Enhancing Biodiversity in the Vineyard - Workshop Notes

Information for McLaren Vale and Barossa Winegrape Growers

An extract of a report prepared by Mary Retallack for the Adelaide and Mount Lofty Ranges Natural Resources Management Board

Government of South Australia
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Images Front Cover: Mary Retallack (left), Chris Penfold (right)

1. DELIVERABLES

1.1. Background Information for Winegrape Growers

Biodiversity

The United Nations has declared 2010 as the International Year of Biodiversity. There is heightened interest in biodiversity and the benefits it can provide in a range of ecosystems, and this is also true for this project. The enhancement of biodiversity in the vineyard takes into consideration the complex range of interactions, which take place between the fauna (animal life), flora (plant life) and the natural balance of this environment. The more genetically diverse these interactions are (quantity and variability), the better buffered, or more sustainable, a system is said to be.

Biodiversity provides a range of 'ecosystem services' which has the potential to improve vineyard health and aesthetics in a number of ways including:

- Protection and enhancement of flora and fauna species diversity (populations and regional communities of native flora and fauna),
- Attracting a range of beneficial species to the vineyard (territorial birds, beneficial insects etc),
- Provision of alternative food and shelter sources for beneficial organisms in the vineyard (wildlife habitats and corridors), and as a result, potentially reducing the need for pesticides,
- Creation of shade and reduction of reflected heat, resulting in lower vineyard temperatures,
- Provision of shelter from winds, resulting in reduced evaporation from vines, minimising spray drift, and reducing wind erosion damage,
- Improved weed management (and a possible reduction in herbicide use),
- Soil protection resulting in improved soil health and structure; minimisation of compaction,
- Enhanced water penetration and retention, and improved water quality where good vegetation buffers are kept around dams and stream banks which filter nutrients before they enter waterways,
- Decreased water table recharge in susceptible regions (and a reduction in salinity related issues),
- Compared to annuals, perennial species may provide a cost-saving in the long run through reductions in tillage and seed costs,
- Reduction in impact of greenhouse effect through absorption and locking up of CO_2,
- Recovery of the ecosystem from unpredictable events,
- Potential improvement in grape quality,
- Improvement of property values where vegetation contributes to aesthetics, and
- A pleasant and informative cellar door experience (brochures and interpretive signage can be used to educate visitors to vineyard sites with enhanced biodiversity).

Floral biodiversity can be achieved in and around the vineyard by incorporating a diversity of plants in the mid row area, adjoining shelterbelts, and remnant vegetation that may adjoin the vineyard. A system, which is high in biodiversity, tends to be more resilient against change. For example, if a species declines for a particular reason (drought, seasonal temperature fluctuations), then other species may be available to carry on with essential ecosystem processes. The more complex the system is, the better buffered it is likely to be, and the more able to adapt to a change in its dynamics.

A monoculture such as a vineyard system can be more susceptible to becoming out of balance. For example, if one or more species dominates a system they may disrupt the normal interrelationships,

which would normally occur in a system; or if a key beneficial species is removed this may allow another undesirable species to dominate.

Table 1: Characteristics of sustainable versus synthetic production systems.

Sustainable	Synthetic
Low or reduced agrochemical input (low prevalence of pest species)	Relatively high agrochemical input (high prevalence of pest species)
A complex ecosystem with high biodiversity	A simple ecosystem with low biodiversity
Tends towards stability	Tends towards instability
Uses existing biological resources	Marginalizes existing biological resources

The benefits of biodiversity to primary production are largely dependent on the maintenance of ecosystem processes that ensure both long-term landscape viability, and long-term horticultural production. The integration of biodiversity and production should therefore focus on restoration or maintenance of native species and plant communities that support these ecosystem processes, rather than the restoration of plant community composition in just a historical sense.

A sustainable ecosystem is more likely to be able to self maintain ecological processes and functions; and as a result biological diversity and productivity is likely to improve over time.

There are three main ways to consider the role of diversity in and around the vineyard. They include:

Species diversity

This is the most common way people think about biodiversity, and it describes the variety of different plant, insect and animal species in an area. The process of growing grapes in the past has in many cases been considered as a monoculture (with very few species), which lacked diversity. These notes will address ways in which species diversity can be enhanced in a vineyard setting.

Genetic diversity

This describes the variety of genetic information contained in individual plants, animals and microorganisms. Genetic diversity is the basis of crop resistance to disease and weather; for example different clones of the same grape variety will perform differently on a range of different sites; or can contain genotypes that help when selecting cultivars to rehabilitate degraded systems; for example, different cultivars of native grasses can be selected based on their drought resistance, vigour and habit characteristics etc

Ecosystem diversity

This is related to the complexity within an ecosystem, the variety of habitats, biotic communities, and ecological processes which are present. For example, if only vines are present, this is likely to attract pest bird species, which seek out and eat berries.

Where there is a diverse mix of native vegetation surrounding the vineyard, this can provide protection for, and is more likely to attract, insect eating and predatory birds species, which protect their territory around the vineyard and actively discourage pest bird species from entering the vineyard. If an excess of plants flowering at the same time attracts aggressive, noisy miners, a limit of 20% flowering species is suggested.

Benefits for the vineyard and the way you present your business

Vineyards should adopt a conservation friendly approach to property design and development from the outset, reducing any harm to native vegetation or habitats for native wildlife. A practical, principled and professional approach to environmental management and the preservation of biodiversity in and around the vineyard is one way to demonstrate a landholders commitment to biodiversity conservation

as a part of their core business, and be able to convey this message to consumers, while benefiting from the many advantages this approach provides.

Focus areas within the vineyard (and its surrounds)

There are a number of locations within a vineyard setting that have different uses, and therefore different potential for biodiversity enhancement.

These include:

Vineyard Production Area

- Vines (canopy, trunk),
- Mid row and under vine areas,

Vineyard surrounds

- Headlands (non producing land required for machinery access),
- Borders (including wind breaks and shelter belts),
- Non-producing areas around infrastructure (sheds, winery, loading pads, water storage),
- Riparian zones along waterways (creek lines, rivers), and
- Land unsuitable for productive grape growing due to salinity, water logging or requirements for wastewater disposal.

The mid row area is approximately half the vineyard area, and is an ideal location to enhance the vineyard biodiversity with native plant species that are ecologically compatible. Changes in mid row and under vine management can increase biodiversity in the vineyard through the encouragement of beneficial invertebrates; the provision of a supplementary food sources in the form of high quality, easily accessible nectar and pollen, shelter from the summer heat and low humidity, and overwintering habitats.

Native vegetation can increase water filtration, as they filter surface and subsurface water or drainage water from vineyards before it re-enters natural waterways.

Natural and artificially established plantings, especially of trees, are used as pumps to regulate groundwater levels where irrigation practices or vegetation clearance has resulted in raised water tables. The benefits of different vineyard management strategies to improve biodiversity are presented on page 12.

Integration of land uses

To achieve an outcome that meets your needs, and also enhances biodiversity requires consideration of all factors that affect land use decisions. Property management planning at the strategic level, and whole property planning at the ground level, are methods that encourage an integrated approach to land use within the vineyard. This is also important to minimise any negative impacts your decisions may have to the vineyard and its production potential.

Potential disadvantages of native vegetation in vineyards

Potential disadvantages of planting native vegetation, in and around vineyard areas, may include:

- The attraction of vineyards pests, potentially increasing their populations in the vineyard,
- Vegetation can shade vines, and compete for water and nutrients; this can have a negative effect on the growth and development of vines.
- Greater frequency of sapling growth in the vineyard from species, such as red gums, located near the vineyard,

- An increased frost risk if not managed properly, and
- Seedbed preparation may create an erosion risk.

Table 2: Benefits of different vineyard management strategies on improving biodiversity.

Vineyard Management Strategy	Improvement	Benefit to Vineyard	Biodiversity Improvement
Vineyard Production Area			
Mid row and under vine areas.	• Introduction of native cover crops (or strategic use of introduced species as nectaries) either in the mid row or around vineyards.	• Attract beneficial invertebrates, which may prey on pest species (reducing the need for sprays). • Improvement of soil health. • Reduce soil erosion.	• Provides a habitat for beneficial insects and soil organisms.
Vineyard Surrounds			
Headlands – non-producing land required for machinery access.	• Establishment of perennial carpet of low growing species tolerant of high traffic.	• Utilising an area that would otherwise be bare and populated by volunteer weed species.	• Provides a habitat for native invertebrates and soil organisms.
Border vegetation (including wind breaks and shelter belts) planted to protect the vines from adverse weather.	• Shelterbelts and corridors progressively replanted to native species (where practical). • Development of understorey (shrubs and grasses).	• Reduce leakiness from irrigation. • Encourage predatory bird species. • Reduce salinity. • Improve functionality of windbreak if it has become patchy over time.	• Habitat and small-scale corridors for native bird species and beneficial insects. • Revegetation or maintenance of remnant vegetation; can also provide buffer zones to minimise spray drift.
Riparian zones along waterways.	• Revegetate around riparian zones.	• Improve water quality. • Decrease run-off. • Reduce erosion.	• Enhance the health of water habitats.
Remnant vegetation.	• Management and preservation of native stands of remnant vegetation.	• Vineyard system is more stable (better buffered) and self-sustaining.	• Improve biodiversity around the vineyard.
Land unsuitable for productive grape growing due to salinity, water logging or requirements for wastewater disposal.	• Revegetation of non-producing area (reclaim degraded areas using appropriate species).	• Reclaim unproductive ground, preserve its condition, create stability and create biodiversity benefits.	• Improve biodiversity around the vineyard.

Green Credentials

Interest in sustainable management systems including the improvement of vineyard biodiversity, is in keeping with a range of natural approaches to vineyard management. This may range from a general interest in vineyard health through to organic or biodynamic management approaches.

Interest in these areas, along with enhancing the biodiversity in vineyards, ties in closely with a number of regional initiatives, which seek to recognise, either formally or informally, the footprint of the vineyard and its green credentials in the eyes of the consumer.

Certification schemes for the Australian Wine Industry are becoming more prominent, and the assessment of vineyard floor health and the biodiversity within a vineyard is an important component of many sustainability assessments. Some of these programs include:

- ***EurepGAP,*** which was created by several European supermarket chains and their major suppliers. GAP is an acronym for 'good agricultural practices'.

  It is now the world's most widely implemented farm certification scheme. Most European customers purchasing agricultural products now demand evidence of EurepGAP certification (and increasingly environmental sustainability) as a prerequisite for doing business.

  For more information go to www.globalgap.org

- ***EntWine Australia*** is a voluntary environmental assurance scheme developed by Winemakers Federation of Australia (WFA) that allows winemakers and wine grape growers to receive formal certification of their practices according to recognised standards.

  For more information go to www.wfa.org.au/entwineaustralia/default.aspx

Other regional initiatives include:

- ***McLaren Vale Generational Farming Project****; for more information go to www.mclarenvale.info*

  Linkages with Chapter 3 - Biodiversity goals including:

  - *To measure and record the biodiversity of your vineyard and surrounding land. To take actions and to maintain your biodiversity and work to improve it in the long term,*
  - *To prevent reductions in biodiversity and reverse any decline on your vineyard/property,*
  - *To monitor and assess biodiversity within your vineyard/property and measure populations and species present,*
  - *To provide appropriate environmental conditions for the preservation and enhancement of biodiversity within your vineyard/property, and*
  - *To adopt vineyard management practices that promotes biodiversity and allows for the reduction of chemical inputs into the environment.*

- ***McLaren Vale Environmental Management Plan****; for more information go to www.mclarenvale.info*

  Linkages to the following action points:

  - *Plant three key vegetation corridors linking key landscapes in the region, established with land management plans for carbon capture and biodiversity benefits, and*
  - *Support the revegetation of creek lines and wine shelterbelts throughout out the vineyards.*

Enhancing biodiversity using introduced species

As well as looking at native species, it is also important to look at the role of introduced species to the biodiversity fabric in the vineyard and its surrounds. There are situations where it is appropriate to use non-local species for conservation plantings, or to improve the biodiversity of the ecosystem.

An example of recent research in this area is the Greening Waipara Project which is an initiative driven by Professor Stephen Wratton in New Zealand. A snapshot of this project is presented below. For more information go to http://www.waiparawine.co.nz/research/greening_waipara

Greening Waipara: Bringing practical biodiversity to the world

The following information is paraphrased directly from Smith, 2010.

Current research strands include:

- Water conservation, vineyard nutrition, pest and disease management, biological control, potential benefits from hawks and butterflies.

Potential benefits of 'natures services' include:

- Biological control of pests as well as weed and disease suppression, and
- Improvements to vital plant pollination; the removal of various toxins from the environment, and the maintenance of good soil nutrition and effective water management.

Buckwheat at Waipara Hills

Phacelia at Waipara Hills

www.waiparawine.co.nz

Vineyards in the Greening Waipara project are encouraged to establish buckwheat and flowering plants such as *Phacelia* and *Alyssum* between vine rows (every tenth row) in order to encourage beneficial insects; such as parasitic wasps to take up residence and attack predators such as caterpillars and mealy bugs. Seed is sourced locally for $0.67/kg. A 100m long strip sown between vineyard rows will cost about $2 for seed (not including labour). Sowing every tenth row has been demonstrated to be effective in managing caterpillars, down below the threshold normally required for spraying with conventional pesticides.

