealing to all

7 Ongoing Maintenance

7.1 Weed control

Ease of maintenance is an important consideration in the design and placement of windbreaks and shelterbelts, particularly if the site is fenced to exclude stock. Ineffective weed control can result in the site being a "weed haven", which then acts as a seed source to spread pest plants across the property. It may also shelter feral species, or reduce the available resources for native fauna.

7.2 Pest control

Feral animal control for species such as rabbit, hare and fox is important in maintaining the integrity of the windbreak or shelterbelt, especially if wildlife habitat is a secondary purpose. Control should be part of a property and region wide integrated program.

7.3 Kangaroos

Kangaroo grazing can be an ongoing problem. Exclusion fencing or tree guards may be possible. Otherwise, plant species selection; planting methods; and layout may be incorporated to accommodate situations where there are large numbers of grazing kangaroos. For example, sowing palatable species like Drooping She-oak Allocasuarina verticillata in amongst less-palatable or prickly species like Prickly Moses Acacia verticillata can minimise or prevent grazing of vulnerable seedlings.

7.4 Biodiversity enhancement techniques

Establish layers of vegetation by planting diversely – structural diversity maximises available resources for native fauna. Include upper canopy, understorey and groundcover vegetation. Different types of species within each layer provide different resources also – rough-barked trees such as stringybarks provide habitat under loose bark for invertebrates that are food for lizards, birds and other animals. A lack of understorey plants can favour aggressive increaser species such as Noisy Miners, which can displace less-aggressive species.

The use of infill planting as a management technique also provides the opportunity to out compete exotic grasses while providing a biodiversity benefit at the same time.

Some key points to consider are:

• Select suitable plants - be aware of time requirements for seed collection, plant propagation and planting

• Establish plants when conditions are suitable, particularly soil moisture

• Encourage natural regeneration as an aid to any revegetation

• Establish species in clumps to help improve the habitat value of the planting

• Consider a combination of methods – machine direct seeding for larger species, and follow-up with tubestock and / or hand direct seeding of other species. Seedlings propagated from cuttings will be hand planted. Some seed is too expensive to be used broad scale with machine direct seeding.

• Fertiliser is generally not needed. Most agricultural soils have an adequate fertiliser history. Fertiliser encourages weed species to grown, and the majority of native species do not respond to fertiliser or respond adversely

• Sowing at the right time (following breaking rains and once weeds have been controlled) and at the right depth (important to consider if machine direct seeding is to be undertaken with a mixture of species).

8 Calendar of Revegetation activi-

Ideally these should be undertaken in advance. Timing will depend on your rainfall area, and the local environmental conditions.

- Begin planning two or more years ahead of seeding or planting
- Start weed control at least 12 months prior to seeding or planting, or earlier depending on the site and the nature of the weeds
- Order seed two years before seeding or planting
- Order plants at least 12 months prior to planting

	YEAR 1				YEAR 2				YEAR 3
ACTIVITY	**SP**	**SU**	**AU**	**WI**	**SP**	**SU**	**AU**	**WI**	
1. Planning	■	■	■						
Determine the area that you plan to revegetate. Work out site specific factors such as: • Tubestock / seed requirements (species quantities) • Proposed weed / animal control programs • Fencing needs Local growers / contractors	■	■	■						
2. Preparing the ground									
Soil Preperation									
Deep ripping of site if appropriate and depending on soil type	■	■	■						
Weed control									
Spray out rows / spot spray for tubestock or hand direct seeding	■	■			■				
Re-spray rows if re-growth, 2-6 weeks prior to planting					■				
Spray around seedlings						■			■
Spray between planting rows (rip lines only)						■			■
3. Pest animal management									
Pest Control									
Undertake coordinated whole-of-property and preferably region control program	■	■	■	■					
Fencing									
Fence off area and exclude stock by now			■						
4.Seeds and seeedlings									
Seed collection, cleaning and ordering									
get in touch with contractors/growers to confirm seed and seedling	■	■	■						

	YEAR 1				YEAR 2				YEAR 3
ACTIVITY	**SP**	**SU**	**AU**	**WI**	**SP**	**SU**	**AU**	**WI**	
Plant orders and propogation	■	■	■						On-going
Finalise									
5. Revegetation									
Direct seeding and planting									
Undertake seeding and / or tubestock planting				■	■				On-going
6. Maintenance			■	■	■	■	■	■	
Monitor for snails, rabbits / hares, weeds					■				
7. Monitoring									
If necessary, slash between rows and / or overspray with grass -selective herbacide	■	■	■	■	■	■	■	■	Winter
8. Ongoing									
Continue to control weeds, pest animals and other site specific actions, such as maintaining fences to exclude stock									On-going for life of project & beyond.

9 Useful References

9.1 Revegetation design & method

Platt, S.J. (2002) *How to plan wildlife landscapes: a guide for community organisations.* Department of Natural Resources and Environment, Melbourne.

Dalton, G. (1998).*Creative Revegetation - Enhancing biodiversity by design*

NCSSA (2000) *Factsheet Biodiversity*

PIRSA (2005) Factsheet Windbreaks

Martin (1999) Fact Sheet - *Natural Regeneration of Native Vegetation*

Rural Solutions SA (2003) Fact Sheet – *Direct Seeding* (Rural Solutions SA, 2003)

PIRSA (1998) Fact Sheet – *Hand Direct Seeding of Native Plants* (PIRSA, 1998)

Murphy and Martin (1999) Fact Sheet - *Seed Pre-treatments for Native Understorey Species*

Burke, Steven (1998) *Windbreaks.* Inkata Press. Port Melbourne, Vic.

Dalton, Greg (1993) *Direct Seeding of Trees and Shrubs. Primary Industries* (SA). Government Printer, Adelaide.

9.2 How to collect and grow seed

Bonney, N. (2003) *What Seed is That?* (Revised Edition), Finsbury Press.

Dean, J. (2002) *Hand Direct Seeding of Native Plants*, Primary Industries & Resources SA Factsheet.

Florabank Guidelines: http://www.florabank.org.au/

Dalton, G. *Direct seeding native trees and shrub*

Greening Australia *How to collect native tree seed, easily.*

Costermans, Leon (1992 revised edition) *Native Trees and Shrubs of South Eastern Australia.* Weldon Publishing, Sydney.

10 Appendices

10.1 Appendix 1 - Revegetation species list

Robertson, M. (1994) *Stop Bushland Weeds – A Guide to Successful Weeding in South Australia's Bushland*, Nature Conservation Society of South Australia.

10.2 Appendix 2 - Revegetation costs

Estimates / Guide only, landholder may supply own labour for many of these therefore costs would come down.

Item	**Your project estimates,**
Fencing: $3,500 - $8,000/km+ materials and labour (depends on type of fencing and number of bends)	
Pre-planting weed control: $0.40/spot for tubestock or hand direct seeding $200/ha for rows for machine direct seeding	
Seed/Plants: $0.80 - $2.50/seedling if ordered at least 6 months in advance $200-300/kg for machine direct seeding mix	
Seeding/Planting: $100/ha for machine direct seeding (depends on size of area) $0.40 - $1.00/seedling to plant (depending on access and soil type)	
Plant Protection: Red-legged earth-mites (RLEM) and/or snails may need to be controlled for machine or hand direct seeded sites, allow $100/ha for snail baiting at the time of seeding, and $50-$100/ha for RLEM depending on accessibility. Guards may be required for seedling planted sites, allow at least $0.40 - $2.00/ guard, plus stakes.	
Post-planting Weed Control: $0.40/plant