The key ingredients that insects need apart from their prey, especially beneficial insects are; **S**helter, **N**ectar, **A**lternative food and **P**ollen (SNAP). For example, if a parasitic wasp is able to have access to all four of these things (or a good number of them) research has shown it is possible they may live up to ten times longer than normal, and kill ten times as many caterpillars. They are in the process of trialling plants native to New Zealand. Biodiversity trails are being developed close to vineyards. The potential educational benefits are supported by appropriate signage and information boards, along with children's quiz books and gifts such as seed packs that serve as rewards for investigative activity.

What is happening in Australia?

In-field based in the Adelaide Hills have designed a machine which allows for the spraying out of any existing mid row vegetation and the sowing of nectaries species in one pass. For more information, go to www.infield.com.au.

The Terraces in McLaren Vale are working in conjunction with local vineyards and are trialling the use of *Alyssum.* They have contributed their experiences to a case study, for more information see page 60.

Prue Henschke is planting a range of local species to act as insectaria. For more information, refer to the case study on page 50.

1.2. Biodiversity Action Planning for the Vineyard

Background

The development of a Biodiversity Action Plan (BAP) is a structured approach, which can be used to identify priorities and plan a strategy for biodiversity conservation of a range of species within a vineyard and its surrounds. There are situations where it is appropriate to use non-local or non-indigenous species for conservation plantings.

These include:

- Where the planting is part of a large property planting, where function and spatial distribution are more important than composition. For example, planting introduced cover crop species in the mid row of a vineyard to provide shelter and a food source for beneficial insects (although native species can also be used),
- Where an economic return is required (such as farm forestry, or saltbush),
- Where the environment has changed to the extent that some local species can no longer survive (salinity, altered soil structure, water logging, frost),
- Where a species is needed to modify the environment so local species can thrive (for example, where a salt tolerant species is used to lower water tables to reduce soil salinity).

Traditionally, vineyards have been grown as a monoculture, where a single crop has been grown over a larger area. In the past any other species growing in the vineyard were regarded as a potential threat, and as a result the vineyard system comprised of very few species, and the system tended to be poorly buffered.

In recent years there has been greater interest in the overall health of vineyards, and how to work with the natural environment rather than fighting against it. We are starting to appreciate how, when a system is in balance, it is more able to look after itself; and that there are thousands of little insect and animal workers in the vineyard who are able to provide 'ecological services' and do much of the work for us. The interest in working smarter, rather than harder, and to produce a product as naturally as possible (with minimal intervention) has given rise to interest in organic, biodynamic and biological viticulture.

The focus here is to understand the biodiversity that exists both within the vineyard and it surrounds; the relationships between both plant and wildlife, and how to enhance the biodiversity it contains.

At the vineyard property scale the focus is to create a quality habitat by increasing the size, shape and complexity of vegetation in key areas of the vineyard to provide the best value for biodiversity. Revegetation can be used to create specific habitats, restore pre-existing or degraded vegetation associations, or expand existing remnants and fragments. There are several ways that native vegetation contributes to biodiversity conservation:

- **Composition** - What species are present? A diversity of species providing a structurally complex habitat is more likely to support a larger range of fauna species than a simple patch of low diversity.
- **Structure -** How are these species arranged and what are their relative abundances? Different fauna species require different structures as habitat; such as tree branches, hollows, dense or open shrubs, a complex ground layer, a range of bark types, different litter types and root types. The more of these structures that are present, the greater the diversity of fauna that can be supported.
- **Function** - What function is the vegetation carrying out? This may include, wildlife habitat, interception of water and nutrients, carbon sequestration, climate amelioration.

BAPs can be used to inform regional strategies at the vineyard and regional level. Conservation can then be coordinated with land protection and viticultural activities.

BAPs will assist viticulturists to identify and prioritise protection of biodiversity assets under their supervision.

A BAP aims to:

- Conserve native biodiversity in and near the vineyard by maintaining viable examples of the range of ecosystems, which normally occur in a particular region.
- Encourage a more strategic use of plant species, protect native plants and the diversity that remains, enhance the quality of these habitats and populations, restore degraded areas or reintroduce key species, and the ongoing management of biodiversity in and around the vineyard.

Assessing biodiversity in your vineyard

1. ***What are the biodiversity assets that you have on your property?***
   - **Identify indigenous species and habitat** associated with the vineyard property. Research and establish an understanding of the original species and habitat.
   - **Identify non-indigenous species**, which add value to the vineyard property by contributing to the diversity of species present, and offer a service to the ecosystem (such as nectaries in the mid row to provide food and shelter to beneficial insects etc).
2. ***What are the threats to biodiversity on your property?***
   - Identify any threatening processes and carry out a detailed assessment of the risks and ways to minimise damage to biodiversity assets.
3. ***What actions should be taken to achieve your biodiversity objectives?***
   - Develop a property **biodiversity action plan** that identifies species and habitat for rehabilitation, and sets targets and strategies. Include actions for habitat enhancement, weed and animal management, buffer zone development and management etc.
   - Seek expert advice on the use of indigenous and non-indigenous plants (where appropriate).

Best viticultural management for enhancing biodiversity

There is a range of ways best viticultural management can enhance biodiversity in a vineyard property. The Winemakers Federation of Australia's Biodiversity Fact Sheet provides some examples of ways to improve soil biodiversity in the vineyard. The full fact sheet can be found at http://www.wfa.org.au/entwine_website/files/resources/AWIS-Biodiversity-Fact-Sheet.pdf

Ways to improve soil biodiversity in the vineyard:

- *A permanent cover of living plants or plant litter will provide protected habitat and a food supply for soil organisms, as well as protecting plant roots from high temperature fluctuations and drying. Mulches in the vine rows and cover crops or native plants between rows will increase the organic matter (inter-row plantings can also be part of an Integrated Pest Management approach). Maintaining vegetation cover on any drainage paths will minimise soil loss and erosion.*
- *By minimising mechanical cultivation, soil compaction can be avoided and soil structure, aeration and drainage maintained.*
- *Monitoring soil for the amount of soil organic matter, the rate at which water infiltrates, and informally checking for signs of biological activity (such as the presence of earthworms in a shovel of dirt) will help to ensure that management practices are maintaining or improving soil health.*
- *Applying fertiliser only as part of a soil and vine management program, in response to petiole or soil testing, helps ensure that excess fertilisers don't leach into waterways or groundwater or cause changes in soil pH that would lead to reduced soil biological activity.*

A list of key areas for consideration when looking at biodiversity in the vineyard is presented below.

Disease and Pest Management

The conservation of remnant vegetation, the planting of shelterbelts around vineyards and/or planting grass species in the mid row may have direct economic benefits in terms of pest control. Studies have found that vegetation can provide shelter, overwintering sites and food sources and therefore influence the natural enemies present in the vegetation as well as the vineyard.

Examples of species that have a role as natural enemies in vineyards, and whose prevalence has been shown to increase where there is host vegetation available include: predatory mites (*Typhlodoromus doreenae* and *Euseius victoriensis*), spiders, staphylinids, predatory ladybirds, lacewings, predatory flies (Tachinidae, Cecidomyiidae, Syrphidae) and a wide range of parasitoids (including *Trichogramma* species*).*

Some of the considerations when adopting an integrated approach to pest management, which minimises the reliance on chemicals, include:

- Monitor disease and pest pressure so that pesticides are applied only when required,
- Look at ways to strategically reduce use of fungicides and pesticides,
- Maintain open canopy architecture to reduce disease pressure, and improve spray penetration, and
- Encourage beneficial insects to provide natural control of insect pests. Be aware of chemicals that are toxic to the predatory insect species[1].

[1] Refer to Bernard M., Horne P. A., Hoffmann A. A., (2004) Ecological Pest Management: The effect of viticultural fungicides on beneficial predatory mites, The Australian and New Zealand Grapegrower and Winemaker, 485a: 7-12.

Vineyard Floor Management

Ensure some type of ground cover is maintained under vine, in the mid row and along headlands; and try to keep exposed ground to a minimum. Ideally a drought tolerant species will be selected which goes dormant during the growing season. Ground cover increases the biodiversity and ecological stability of the system. Groundcover can be used to improve soil stability, and to provide a habitat for a range of beneficial insect species (including predators and parasitoids, and predatory mites). A higher number of flowering plants promote a constant food supply for beneficials.

Aim to have at least 5% of the vineyard property dedicated to ecological compensation areas (border vegetation, trees, shrubs) to help provide habitat for beneficial insects.

Weed Management

When poorly managed, weed control in vineyards has the potential to be very expensive, environmentally damaging, and detrimental to vine productivity and grape quality. Herbicide resistance can also develop when herbicides are used excessively and inappropriately.

There are a range of considerations when maximising the success of your weed control strategy, they include:

- Seeking out alternative weed control methods where possible. For example, use mulch under vine to smother weeds, mow volunteer weed species prior to flowering and setting seed, and plant native grass species to outcompete weeds (when they are mature).
- Using herbicides with a low persistence and risk to the applicator (if alternatives to herbicides cannot be found). Use herbicides in a targeted fashion (spot spraying of problem weeds), is preferred rather than broadcast (wide spread) applications. Try to reduce the amount of herbicide applied in the mid row and under vine.

Soil health and plant nutrition

The loss of microbial diversity in the mid row is likely to affect the functional stability of the soil microbial community. Soils which have reduced biodiversity due to low plant species diversity, are also know to be less resistant and resilient to disturbances and stresses.

Simple ways to improve soil biodiversity in the vineyard include:

- Building up soil organic matter prior to planting,
- Ensuring there is a permanent cover of living plants or plant litter that will provide a protected habitat and a food supply for soil organisms, and protect plant roots from high temperature fluctuations and drying out,
- Use mulches, compost and/or permanent cover crops between rows to increase the organic matter,
- Minimising mechanical cultivation to avoid soil compaction and to maintain soil structure, aeration and drainage, and
- Minimising soil erosion and enhancing soil structure and soil biological activity.

Have a good understanding of soil and vine health prior to applying fertilisers into the vineyard system.

- Make informed decisions when applying fertilisers in the vineyard. Understand what you are applying (composition), and why you are applying certain products (respond to visual health indicators, petiole and/or soil tests),
- Fertiliser applications should be applied when there is maximum uptake by the grapevines (via the roots or leaves depending on the application),
- Look for natural alternatives to synthetic fertiliser products where possible. Try to improve soil organic matter through the incorporation of compost and mulch products, to maintain an active soil life. This will help to improve optimal grapevine nutrition, buffering potential, improved water holding capacity, and better soil structure; and
- Minimise nutrient losses through leaching, run-off, and atmospheric loss.

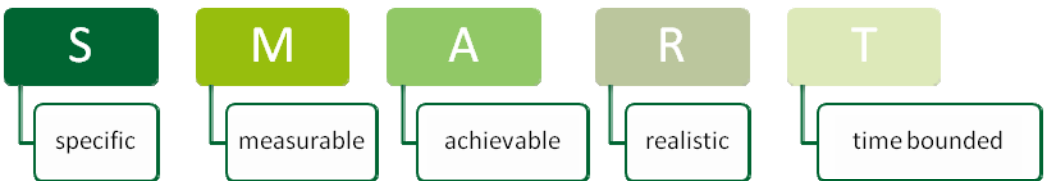
Each of these components should be considered when developing a BAP for your property.

1.3. Biodiversity Action Plan – Managing Remnant Vegetation and Revegetation Projects

The planning stage

The first step in the process of either managing remnant vegetation, or to carrying out revegetation works, is to make plan. A biodiversity action plan can be used to underpin the decisions you make in putting your plan into action. Time taken to gather background information and develop a strategy will help to minimise setbacks and disappointing results.

In developing this plan you be asked to consider your goals and objectives. They will need to be:



To start the biodiversity action plan (BAP) process we will start with the **Now**, and then go onto the following sections:

- Now, Where, How, Actions, Monitoring and Maintenance.

BAP Template

A summary of each stage in the biodiversity action plan is presented below:

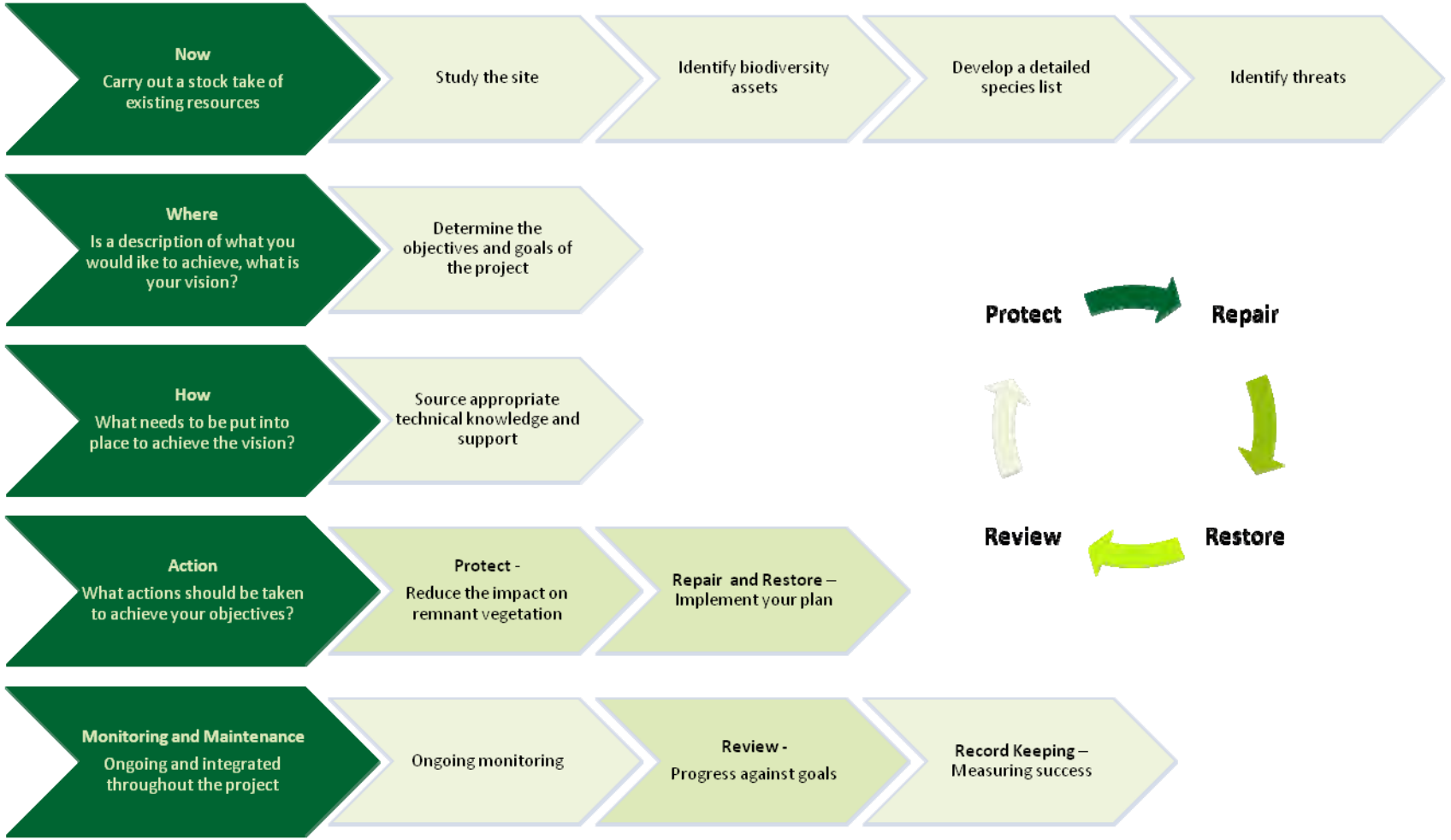


Figure 5: Biodiversity action plan template for remnant vegetation and revegetation

NOW

Carry out a stock take of existing resources.

1. **Study the site**

- ***Aerial photograph***

  Document the status of the site prior to the commencement of the project. This forms the basis of a plan of action, and one of the first things you can do is source an aerial photograph of your property.

  This can be a valuable management tool to:

  - Record a point in time so you can see the remnant area, or area for revegetation, in relation to the vineyard, and benchmark any changes that take place over time.
    - Provide a valuable insight into the remnant or revegetation area itself, and how it fits in with the other management objectives and practices of the vineyard, including the broader environment.
    - Assist in planning and recording your management activities.
    - Map the different components of the site including main weed areas, exclusion, and buffer zones.

  Aerial photographs of your property can be ordered from the Department of Environment and Heritage (Mapland). For more information see, www.environment.sa.gov.au/mapland

- ***Plant cell density digital photograph***

  If you utilise plant cell density mapping as a regular component of vineyard management, request any future maps incorporate areas of remnant vegetation and/or revegetation. This will provide an indicator of plant vigour over time, highlight any changes and identify any areas that are impacting on plant health (either in the vineyard or along revegetation/remnant vegetation areas).

- ***Photo points***

  Take photos at set photo points throughout the remnant or revegetation project, to document habitat condition and any change in weed cover at strategic locations. Take photos at the beginning and key review times during the project. This is often one of the most important parts of documenting a biodiversity project that is often overlooked.

2. **Identify biodiversity assets**

   What are the biodiversity assets that you have on your property? It is important to have a good knowledge of what the remnant or revegetation area contains. This includes the plants and animals present and the physical characteristics.

   Consider the following characteristics of the site:

   - ***Soil type and fertility***

     Assess the different soil types found in the vineyard and its surrounds, the condition of the soil (compaction, hard pans, friability, salinity), and its nutrient status. This can be important for native species with a low threshold for phosphorous and other nutrients commonly found in horticultural production areas.

   - ***Slope, topography and aspect***

     Slope, topography and aspect are all important factors when deciding the best way of managing a remnant stand of vegetation or revegetation project, and its susceptibility to frost, prevailing wind and a range of other factors.

- ***Hydrology***

  The water dynamics of the site may have been altered by the removal of trees in the past; leading to a rise in the water table and possible salinity issues. It is important to understand these associations on fragile sites and what can be done to remedy the situation.

- ***Site history***

  History such as fire, clearing; and prior use, such as previous logging will help to explain the present condition of the vegetation.

- ***Size and shape***

  A small remnant may have some disadvantages over a larger remnant in regard to its long-term viability, although a smaller remnant may be easier to manage for weed control and basic maintenance. The shape of the remnant is also important. If there are a high percentage of edges compared to internal area, then more time may be spent on boundary issues such as weed control and/or maintaining fences.

- ***Connection to other remnants***

  For remnant vegetation or a revegetation project to be considered sustainable and provide ongoing habitat, it must be healthy. If a stand of native vegetation is linked to or located near another area of native vegetation then there is a greater likelihood the area will survive and be self-sustaining. Linked patches provide the added benefit of a wildlife corridor, while an isolated patch of native vegetation is likely to be poorly buffered against change.

- ***Habitat potential***

  As is the case with beneficial insects in a vineyard, signs of native bird and animal species present in the remnant or revegetation area will provide an indication of its habitat potential. The presence of dead trees, hollows and logs on the ground are important aspects of habitat provision. Useful indicators of healthy remnant vegetation or a mature revegetation site include healthy, mature trees that actively produce seed and have an array of nesting hollows, regenerating saplings and shrubs, diverse understorey and few pests and weeds.

- ***Vegetation type and structural diversity***

  The assessment of vegetation type is an important part of the site assessment and should be as detailed as possible. Canopy cover should be noted as a percentage of the total area along with the condition, height and diversity of each level of vegetation including the upper canopy, mid strata, understorey and ground cover vegetation. Different types of species in each layer provide an extra layer of diversity.

Research may be required to fully understand the plant and animal species present and their habitat requirements. You may wish to access professional assistance to capture this information accurately.

Table 3: Design principles of best possible remnant vegetation.

Issue	Principle
Patches	
Quality	Protect the best native vegetation first.
Size and number	The bigger the better, and the more types of habitat the better.
Shape and edges	The more compact the better, consider 'edge effects', and include buffers.
Position	Consider all competing land uses.
Sites	
Local significance	Include watercourses and areas, which provide for threatened species (rare, valuable, endangered).
Linkages	
Connectivity and corridors	The more connected the better. Include corridors and provide stepping-stones.

3. **Develop a detailed species list**

   - Identify indigenous species and habitat associated with the property.
     - Include the habitat locations of your property and neighbouring properties on map.
     - Research and establish an understanding of the original species and habitat.

   You may need to seek the expertise of a specialist in this area. Contact the Adelaide and Mount Lofty Ranges Natural Resources Management Board for assistance.

4. **Identify threats**

   What are the threats to biodiversity on your property?

   - Identify any threatening processes. Carry out a detailed assessment of the risks, and ways to minimise damage to biodiversity assets.

     A range of threats may be posed from:

     - Habitat clearance, degradation or fragmentation of the remnant,
     - The introduction of predators and competitors,
     - Invasion by pest weed species and weed competition,
     - The use of chemicals including; herbicide spray drift and non target damage from the vineyard,
     - Fire,
     - Salinity,
     - Nearby development,
     - Erosion,
     - Grazing,
     - Sources of pollution, and
     - Lack of knowledge and awareness (leading to negative impacts).

   All of these aspects should be considered when you carry out a threat assessment. Make sure you include the management processes that commonly occur in the vineyard.

WHERE

Is a description of what you would like to achieve, what is your vision?

5. **Determine the objectives and goals of the project**

   What are your objectives (what do you want to achieve?), and when will you know when you have reached your destination (goals)?

   They should be **s**pecific, **m**easurable, **a**chievable, **r**ealistic and **t**ime bounded (SMART).

   - Develop a plan which meets your objectives,
   - Ensure this is within the capacity of your available resources (time, money, expertise), and
   - Consider how this plan incorporates other parts of the vineyard property and biodiversity within the vineyard itself.

HOW

What needs to be put into place to achieve the vision?

6. Source appropriate technical knowledge and support

It is important to take the time to develop a strategic plan with sound information to minimise setbacks and disappointing results.

- Seek information and expert advice on the use of indigenous native plants and/or non-indigenous plants (if necessary).
- There is a range of support services available (local NRM Board, Greening Australia, Landcare).
- See what sources of funding are available to you (government grants etc).

Refer to the list of support services presented in Appendix 4 and industry contacts and plant suppliers presented in Appendix 5.

ACTION

What actions should be taken to achieve your biodiversity objectives?

Refer to the 'step by step' guide for managing remnant vegetation or revegetation projects.

The hierarchy of techniques for managing remnant vegetation is presented below.

Action	Examples of action
1. **Protect**	Protect the best areas first. Initially focus on the high quality large remnants, particularly those of an endangered vegetation type,
2. **Repair**	Next, work on improving the quality of degraded vegetation, and
3. **Restore**	Thirdly, consider revegetation works.

7. Protection - Reduce the impact on remnant vegetation

Protect the best native vegetation first. You will recognise the best areas of native vegetation as being those in which:

- Most layers of vegetation are still present (canopy trees, under storey shrubs, ground-layer grasses),
- Many native species typical of the habitat are represented,
- The vegetation is relatively free of disturbance, including introduced weeds, and
- There is significant faunal activity indicating ecosystem function (e.g. pollination, wood decay, breeding populations).

There is a range of protective measures that can be carried out, which include:

- Monitoring and removal of invading pest plant species. Removal of weeds can improve natural regeneration by removing competition,
- Fencing off the remnant vegetation to protect the area from stock and/or pest animals. Fencing also signals the decision to manage the remnant differently to the rest of the property, and
- Developing a strategy to actively control pest animals including, foxes and rabbits, using a number of techniques such as fencing, shooting and poisoning.
  - Poisoning programs should be carefully monitored to ensure non-target species are not taking baits.
  - A control program should be developed in conjunction with neighbouring properties; and the benefits of a control program should be weighted against the potential impact of the works on remnant and associated wildlife.

8. Repair and Restore – Implement your plan

- ***Site preparation – weed control, ground preparation, moisture conservation, frost protection***

  Ensure you have an appropriate timeframe to execute your weed control strategy, prior to, and during any subsequent replanting. Ensure the ground is adequately prepared, and you have given consideration to how you will maintain adequate moisture to new seedlings and protect them from frost (if this is likely to be an issue).

- ***Revegetation techniques***

  Once the site preparation has been carried out, you can consider the restoration of the remnant or revegetation area. Depending on your preferences, there are a number of replanting techniques available:

  - **Assisted natural regeneration** of native species by creating optimal conditions to ensure successful seed germination and survival.
  - Revegetation by **direct seeding** in which sites are seeded manually.
  - Revegetation using seedlings grown into **tube stock**.

MONITORING AND MAINTENANCE

Should be ongoing and integrated throughout the project.

9. Ongoing monitoring

Develop a monitoring program to observe any changes in species generally, or with a focus on an indicator species.

- Observation of remnant vegetation is important for effective management. Documentation of the following should be carried out:
  - Key growth periods such as flowering and the timing of seed set, for both native and exotic species,
  - The success of regenerating species,
  - Soil moisture, and
  - The impacts of management techniques.
- Monitor the change in biodiversity attributes (insect, animal activity etc.) as a response to vegetation enhancement.

10. Review - Review progress against goals

It is important to review your progress to determine if your current strategy is meeting the biodiversity improvement goals you set previously; and if not, it is a good way to implement a continual improvement process, and to modify your approach going forward.

11. Record Keeping

Evaluate the success of managing remnant vegetation at key times (2, 5, 10 years and so on).

This can be done:

- **Visually** by updating photo points, creating drawings/diagrams which capture changes to the structure or area of vegetation or species population; map changes on aerial photos, or
- **Numerically** by carrying out counts of species or scores for habitat condition to show changes over time.

1.4. A Step by Step Guide to Managing Remnant Vegetation and Revegetation Projects

Remnants include the vegetation remaining after an area has been cleared or modified. Remnant vegetation is an important resource with high biodiversity values, which may include stands of trees, shrubs, herbs, grasses and ground covers that border the vineyard.

The remnant may be linear strips, small patches, or larger blocks of land. The enhancement of remnant vegetation (through the creation of tree buffers/corridors or additional habitats) can potentially serve a dual role, through the provision of habitat, and maintenance of ecological processes.

Some of the benefits of maintaining remnant vegetation or reclaiming degraded areas through revegetation in a vineyard setting include:

- Providing habitats for native plants and animal species (including threatened species) and corridors for native animals,
- Providing erosion control,
- Windbreaks for vineyards and under storey grass growth,
- Reducing the rise in the regional water tables and reducing the effects of salinity,
- Providing soil surface litter and foliage cover, acts as natural mulch, provides habitat for a range of fauna and helps to improve soil structure,
- Providing important associations with ectomycorrhizal fungi which aid in the uptake of nutrients and the recovery of native vegetation following disturbances,
- Benefits from ecosystem services (increased biodiversity),
- Minimising the impacts of the greenhouse effect by absorbing and locking up carbon dioxide, and
- Enhancing the aesthetic appeal of the property (and increasing property values).

It is important to maintain multiple layers of vegetation (grasses, shrubs and trees) and multiple species within each strata, rather than a single layer of vegetation for maximum ecosystem and biodiversity benefits.

The ability of a stand of remnant vegetation or reclaimed site to provide wildlife habitat is an indication of the degree of biodiversity that exists within the stand. It is important to have a specific management focus to ensure native vegetation surrounding the vineyard is managed adequately and the goals of the project are clearly understood.

Biodiversity Action Plan

The first step in the process of managing remnant vegetation or carrying out revegetation works is to develop a biodiversity action plan. Time taken to gather background information and develop a strategy will help to minimise setbacks and disappointing results. Seek expert assistance when developing your plan to streamline access to information, and support to tailor your approach.

The 'step by step' sections presented below fit into the Biodiversity Action Plan under:

- Section 7 – Protection, and
- Section 8 – Repair and Restore

For more information about developing a BAP for managing remnant vegetation or revegetation projects go to page 18.

KEY STEPS IN MANAGING REMNANT VEGETATION

Protect

Protect existing patches of remnant vegetation or degraded areas to be revegetated.

Repair

Repair the remnant. Prioritise your efforts to repair and recover good bush first.

Restore

Allow plants to naturally regenerate before planting more.

Site Preparation

Weed control | Ground preparation | Protection from grazing | Moisture conservation

Species Selection

The species you select, their spacing and planting method will be dictated by the reason for the planting

Revegetation technique

Assisted natural regeneration | Direct seeding | Tube stock

Maintenance after planting

Weed control | Replacement planting | Review

Figure 6: A 'step by step' guide for managing remnant vegetation and revegetation projects.

KEY STEPS IN MANAGING REMNANT VEGETATION

1. Protect

It is important to protect existing patches of remnant vegetation or degraded areas to be revegetated. It is easier to protect bush than to re-create it, even if it is degraded bush.

To protect the remnant or revegetation site from further damage, consider the following options:

- Clearly identify the area to be protected, or revegetated, and areas that are not to be disturbed,
- Install appropriately designed fences to exclude grazing pressure (minimise unnatural nutrient build up), and block vehicle traffic from entering native vegetation areas,
- Develop or maintain the location of firebreaks,
- Develop or maintain gates and access tracks or roads,
- Identify the location for on-site storage of nursery stock prior to planting,
- Ensure there is an appropriate buffer zone between management areas to protect from spray drift,
- Identify the location of monitoring plots, photo-points or soil pits,
- Develop a pest, animal, and weed control program, and
- Ensure drainage water or run-off does not flow into the area.

2. Repair

The repair of the remnant will include retaining important components of the remnant, such as:

- Keeping dead trees with hollows,
- Protecting rocky areas, and
- Leaving vegetative litter and logs on the ground.

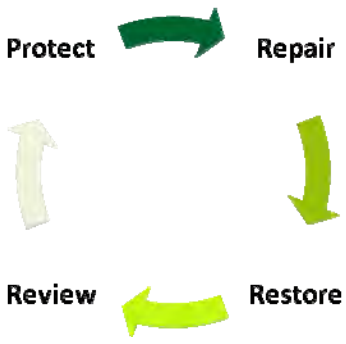
Prioritise your efforts to repair and recover good bush first. This involves the removal of weeds and feral animals. Weed management of remnant vegetation is a priority.

- Target best native areas first, then look towards weedy areas,
- Map weeds and other threats,
- Remove invading, non-indigenous plants from habitat areas,
- Start with tiny infestations before they get too big,
- Work with neighbours to control the whole weed population, and
- Limit soil disturbance as this may encourage more weed invasion.

3. Restore

Restore the natural regeneration in your remnant. Allow plants to naturally regenerate before planting more.

- Be patient while trees and shrubs grow back naturally; allow understorey plants to regenerate,
- Use local indigenous species from local provenance seed where possible,
- Get the right mix of trees and understorey at the right spacing,
- Increase the size of remnant patches,
- Join areas of remnant vegetation; look at possible corridor linkages from a regional perspective, and
- Plant in stages and establish layers of plants.



4. Site Preparation

- ***Weed control***

  Weed competition is the major cause of failure in revegetation. Young seedlings need time to develop a vigorous and deep root system that can tap into reliable sources of soil moisture, and actively compete with weeds. Therefore it is vital that new seedlings have access to a weed free volume of soil until well established.

  For the best results start weed control two seasons before carrying out your revegetation strategy. Satisfactory results are often achieved by controlling weeds for at least one full year before planting. A range of chemical and non-chemical methods can be used, and this depends on the technique used for planting, the soil type, the weed burden, and the desired outcome.

  If you are reclaiming areas where salvation jane is an ongoing problem, it is possible to release key beetle and weevil species to provide long term biological control. For more information, see http://www.sardi.sa.gov.au/pestsdiseases/pests/biological_control/salvation_jane .

- ***Ground preparation***

  All revegetation projects require some form of soil disturbance to prepare the site so its ready to receive seeds or plants. How much disturbance is carried out depends on the technique and the soil type. The advantages of soil disturbance are that it can create an easier path for roots to penetrate and that it makes it easier to plant. The main disadvantages are that it can also stimulate weed germination and increase moisture loss from the soil.

- ***Protection from grazing***

  Whatever method you choose to revegetate your site, your young plants will be vulnerable to grazing by domestic, native and feral animals. There are several options to prevent grazing or browsing of your plantings. This includes fencing to exclude animals, the use of tree guards, reducing pest populations prior to planting, using deterrents and trapping.

- ***Moisture conservation***

  It is preferable to have a water source available to encourage early growth of seedlings until they are established. Other techniques for conserving soil moisture include the application of mulch and using tree guards, which help to conserve moisture and prevent browsing.

5. Species selection

It is important to consider what you want to achieve. The species you select, their spacing and the planting method will be dictated by the reason for the planting.

It is generally accepted that when carrying out revegetation for conservation purposes, it is best to choose species that occur locally as it maintains the genetic integrity of those local populations. These species are well adapted to the environmental conditions of the site; and their pollinators, predators and dependent wildlife are also present.

Species selected for revegetation should:

- Provide a food source and/or shelter to a wide range of beneficial insects,
- Be easy to grow and manage,
- Require minimal inputs,
- Provide little or no competition to vines for water and nutrients,
- Flower for extended periods during the growing season,
- Not be suitable hosts for light brown apple moth, vine moth and other pest species,
- Not develop into an intrusive weed, and
- Preferably be self-sowing annuals or perennial plants.

6. Revegetation techniques

Depending on your preferences, there are a number of planting techniques available:

- **Assisted natural regeneration** of native grass species by creating optimal conditions to ensure successful seed germination and survival. This can be achieved by preparing an adequately receptive seedbed, in which seeds can germinate and grow. The factors which influence the success of natural regeneration include, seed supply and viability, soil condition, competition, predation of young plants, and natural hazards and controls.
- **Direct seeding** is the most common way of sowing large areas. The species selected for planting may not be suited to direct seeding using conventional equipment. This may involve the use of modified equipment or pelletised seed so it can pass through seeding machines successfully.
- **Planting using seedlings grown into tube stock** is mostly limited to small-scale revegetation projects due to the cost of individual tube stocks and the time involved in planting them. A pottiputki (pictured right) is a device that can be used to plant tube stock. For more information go to http://www.treemax.com.au/revegetation/pottiputki.html

The positive and negative aspects of natural or assisted regeneration, direct seeding, and/or tube stock planting are presented below (modified from FloraBank 'Native Vegetation Management Tool').

Table 4: Positives and negatives of natural or assisted regeneration

Direct seeding	Tube stock planting	Natural regeneration
Positives		
Lower establishment costs.	More reliable.	Plants are well adapted to the site.
Natural look and more diversely structured.	Uses small quantities of seed.	Establishes healthiest plants.
Establishes healthier plants.	Revegetation is visible to passers by.	Lowest establishment costs.
Negatives		
Long establishment times may lead to more maintenance such as weed control.	May not be able to access stock or seed with local provenance in desired quantities.	May have to wait a long period for results.
Ants have been known to take seed.	Often results in unnatural looking rows.	Needs a nearby seed source.
Uses lots of seed.	Higher establishment costs.	Long establishment times may lead to additional maintenance (weed control).

7. Maintenance after planting

Timely follow up after planting is critical for the long-term success of your revegetation project.

- ***Weed control***

  A weed-free area of 1m diameter should be maintained around each plant for the first one to two seasons, to encourage successful seedling establishment.

- ***Replacement planting***

  Carry out additional plantings to fill gaps or to replace species that have failed or are under-represented.

- ***Review your progress periodically***

Additional Information - Cost benefit analysis of shelterbelt establishment

The following information is paraphrased directly from Thompson and Hoffmann, 2010.

It is well established that woody vegetation immediately adjacent to vines can enhance natural enemies and their contribution to pest control.

Shelterbelts adjacent to vineyards are typically in the range of four to ten metres in width. Costs are variable, depending on whether grape growers undertake the revegetation project themselves, or use a subcontractor; and depending on the length of associated fencing. Common costs incurred in revegetation projects include:

- Project planning and management,
- Transport costs for machinery, seeds, seedlings and personnel,
- Mechanical and chemical site preparation,
- Fencing,
- Weed control,
- Seed and direct seeding costs or seedlings and seedling establishment costs, and
- Tree guards, and/or stakes.

Depending on the size of the revegetation project some of the costs such as; fencing, site preparation, line/boom spraying of herbicides and direct seeding decrease, on a per hectare basis as the size of the project increases. This is mostly due to a fixed cost per project for mobilisation and transport of equipment. Other costs such as seedlings, seed and tree guards, are more likely to be independent of the size of the project (the cost per hectare doesn't change unless a discount can be realised through bulk purchase). Indicative costings when establishing a shelterbelt (Thompson and Hoffmann 2010), are presented below.

Table 5: Indicative costings when establishing a shelterbelt

Task	Time (Hours per hectare)	Cost
Mechanical site preparation		
Deep ripping (tractor and ripper)	1.2 to 1.5 hrs	$60 / ha
Deep ripping and cultivation		$140 / ha
Herbicide application		
Labour, equipment hire and herbicides (boom line spraying). *Up to three applications may be required.*		$90 per application
Chemical costs		$15 to 30 per application
Seeding		
Seed sourced and planted by the grower		$250 / ha
Seed sourced and planted by the contractor		$400 / ha plus labour costs
Hire of seeder		
Alcoa (the Alcoa Machinery Loan Scheme)		$30 / day
Seedlings - Recommended Rate (1,000 / ha)		
Small seedlings purchased in bulk (>1,000)		$0.80 ea
Larger seedlings (200 to 300mm pots)		$6 ea
Planting		
Planted by hand (labour and hand planter)		$0.50 / plant
Planted mechanically	6 to 20 hrs per 100 seedlings for experienced planters and >20 hrs per 100 seedlings for inexperienced volunteers	$20 to 100 / hr
Guards		
Cartons or cut down plastic containers		$0.17 ea
Commercial seedling guards		Up to $1.00 ea
***Fencing**		
Plain wire fence		$1,100 per km
Rabbit proof fence (one barbed, four plain wire, rabbit mesh, 90cm high plus 15cm buried) with additional labour costs		$3,350 per km

**A square hectare requires 400m of fencing but a hectare of shelterbelt 4m wide would require 5km of fencing if fenced on all sides.*

Below is an example of the cost of establishment of a shelterbelt (4m and 10m wide) by a contractor or grower using seedlings, with and without the most economical fence (Thompson and Hoffmann 2010).

Table 6: Costing example of establishing a shelterbelt by a contractor or grower.

Contractor				Grower			
Cost description	**With fencing**		**No fencing**	**Cost description**	**With fencing**		**No fencing**
a. 4m (4m x 2,500m) b. 10m (10m x 1,000m)				a. 4m (4m x 2,500m) b. 10m (10m x 1,000m)			
Site preparation using contractor deep ripping		$ 60	$ 60	Site preparation using contractor deep ripping. No machinery cost, in-kind labour at $15 / hr.		$ 15	$15
Fencing materials @ $1,100/km (plain wire)	a	$ 5,508		Fencing materials @$1,100/km (plain wire)	a	$5,508	
	b	$ 2,461			b	$2,461	
Fencing labour @ 44 hrs. Labour / km = $1,500 / km. Labour cost estimated at $34 / hr.	a	$ 7,512		Fencing labour, in-kind, labour cost estimated at $15 / hr or $660 / km.	a	$3,305	
	b	$ 3,357			b	$1,477	
Boom spraying three times @ $89 / ha / application		$ 267	$ 267	Boom spraying three times chemical cost only		$90	$90
100 seedlings @ $0.80 ea		$ 800	$ 800	100 seedlings @ $0.80 ea		$800	$800
Plastic guards plus stakes		$ 1,000	$ 1,000	Grower supplied milk cartons or similar guards and stakes		$170	$170
Mechanised planting @ $0.50/plant labour and planter hire		$ 500	$ 500	Mechanised planting, hire planter @ $100 / hr		$100	$100
Total cost per ha contractor	**a**	**$ 13,020**	**$ 2,627**	**Total cost per ha grower**	**a**	**$8,813**	**$1,175**
	b	**$ 5,878**			**b**	**$3,953**	

Estimating the benefit of natural enemies provided by vegetation adjacent to a vineyard

The value of vegetation to pest control is estimated by calculating the value of the natural enemies provided, if these animals were purchased from commercial suppliers. The value of adjacent vegetation to the grower is at least $516 to $696 for each 100m of native vegetation shelterbelt of 4 to 10m in width. The cost of establishing a typical 4m to 10m metre wide shelterbelt ranges from $628 to $728 per 100m for a fenced shelterbelt installed by a contractor, to $47 to $88 for an unfenced shelterbelt put in place through grower provided labour and machinery.

Based on the costs and benefits estimated here, there will be a net gain for every year except the first year for a fenced shelterbelt installed by a contractor. For a shelterbelt lifetime of 20 years, with benefits in terms of natural enemies being derived from conservatively the fifth year, this represents a net gain ranging from $7,462 for the most expensive option (fenced 10m shelterbelt installed by a contractor), to $8,203 for an unfenced 4m shelterbelt installed by the grower.

Table 7: Cost benefit of establishing a 100m long shelterbelt (4m or 10m wide) over 20 years

Established by	Fenced/ unfenced	Width	Cost ($)	Benefit/year ($)[1]	Net gain first productive year [1]	Net gain over 20 years [2]
Contractor	Fenced	4	$628	$550	$ (78)	$7,622
		10	$788	$550	$(238)	$7,462
	Unfenced	4	$104	$550	$ 446	$8,146
		10	$216	$550	$ 334	$8,034
Grower	Fenced	4	$400	$550	$ 150	$7,850
		10	$510	$550	$ 40	$7,740
	Fenced	4	$47	$550	$ 503	$8,203
		10	$88	$550	$ 462	$7,162

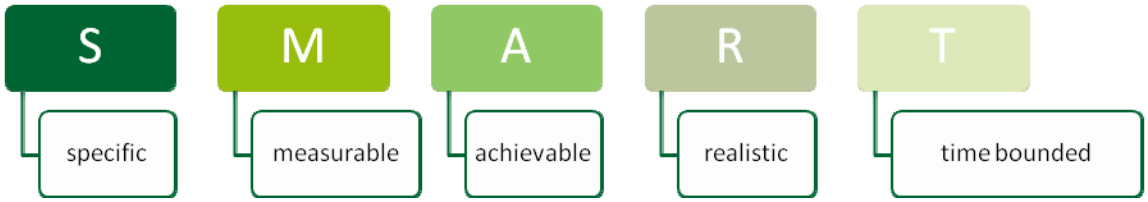
[1] Mean value based on our measurement in vineyards with shelterbelt widths 4 to 10m. It is possible that natural enemy abundance will vary with width.
[2] Assuming production of natural enemies at the rate assessed in our studies for 5 to 20 years post establishment, with a single establishment cost.

1.5. Biodiversity Action Plan – Establishment of Native Grasses

The planning stage

The first step in the process of incorporating native grasses into a vineyard, either in the mid row or in the vineyard surrounds, is to make a plan. A biodiversity action plan can be used to underpin the decisions you make in putting your plan into action. Time taken to gather background information and develop a strategy will help to minimise setbacks and disappointing results.

In developing this plan you be asked to consider your goals and objectives. They will need to be:



To start the biodiversity action plan (BAP) process, we will start with the **Now**, and then go onto the following sections:

- Now, Where, How, Actions, Monitoring and Maintenance.

BAP Template

A summary of each stage in the biodiversity action plan for the establishment of native grasses is presented below:

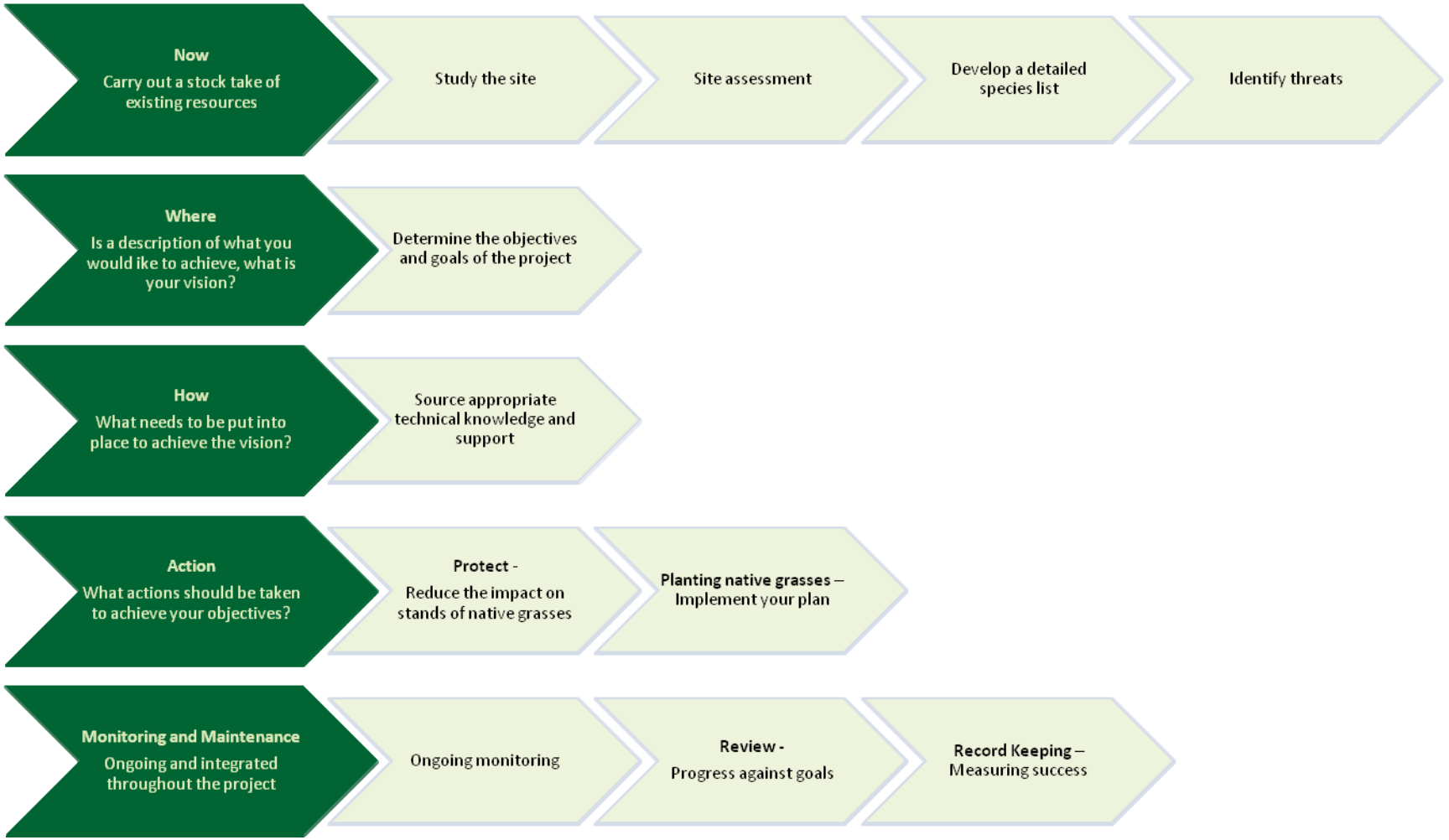


Figure 7: Biodiversity action plan template for native grasses.

NOW

Carry out a stock take of existing resources

1. **Study the site**

   - **Photo points**

     You may wish to document progress from set photo points situated at key locations where native grasses will be established, either in the mid row, or in the vineyard surrounds.

     This is a good way to document:

     - The success of seed germination, seedling establishment, or the condition (and density) of mature stands of grasses over time.
     - Any change in weed cover at strategic locations.

   Take photos at the beginning, and at key review times during the project.

2. **Site Assessment**

   It is important to have a good knowledge of the site characteristics prior to deciding what species of native grasses to plant. Consider the following characteristics of the site:

   - ***Soil type and fertility***

     Assess the different soil types found in the vineyard and its surrounds, the condition of the soil (compaction, hard pans, friability, salinity), its nutrient status and suitability for native grasses. Some native grass species have a low threshold for phosphorous and other nutrients commonly found in horticultural production areas. Other species respond favourably to the incorporation of specific fertilisers.

   - ***Slope, topography and aspect***

     Slope, topography and aspect are all important factors when deciding the best way of managing an area to be planted, and the selection of appropriate grass species depending on their susceptibility to frost, water logging and their key periods of growth (C_3 grasses are winter active and C_4 grasses are summer active).

   - ***Hydrology***

     It is important to understand the hydrology of water flow on fragile sites if there is an underlying salinity issue (due to the removal of trees in the past), and how freely drained a site is (some grasses do not respond well to water logging).

   - ***Size and shape***

     A small planting of native grasses may have some disadvantages over a larger area, which is likely to be more stable. If there are a high percentage of edges compared to internal area, such as in a mid row, which is long and thin, then more time may be spent on weed control along the borders.

   - ***Connection to other stands of native grasses***

     Consider the proximity of your native grasses planting to other stands of native grasses that may prove a good seed source in the future. Genetic material with local provenance will provide a valuable indicator of which species are likely to prosper, their habit and the diversity of species, which naturally occur in your local area. Research may be required to fully understand the native grass species present and their habitat requirements.

     You may wish to access professional assistance to capture this information accurately. A series of native grass identification cards have been developed as a part of this project and are located at the end of this report.

3. **Develop a detailed species list**

   Identify indigenous grass species located on the property.

   - Identify other native grass species that may be suitable for use on your vineyard. Some species have been bred for specific qualities favoured by broad acre farmers, and these may also be suitable for use in a vineyard mid row setting.
   - Source information about the habit and growth requirements of a range of native grasses you may wish to use. This information is becoming easier to find as more viticulturists are becoming interested in enhancing the biodiversity on their properties, and are trialling the use of a range of native grass species.

   You may need to seek the expertise of a specialist in this area. Contact the Adelaide and Mount Lofty Ranges Natural Resources Management Board for assistance.

4. **Identify threats**

   What are the threats to the successful establishment of native grasses on your vineyard property?

   - Identify any threats posed, including the management processes that occur in the vineyard such as:
     - Herbicide drift,
     - Invasion from weed species (especially during establishment),
     - Loss of seed by ants, other insects, birds and animals, and
     - Excessive fertiliser (historical stores of phosphorous and other fertilisers in the soil, drift from foliar sprays, run-off from fertigation).
   - Once you have carried out a detailed assessment of the risks, think of ways to minimise damage to native grasses and other biodiversity assets.

WHERE

Is a description of what you would like to achieve, what is your vision?

5. **Determine the objectives and goals of the project**

   What are your objectives (what do you want to achieve) and when will you know when you have reached your destination (goals)? They should be **s**pecific, **m**easurable, **a**chievable, **r**ealistic and **t**ime bounded (SMART).

   - Develop a plan which meets your objectives, ensure this is within the capacity of your available resources (time, money, expertise), and
   - Consider how this plan incorporates other parts of the vineyard property, such as revegetation of degraded areas, and biodiversity within the vineyard itself.

HOW

What needs to be put into place to achieve the vision?

6. **Source appropriate technical knowledge and support**

   It is important to take the time to develop a strategic plan with sound information to minimise setbacks and disappointing results:

   - Seek information and expert advice on the use of indigenous native grasses, and
   - Find a reliable source of seed either from your own property, local native seed groups, or commercial seed suppliers. Know the types of questions to ask regarding seed germination and viability testing etc.

   Refer to the list of industry contacts and plant suppliers presented in Appendix 5.

ACTION

What actions should be taken to achieve your biodiversity objectives?

Refer to the 'step by step' guide for managing native grasses.

7. Protection - Reduce the impact on stands of native grasses

There is a range of protective measures that can be carried out, which include:

- Clearly marking the areas of native grass establishment so they are not disrupted or inadvertently sprayed out by vineyard staff.
- Monitoring and removal of invading pest plant species (especially during the establishment phase). Removal of weeds can also improve natural regeneration by removing competition.
- Fencing off the area from stock and/or pest animals, if you are managing a stand of native grasses surrounding the vineyard.

8. Planting native grasses – Implement your plan

Site preparation – weed control, ground preparation, moisture conservation, frost protection

- Ensure you have an appropriate timeframe to execute your weed control strategy prior to establishment. It may take several years to exhaust the weed seed bank, and it is advisable to start weed control at least six to nine months prior to planting.

Planting techniques

Determine which revegetation technique you will use and which technique is the most appropriate. For example, the use of:

- **Assisted natural regeneration** of native grass species by creating optimal conditions to ensure successful seed germination and survival,
- **Direct seeding** is the most common way of sowing large areas such as the vineyard mid row, or
- Planting using seedlings grown into **tube stock** can be used for small-scale revegetation projects.

MONITORING AND MAINTENANCE

Should be ongoing and integrated throughout the project.

9. Ongoing monitoring

Develop a monitoring program to observe the success of native grass establishment and recruitment.

- Observation of native grasses is important for effective management.
  - Key growth periods such as flowering and seed set, the success of regenerating species, soil moisture, and the impacts of management techniques should be documented.
- Monitor the change in biodiversity attributes (insect, animal activity etc) as a response to vegetation enhancement.

10. Review - Review progress against goals.

It is important to review your progress to determine if your current strategy is meeting the biodiversity improvement goals you set previously; and if not, it is a good way to implement a continual improvement process and to modify your approach going forward.

11. Record Keeping

Evaluate the success of establishing your native grass stand. This can be done:

- **Visually** by updating photo points, making drawings/diagrams of changes to the structure, or area of vegetation or species population, map changes, or
- **Numerically** by **c**arrying out counts of species or scores for habitat condition to show changes over time.

1.6. A Step by Step Guide to Establishing Native Grasses

Native grasses can make an important contribution to improving vineyard sustainability, but care must be exercised to ensure the species suitability for each situation, and to minimise any yield loss from the vines.

One of the main strengths of native grasses over exotics is that they are already adapted to the Australian environment with low input requirements. Their ability to cope with variable and extreme climatic conditions and nutritionally poor soils potentially makes them a good choice as ground covers, both in the vineyard and its surrounds.

Generally native grasses remain a product of natural selection, unlike most exotic species currently used. For this reason there are some problems with the use of native species, such as prolonged shedding of seed, dormancy mechanisms that need to be overcome, seed that is not suited to delivery through conventional seed drills, problems with seed purity, fertility, and the cost of seed.

The main points to consider when establishing native grasses in the vineyard are:

- Education to recognise the difference between native and introduced species in the vineyard and their growth habits,
- Allowing native grasses to develop mature seed heads, and mowing only once the native grass has shed its seed,
- Use herbicides selectively against weeds when native grasses are dormant, and
- Understand the growth habit of the grass species; for example, understanding the minimum height for different grasses, that needs to be retained prior to slashing to ensure its survival.

The basic steps for incorporating native grasses (or other beneficial species) into the vineyard are outlined below. As with revegetation, it is important to consider what you want to achieve. This will guide the selection of appropriate species.

C3 and C4 photosynthetic pathways

Many native grasses are long-lived, summer-active perennials that maintain varying amounts of green leaf during the winter months. A combination of C_3 and C_4 grasses provides the best all-round habitat for native invertebrate species and increases biodiversity.

- ***C_3 grasses*** are winter active, establishing and/or actively growing during autumn, winter and spring.
  - They are also referred to as perennial *cool* (wet or dry) season grasses, and will be green all year if moisture is available during summer; they tend to be frost tolerant.
- ***C_4 grasses*** are summer active, establishing and/or actively growing during spring, summer and autumn.
  - These are perennial *hot* (wet or dry) season grasses, that tend to be susceptible to frost (dormant in winter), and green and growing in summer.
  - They are generally better adapted to higher temperatures, higher light intensities and lower (<50 ppm) CO_2 concentrations than C_3 plants.

KEY STEPS IN ESTABLISHING NATIVE GRASSES

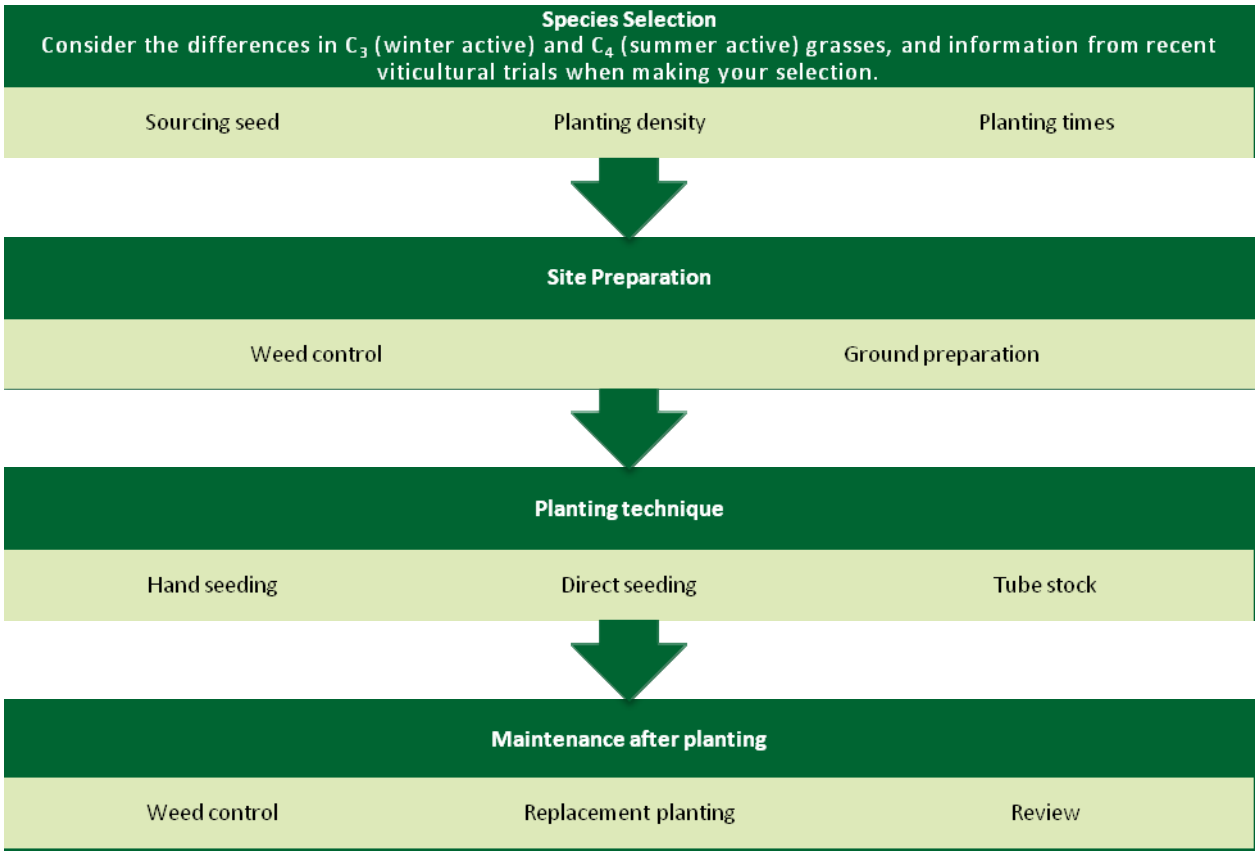


Figure 8: A 'step by step' guide for establishing native grasses.

Step by Step Guide to Establishing Native Grasses

1. Site Preparation

- **Weed Control**

  Young seedlings need time to develop vigorous and deep root systems that can tap into reliable sources of soil moisture and actively compete with weeds. It is vital that new seedlings have access to a weed free area of soil until well established.

  For the best results start weed control the season prior to planting in early spring, in order to kill weeds and reduce the soil seed bank prior to planting in the mid row the following autumn (if this is practical). It may take more than one season to exhaust the weed seed bank.

  Ongoing weed control throughout the early stages of seedling development is important to ensure seedlings can outcompete weeds. Once established, native grasses tend to compete strongly with a range of weeds in spring and summer (including caltrop and wireweed).

  In some cases it may be necessary (or advantageous) to apply herbicide to the mid row and plant a cover crop species soon after (or in the same pass with specially designed machinery). This may be more successful with introduced species such as buckwheat, *Alyssum* or *Phacelia*. It is recommended these species are planted every tenth row in the vineyard.

  Note: The planting of these species for shelter, and food for beneficials has not been trialled extensively in Australia, and caution should be taken to ensure the species planted does not become invasive. Alternatively, you may wish to consider planting native vegetation near the vineyard that can provide the similar benefits.

The aim is to create a shelter and food source for beneficial insects when they are needed in high numbers to control light brown apple moth or other pest insect species. It is important to ensure any herbicides used to control weeds do not suppress the seed germination of newly planted species.

- **Ground preparation**

  While native grasses are tough and hardy when established, they will not germinate and establish except under suitable conditions. Ensure any hard pans are broken up to allow for successful seedling germination.

2. Species Selection

When planting native grasses it is generally accepted that it is best to choose species that occur locally, if it is possible to source a reliable supply of good quality seed. They are more likely to be adapted to the environmental conditions of the site, and their pollinators, predators and dependent wildlife are present.

A mid row perennial native grass sward for vineyards should:

- Have low water use (especially during the summer months),
- Have a low physical profile, and
- Be sourced from local seed where possible.

Consider the differences in C_3 (winter active) and C_4 (summer active) grasses, and information from recent viticultural trials when making your selection.

It is important to consider the possible negative impact the establishment of native grasses may have on grapevine yield. If native grasses are grown in unsuitable situations or at high density, the spring and summer active native species can impact significantly on vine yield through competition for water.

For example, wallaby grass grown in the Barossa Valley reduced the yield of young Shiraz vines by 30%; but in the Coonawarra there was no yield impact on old wide spaced vines in a dry grown vineyard (Penfold and McCarthy, 2010). It may be better to wait until the vines are mature until native grasses are established in the mid row.

- **Sourcing seed**

  When sourcing seed there are two main sources, either:

  - Source seed locally from existing stands of native grasses. This may be important if provenance is important to you as seed from locally occurring grasses is more likely to be adapted to your site if it is located nearby.
  - It is important to understand when the seed is mature, how to collect the seed (this may be done mechanically), clean and prepare the seed for sowing.
  - Alternatively, there is a range of commercial seed producers available both within South Australia and interstate. This may provide the benefit of a reliable source of good quality seed.

When sourcing seed commercially, request the results of a seed viability and germination tests prior to purchase.

- **Planting density**
  - It is important to understand the habit of the native grass to better understand the optimum planting density. For example, it is important to have a relatively sparse cover of wallaby grass on the ground, as this mirrors its natural habit in nature.
  - A perennial or tussock grass will persist for a numbers of years and can grow up to 30cm in diameter. A thick mat, like other mid row cover crops, is not preferred and doesn't appear to be required for the grass to exclude weed species. A dense mat of wallaby grass may end up competing with the vines for moisture and this will need to be closely monitored.
  - Wallaby grass has the capacity to regenerate and its natural recruitment will fill some of the gaps. This is preferable rather than reseeding over the top of existing stands to fill any small holes.
- **Planting times**

  As a general rule of thumb the following sowing times should be observed:
  - Plant C_3 species in autumn, prior to or during a breaking rain event, while the soil temperature is still warm.
  - Plant C_4 species in late winter or early spring, depending on seasonal conditions and when adequate soil moisture is available.

3. Planting Technique

The biggest issue when establishing native grasses in the vineyard is getting viable seed to the mid rows. Determine which revegetation technique you will use depending on where you would like to establish native grasses.

- **Hand seeding (broadcast)**
  - It is possible to spread native grass mulch with mature seed heads by hand but where an economic use of seed, and an even take is required, direct seeding is the best option.
- **Direct seeding**
  - Because of the uneven nature of the seed and its awns, it may be necessary to pelletise the seed with a clay mixture to ensure it can pass through a modified seeder (this can be done by a commercial operator).
  - The pelletised product is larger than the original seed and substantially heavier. This provides it with the ballistic properties needed for seed to be distributed evenly through a modified seeder. This also allows for the addition of insecticide and fungicide to the seed that assist in survival.
  - Alternatively a specially modified seeding machine can be used where the seed is suspended in water, which causes the hairs to lie flush with the outside shell. A polymer is used to thicken the water to enable it to carry the seed through the seeder. A pump can be calibrated to regulate the seeding rate with accuracy.
- **Tube stock**
  - It is not financially viable to plant tube stock to the mid row; but this method of planting may be used as a part of a revegetation project where a degraded site is being reclaimed, or if you wish to develop your own nursery to supply a source of seed for future projects.

4. **Maintenance after planting**

- ***Weed Control***

  Weed control should be carried out once native grasses have been planted and until they are mature and able to outcompete weed species.

  The following comments have been sourced from John Stafford's work at Henschke's Vineyards:

  'Chloris truncata is a C4 summer active grass and can be sprayed with up to 2 litres/ha of glyphosate at the start of winter to prevent smothering of the grass by weed species while it is relatively dormant. Trials with organic herbicides such as BioWeed™ Herbicide have shown that the soft tissued broadleaf weeds can be controlled with very little impact on the native grasses. Regular close mowing of erect native grasses like *Austrodanthonia* has been shown to extend soil moisture reserves by up to six weeks. However, this is achieved by stunting the root system and thereby making the native grass more vulnerable to moisture stress. Shorter or more prostrate grasses (eg, *Chloris truncata* or *Microlaena sp.*) are better able to sustain regular mowing.'

  The following comments are sourced from Chris Penfold's GWRDC trial work:

  'When dormant and during winter, windmill grass is recognized as being tolerant of glyphosate herbicide. However, if oxyflurofen (Striker®) is used to spike the mix this may prove lethal to the windmill grass and may suppress any new growth. If weed growth is taller than the native grasses a sponge wiper can be used to remove weed competition.'

C4 (summer active) grasses are generally regarded as being more tolerant to translocated herbicide such as glyphosate that may be used to control winter growing weeds when the grass is dormant.

- ***Replacement planting***

  It may be necessary to replant any missing grasses the following season. This may involved manually spreading seed in bare patches, direct drilling over existing plantings, replanting tube stock in a revegetation situation or waiting for natural recruitment to occur (species dependent).

- ***Review progress periodically***

Additional Information - Approximate costs of production for native grasses

The following information is paraphrased directly from Penfold, 2010.

Approximate costs of production for three cover crop species over a five-year period using a contractor for field operations are presented below.

Table 8: Indicative costings when establishing native grasses compared to saltbush and barley ($/ha).

Task	Wallaby grass	Saltbush	Barley
Seed	$800	$500	$100
Operations			
Seeding	$180	$180	$900
Spraying	$400	$250	$500
Mowing	$688	$375	$312
Herbicides			
Jaguar	$116		
Glyphosate	$14	$42	$35
Basta			$400
$/ha/5 years	**$2,198**	**$1,347**	**$2,247**
$/ha/year	**$440**	**$270**	**$450**

Perennial native grasses and plants can offer a cost effective alternative to annual and introduced species, through a reduction in costs and water use while simultaneously suppressing weeds. Native grasses require fewer or almost no inputs (such as fertiliser or supplementary water) once established.

Based on cost alone, the use of native perennials as cover crops would appear to be a feasible option to the conventional cereal crops when viewed over a longer time frame.

The high upfront costs of seed, however, may require growers to introduce the native species in small blocks, with the potential for harvesting their own seed from stands as they become established.

A financial analysis of the costs involved in establishing and managing native perennials versus annual cereal cover crops over a five-year period, revealed that saltbush would be cheaper than an annual cover crop, while the perennial native grass and the annual cereal were very similar.

1.7. Identification of Demonstration Sites (Case Studies)

Demonstration sites were identified from participants who responded to questionnaires and indicated they were interested in attending workshops in the Barossa Valley and McLaren Vale wine regions.

Details of growers involved in enhancing the biodiversity on their properties are highlighted in the case studies presented below.

Focus Area	Barossa Valley Wine Region	Focus Area	McLaren Vale Wine Region
Native grasses, managing remnant vegetation and revegetation.	• Falkenberg Vineyard (Daniel Falkenberg) • C.A. Henschke and Co (Prue Henschke) • Lehmann's Boongarrie Estate Vineyard (Phil Lehmann) • ▪ 刹 ▪ ▪ 矽離壅 ▪ ▪ 涼D eans) Vineyard (Leon Deans)	Mid row	• The Terraces (Troy Elliker) – Alyssum planted as a shelter and nectary species (introduced species).
		Managing remnant vegetation and revegetation.	• Chapel Hill Kangarilla Vineyard (Rachel Steer and Ian Janssan) • Gemtree Vineyard and Wetlands (Melissa Brown)
			• Wetland and Old Rifle Range Vineyards (Sami Gilligan)

The following case studies were collated from property visits and discussions with the people involved in carrying out the projects presented below.

Mary Retallack from Retallack Viticulture carried out interviews in March and April 2010.Thank you to everyone who participated and shared their experiences.

The case studies are presented by region, with the project presented alphabetically.

FALKENBERG VINEYARD

Contact: Daniel Falkenberg

Projects: Establishment of wallaby grass in the mid row, plus revegetation of remnant vegetation areas surrounding the vineyard.

Location: Nuriootpa (Barossa Valley Wine Region)

The following notes have been collated through conversations with Daniel Falkenberg (right) and his father, Ian Falkenberg.

Vineyard

- The vineyard was established in 1997 and planted to Shiraz and Grenache on their own roots. The vineyard is approximately 5 ha in size.
- The topsoil is highly variable grading from grey sand with hard yellow clay underneath, to loamy soil with red clay underneath.
- Every second row is ripped each year with a specially modified ripper that can incorporate Neutrog at depth.

Weed control

The main weeds located in the vineyard are salvation jane, wireweed and evening primrose. It is important to start weed control in the mid row nine to twelve months prior to the planting of native perennial grasses, to provide adequate time to mine the existing weed seed bank and start with a clear surface.

The site was prepared early in the growing season using Roundup PowerMax spiked with Spotlight. The mid row was sprayed out twice prior to seeding to kill the salvation jane and wireweed, and ensure the soil surface was ready for planting the four species of wallaby grass. A week after the seed was planted Roundup was sprayed over the soil surface prior to any seed germination. Wallaby grass seems to tolerate the use of Jaguar to remove broad-leafed weeds early in the growing season.

Wireweed was sprayed out under vine and in the mid row prior to the establishment of native grasses. Wireweed persists at the end of strainers, where there is less competition from grasses.

Wallaby grass was planted in the mid row in May 2009 (six months active growth to April 2010). Note the absence of weed species where the wallaby grass has established.

It is important when planting native grasses to start with minimal weed pressure, as young seedlings don't compete well with established weeds; and to be persistent with weed control during establishment. Once wallaby grass is established it appears to compete favourably with wireweed. Daniel's general observation is that weed pressure is much less overall than at the same time last year.

Seed quality

The quality of native grass seed and its viability can vary depending on the season and the time of the year it is harvested.

The mature head can drop seed quickly (in late November/December). It is important to collect the seed as soon as it is mature, and prior to it falling to the ground. If the seed is collected too early it may not be fully mature which will reduce germination rates.

The Mid-North Grassland Working Group has developed a specialised native grass-harvesting machine, which incorporates a rotating brush that extracts and deposits the seed in a collection drum.

It is important for growers to request the results of seed viability and germination testing prior to purchasing seed from a commercial reseller. This will provide a guide to expected germination percentage for a particular batch.

Wallaby grass heads (once the seed has fallen).

Sourcing Seed

Seed was sourced commercially from Native Seeds Pty Ltd in Victoria www.nativeseeds.com.au. A four species mix incorporating the following species of Wallaby grass was used:

- **Common wallaby grass** *Austrodanthonia caespitosa* (also known as white top)
- **Wallaby-grass** *Austrodanthonia racemosa*
- **Brown-back wallaby grass** *Austrodanthonia duttoniana*
- **Wallaby-grass (LIG 179)** *Austrodanthonia fulva*

Kangaroo grass is considered too vigorous for the vineyard mid row, and it can be difficult to establish.

Pelletised wallaby grass (four species mix) ready for seeding.

Seed treatment

Seed is cleaned and pelletised with a clay covering to provide it with the ballistic properties required to pass through a modified seeder.

A third party carries out the pelletising process (separate from the commercial seed reseller). The seed is dyed blue, which is a visual deterrent to birds so they won't eat the seed. This seems to work well.

Other native grasses (such as kangaroo and spear grass) can be hard to clean and pelletise due to their physical structure.

Seeding

Chris Penfold's seeder was used to plant wallaby grass in the vineyard mid row in May 2009, at a rate of about 10kg per sown hectare. It is possible to reduce this rate to 5kg per sown hectare; but given 20% or more of the seed is likely to be unviable the 10kg rate seems to be a good balance.

In hindsight, Daniel believes that dry seeding any time from March onwards would be beneficial as the seed will be in the soil prior to opening rains while the soil temperature is still warm. The seed can be dry drilled and is unlikely to blow away due to its pelletised clay treatment. It is important <u>not</u> to incorporate DAP or other phosphate fertilisers when planting native seeds, as this will reduce the likelihood of success. The headlands and other vacant areas of the vineyard will be planted this season.

Rear view of Chris Penfold's 6 row seed drill. The rear wheels ensure the seed is firmly bedded into the soil.

Disk Drill showing Danthonia seed (blue colour) in furrow. Seed planted into soil at 1cm depth

Germination

Germination of up to 80% is considered a good result. Last season there was no observable seed germination for the first three months, until the soil started to warm up in September. Some of the grasses have reproduced from seed produced in the same season and new seedlings can be found near mature plants.

Chris Penfold's specially modified 6 row seed drill for planting native grass seed into mid row of vineyard.
Photograph courtesy of Ian Falkenberg

Biodiversity

- A four species wallaby grass mix has been used to encourage biodiversity.
- Some species will establish quickly (which is important to compete with weeds quickly) while others will establish more slowly and will be less vigorous.
- By planting with more than one species this provides the benefit of varying the growth habits of each species, rather than having a disappointing result if only one species is planted and the germination is poor.
- The vineyard is surrounded by peppermint gum grassy woodland, which provides a great habitat for red-capped robins, diamond fire tale finches and a range of other declining woodland bird species. These birds tend to be seed eating and insectivorous rather than fruit eaters, and do not pose a problem in the vineyard.
- Predatory birds such as falcons and hawks also frequent the woodland areas and actively patrol the vineyard border. They are an active deterrent to any pest bird species such as starlings, rosellas and crows that may otherwise flock to the vineyard.
- In spite of native vegetation in close proximity to the vineyard, fruit loss and damage by birds has been insignificant since the vineyard was planted in the 1990's.

Issues

- There has been no negative impact on yield observed to date, however the trial is still in its early days and this aspect is being monitored.

Good sward of native grasses in mid row of vineyard (Shiraz) November 2009
Photographs courtesy of Ian Falkenberg

Wallaby Grass - Habit

- It is important to have a relatively sparse cover of wallaby grass on the ground as this mirrors its natural habit in nature. A perennial or tussock grass will persist for a number of years and can grow up to 30cm in diameter.
- A thick mat, like other mid row cover crops is not preferred and doesn't appear to be required for the grass to exclude weed species. A dense mat of wallaby grass may end up competing with the vines for moisture and this aspect will need to be closely monitored.
- Wallaby grass has the capacity to regenerate and its natural recruitment will fill some of the gaps. This is preferable rather than aggressively reseeding over the top of existing stands to fill any small holes.
- Wallaby grass is a deep-rooted grass with roots of mature grasses extending down to 60cm. While grasses may compete with vines to some degree, their deep root system makes them hardy, tolerant of drought conditions; and their root system can help to open up the soil and improve soil structure and infiltration for moisture. Competition may be managed with careful consideration given to planting density (as mentioned above).

Establishing wallaby grass in the vineyard mid row (note the sparse planting density). March 2010.

Daniel's early observations are:

- **Common Wallaby grass** *Austrodanthonia caespitosa* and **Wallaby-grass (LIG 179)** *Austrodanthonia fulva* may be better suited to drier soils and provide less competition to vines that have low to medium vigour.
- **Small flower Wallaby grass,** *Austrodanthonia setacea* and **Common Wallaby grass** *Austrodanthonia caespitosa* may be a good combination as they grow in similar environments.

Regeneration Area

In addition to the current vineyard project, an area of 4ha next to an older vineyard (since removed) was revegetated during the 1990s. This consisted of planting locally endemic peppermint box tree species. A new section next to this original area (and next to the current vineyard) is in the process of being planted to native perennial grasses.

This area was seeded with native grasses in 2009. The results were poor due to water logging issues. Historically this area had vineyard planted on it, topsoils are hard compacted over yellow clay. Note the natural regeneration of Native Cyprus pine in the background.
Photograph courtesy of Ian Falkenberg

Revegetation of understorey with native grasses (spear grass and wallaby grasses) in a stand of remnant Peppermint Woodland. The native grasses were planted in 2009 with locally collected species. Historically this woodland was heavily grazed and cut for fence posts in the late 1940s and early 1950s. *Photograph courtesy of Ian Falkenberg*

A four species mixture of wallaby grass was sown using Chris Penfold's modified seeder in May 2009. The take was variable (compared to the vineyard) and this may have been attributed to a water logging issue (the vineyard is more freely drained due to deep ripping in the mid row). Further seeding will occur this season along with the wooded regeneration area.

General comments regarding revegetation

- It is important to remove stock and manage grazing pressure. It has taken nearly 20 years for the remnant woodland section to recover from a long history of over grazing,
- Do not collect or remove fallen timber from remnant areas,
- Control pest plants and feral animals (rabbits), and
- Monitor, or control, mistletoe if it gets out of hand.
  - A good population of possums (brush tailed and ring tailed possums exist on the property) and mistletoe is hard to find. Where there are no possums present, mistletoe tends to be widespread and hard to control.
  - However, possums can also become a problem and at times can cause some over grazing of eucalypt foliage.

Revegetation planted in 1992 with local endemic species. Historically this area was cropped and heavily grazed. Fallen timber in the foreground is important for native birds and is left untouched.
Photograph courtesy of Ian Falkenberg

Additional Project History by Ian and Daniel Falkenberg

The purpose of this project was to establish native perennial grasses within an existing vineyard. The goals were to:

- Use drought tolerant and deep-rooted characteristics of native perennial grasses to improve water through flow and retention in soil profiles, thus reducing dependency on irrigation.
- Improve habitat value of degraded pasture areas and surrounding native vegetation for native birds, particularly seed eating and insectivorous species.
- Achieve a significant reduction in the abundance and distribution of undesirable pest plants (weeds)
- Reduce dependency and use of chemicals to control weeds.
- The native perennial grasses are expected to assist with soil stabilisation and prevent soil loss.

The native grasses (including *Danthonia fulva, D. caespitosa, D. duttoniana, and D. racemosa*) were planted using direct seeding techniques in the mid rows of the vineyard and the open pasture areas. In the remnant woodland sites, native perennial grass seed (including *Themeda triandra, Danthonia fulva, D. caespitosa, D. duttoniana, and D. racemosa and Austrostipa spp*) were established using a broadcast technique. All areas were dominated by annual weeds; including the vineyard, open pasture sites, and areas adjacent to native remnant vegetation and woodland sites. A key issue of the project was the control of pest plant species prior to direct seeding. Weeds were removed from the mid row of the vineyard and open pasture areas through a continuous application of Glyphosate (Roundup) herbicide over a 12 month period; and a selective herbicide (Jaguar and Hammer) was used to control invasive weed species following the direct seeding and germination of seed.

We planned to burn open pasture sites using a low intensity fire to remove the dry thatch. However due to drought conditions over the past 3 years, the levels of fuel material was too low to carry a fire and therefore this technique was not used, although two attempts were made to burn the area in Autumn 2009. Good seasonal conditions occurred during late autumn and through winter and spring 2009 and it is anticipated that the use of fire will be used to remove the dry thatch prior to direct seeding of the last remaining area in autumn 2010. It is anticipated that direct seeding will be undertaken immediately after the burn across the treated area. Treated sites will be covered with a mulch to ensure seed remains on site and in contact with soil. A selective herbicide will be used to control invasive weed species following germination of seed.

Pelletised native perennial grass seed was purchased and used in the vineyard areas including: *Danthonia fulva, D. caespitosa, D. duttoniana, and D. racemosa.* In the open pasture areas: *Themeda triandra, Danthonia fulva, D. caespitosa, D. duttoniana, and D. racemosa and Austrostipa* spp were primarily used. The treated areas (vineyard and open pasture areas) were harrowed lightly prior to seeding to ensure good penetration of the seed drill into the soil, and that a good seedbed was created for the pelletised seed. Direct seeding was undertaken in May/June 2009 and following good opening rains. Some limited germination was observed in the vineyard areas over the following 6 to 8 weeks; however the weather was relatively cold and wet. In early September 2009 a further assessment was undertaken of direct seeding, with overall results rated as poor, with an estimated 40% of the seeded areas showing emerging plants at low densities.

During October and November 2009 we experienced a period of very hot weather followed by good soaking rains. In late November 2009 a further assessment was undertaken of direct seeding sites with overall results rated as average to very good with an estimated 70% of the seeded areas showing reasonably good coverage of native grasses. Some of the earlier grasses have set seed and have developed into a good dense sward of native grasses. Patience is an important factor when planting native grasses; and seasonal factors such as temperature (soil) and rainfall (soil moisture) were significant factors in the successful germination of native grasses.

Direct seeding technique has proved to be the most practical and successful method of establishing native perennial grasses over large areas. Pelletised native seed was planted at a rate of 10kg / ha to a depth of about 0.5 to 1.0cm.

HENSCHKE'S SCHILLINGS AND HILL OF GRACE VINEYARDS

Contact: Prue Henschke

Project: Planting of native grasses in the mid row and establishing native plant species as nectaries for beneficial insects within the vineyard.

Location: Keyneton (Eden Valley Wine Region)

Establishing native grasses in the vineyard

Prue Henschke has been working with native grasses in vineyards over the last ten years. A mix of three wallaby grass species (*Austrodanthonia* species) have been planted in the 'Hill of Grace' vineyard from local provenance seed. The seed was originally collected from nearby roadsides, and a native grass nursery has now been established on the property to provide an ongoing source of seed for the vineyard. This is a cheap way of having access to seed, with the added benefit of the genetic material being well suited to the local environment.

The seed was planted using John Stafford's custom built hydro seeder, which uses water-based polymer as a carrier to transport the seeds through the seeder, and into the mid row at a set rate. The seed is planted at about 3kg/ha in five separate rows within the mid row. A shielding mechanism enables either; herbicide to be applied, or inter-row mowing of the unplanted sections of the mid row. This can be useful to suppress weed competition in the early stages of native grass establishment.

Early weed germination can be managed with an organically approved pine oil extract without impact on the grasses. By planting grasses in rows, this facilitates mowing in-between the rows, to control problem weed species. This is important in the long term, so the vineyard can be managed organically, and it reduces the reliance on pine oil, which is expensive.

A carbon-based tea is being incorporated in the vineyard to increase organic matter, encourage the growth of native grasses, and enhance soil microbial activity and quality. Wallaby grass (*Austrodanthonia* species) doesn't naturally recruit as well as other species, such as windmill grass (*Chloris truncata*), which readily recruits when seeds fall to the ground in wet conditions. Similarly, some wallaby grass species don't do as well in the gullies in heavier textured soils, and others such as *Austrodanthonia tenuior* is more suited to these areas. You can read more about Prue's work with native grasses at www.henschke.com.au/vineyards/nativegrasses/

Native species used as insectaria – part of the ecosystem services

Several low growing shrub species are being trialled for use in the vineyard as nectaries to provide a source of nectar to beneficial insects. This work is being carried out in conjunction with the CSIRO Ecosystem Services project. Up to fifteen plant species including, *Bursaria*, *Goodenia*, and *Lomandra* (as well some threatened species) are being planted in groupings to create insectaria around the vineyard. *Bursaria* is planted every 20 metres in the headlands (next to strainer posts), and in the future *Lomandra* (iron grass) will be planted every 20m throughout the vineyard (under vine and next to intermediate posts). These species flower during the months of November and December, which is the time beneficial insects are needed to biologically control LBAM and other pest species in the vineyards. Additional information about this project can be found at www.henschke.com.au/vineyards/ecosystem/

Sweet bursaria is being planted at the end of rows every 20m to act as a nectary.

Groups of key nectary species are planted around the perimeter of the Schillings Vineyard.

LEHMANN'S 'BOONGARRIE ESTATE' VINEYARD

Contact: Phil Lehmann

Project: Using minimal intervention to conserve biodiversity around the vineyard.

Location: Eden Valley Wine Region

Phil and Sarah Lehmann purchased Boongarrie Estate in 2002. The property is 120 hectares in size. A ten hectare Cabernet Sauvignon and Shiraz vineyard was planted in 1999. The remainder of the property is planted to a small four-hectare olive grove and used for grazing stock.

Phil takes a 'hands off' approach to managing the vineyard, and the other parts of the property, which includes old remnant red gums and a creek line. By observing what goes on during the season, considered decisions are made to complement the management of the property, where required with minimal intervention. The vineyard will be farmed biodynamically in the future.

Irrigation water is collected in dams on the property. There has not been sufficient water to irrigate the vines over the last two seasons. Traditional herbicides have not been applied to the vineyard in recent years; BioWeed™ was applied in 2008 as a 50cm strip spray.

Sheep are used to graze the ground cover down to a manageable level, two or three times a year. The intensity of stocking numbers is important to determine how heavily the ground is grazed. Sheep tend to selectively eat out the centre of the salvation jane florets and prefer grasses, often leaving many of the broad leaf weeds behind. During summer the growth from volunteer weeds is limited, because there is little soil moisture available. Weeds such as salvation jane and couch tend to dry out more quickly than the vines. Any additional weed growth is managed using a Howard mulcher.

Soil moisture monitoring capacitance probes were installed recently to help guide irrigation scheduling when there is sufficient water available to irrigate. The soil is light sandy loam and the soil profile is shallow where there are iron stone ridges. The soil hasn't been worked for five years. This has enabled the build up of a range of low profile ground cover species in the mid row and under vine.

This area is managed with little intervention and this provides a constant ground cover, which works well to conserve soil moisture, and to encourage biodiversity on the site in preference to bare soil. Mulch will be applied under vine in the future to encourage uniform growth from weaker vines.

	
A range of low profile ground cover species has produced a thick mat to protect the ground surface.	Sheep are used to graze the under vine area. Couch grass has started to gravitate from the under vine area into the mid row. The area covered by couch is reducing.

Couch used to be prevalent in the vineyard, and over time it has retreated to the mid rows, and it doesn't appear to be actively competing with the vines. It may be possible to reintroduce natural beetle and weevil species onto the property to biologically control the salvation jane, and achieve long term control in the future.

	
The creek line has been heavily grazed in the past. It will be fenced off in the future and revegetated.	Grazing to the area near the vineyard dam has been restricted and this has allowed the natural recruitment of red gum seedlings to prosper.

The creek line will be fenced in the future, and the area around the dam has been less heavily grazed in the last couple of seasons. There are a number of large remnant gums located near the dam, and in the last couple of seasons there has been increased seedling growth from under several of the old red gums (this may be a stress response). The new seedlings have been able to flourish now there is reduced grazing pressure.

Phil is keen to plant native grasses in the future and continue with the conservation of remnant trees (including the control mistletoe growing in the canopy), and to revegetate the eroded creek line.

A dam at the base of the property is saline and Phil would like to look at ways of reclaiming this area back and improving its hydrology and eventually its productivity.

NAIMANYA (DEANS) VINEYARD

Contact: Leon Deans

Project: Managing remnant vegetation near an existing vineyard.

Location: Eden Valley Wine Region

The Deans Vineyard is located near the Kaiserstuhl Conservation Park at the top of Mengler's Hill in the Barossa Valley. The property is 30 hectares in size and comprises 5.6 ha of vineyard planted to Shiraz and Riesling, along with several areas of remnants. A small 1 hectare remnant has been fenced off from stock since 1974.

The management of the remnant is largely 'hands off' although there is an issue with *Monadenium,* an invasive weed species, which is progressively removed as it is found. A species survey has identified between 79 to 82 native species, including some of which are regarded as threatened species.

Until recently a second five hectare remnant was ungrazed. In the last two years, this stand has been periodically grazed to keep salvation Jane down. Blackberries and olives are progressively removed from this area. There are a number of important orchid species present in this remnant and *Xanthorrhoea* are in good condition after the recent rains. In the future a watercourse will be fenced off to exclude stock and to assist revegetation. This will provide stepping-stones and corridors to the existing remnants and stands of native vegetation on neighbouring properties.

This stand of remnant vegetation has been fenced off from grazing since 1974.

Blackberry and olives need to be systematically removed from this stand of remnant vegetation.

CHAPEL HILL KANGARILLA VINEYARD

Contacts: Ian Janssan and Rachel Steer

Project: Revegetation of a degraded creek line.

Location: Kangarilla (McLaren Vale Wine Region)

Kangarilla Vineyard

The vineyard is approximately 30 ha in size and is located on Days Road at Kangarilla. It is planted to Chardonnay, Verdelho, Shiraz, Sangiovese, and Savagnin. The creek line runs from the south to the north through the vineyard. The property has a number of significant red gums. Apart from these trees there are few remnant markers. The area between these trees was slashed in the past.

The creek line runs through the middle of the vineyard.

Replanting has occurred around sensitive areas of the creek line to preserve the bank as much as possible

Timeline

The creek line was overgrown and choked with ash trees, watsonia and phalaris grass prior to commencement of the project. Work commenced with the removal of ash trees from the southern section of the creek line. The trees were cut back leaving a stump, which was painted with Roundup. The tree tops were removed using a tractor. It has been necessary to retain the butts, and roots of the bigger trees, as they hold the creek bank together. This does cause some problems, as suckers may grow back if the trunk is still viable. Where the ash trees are small saplings, they are removed entirely. Where invasive vegetation has been removed, there is a regeneration of other vegetation such as rushes, which are starting to return to the creek.

Ash trees were cut and painted with Roundup. New sapling growth needs to be removed or sprayed as it appears.

Weed matting was used to help suppress weed growth. In some areas, the matting was disturbed by birds gathering the matting for nesting material.

Watsonia was sprayed using Roundup Biactive. It is important to use the Biactive formulation to minimise any negative impacts along the watercourse. By targeting the watsonia when it was actively growing (and flowering), this maximised the uptake of the chemical through to the corm and resulted in an excellent kill rate. In some cases the watsonia needed to be treated several times. It is important to kill the corm to stop it spreading (regeneration from seed is low). The killing of watsonia has resulted in a dense mat of mulch and rotting corms, which will be unviable in the future.

A shrub is prospering near the rotting remnants of a rotting Watsonia corm.

Watsonia killed effectively with Roundup when foliage is green and flowering. This helps to exhaust the corm.

This is a good way to retain organic matter, reduce erosion along the bank and provide a good layer of mulch where plant tube stock can be planted in the future.

The spraying out of a larger area with tube stock planted in groupings worked well rather than inter-planting in existing weedy areas and hoping new plants would outcompete the weeds (this approach didn't work). If weeds persist, an area of one meter is spot sprayed around each plant. Pink marker dye and bamboo stakes were used to keep track of the areas sprayed ready for planting.

Watsonia killed ready for replanting. The remaining dry foliate provides a good layer of mulch for tube stock.

A one-metre area will be sprayed out around plantings to allow them to establish with low weed pressure.

Revegetation commenced in August 2008, however at the soil was dry, a petrol driven posthole auger was needed to create a hole for the tube stock. The hole was wider than required and as the soil contains a high clay content it was difficult to retain enough friable topsoil to back fill the hole. The auger may have also smeared and sealed the sides of some of the holes. This, along with poor rainfall from September onwards, resulted in the success rate of planted grasses and trees being very low.

In June 2009, the same sections were replanted but much earlier in the season. In comparison to 2008, 2009 received excellent winter rainfall and the conditions were more suitable to planting tube stock. The results to date have been promising. A small trowel was used to open the ground up for placement of the tube stock and as the soil was damp it was easily pressed back around the plants. Tube stock was staked and weed mat was used to smother the germination of future weeds, where weed pressure was high.

The plants were grouped into areas where the weeds had been sprayed out. This worked well to concentrate the plantings to particular areas and to be able to mow between them to keep weed pressure down. The spaces between these plantings will be filled in the future. Generally a take of up to 80% is considered good. Up to 20% of tube stocks may be lost due to a range of issues including physical damage, grazing pressure, drought or competition from weeds. There have been some problems with kangaroos chewing on the new replants.

The capacity to irrigate new plantings is preferable to get them established.

Ongoing Maintenance

After the initial clean up and planting of the native plants some ongoing maintenance is required. This comprises:

- Spot spraying with Roundup,
- Using a whipper snipper, or mower to keep unwanted weeds down, and
- Watering the plants.

Partnership

Chapel Hill has been working with the Adelaide and Mount Lofty Ranges Natural Resources Management Board, who sourced and supplied native, local species for their plantings. Chapel Hill is responsible for the site preparation and ongoing maintenance after the tube stock has been planted. This was an initial three-year agreement, which in the process of being extended for another three years. The types of plants used comprise rushes, shrubs, small to medium trees and large tree species.

A full list of species planted (and their preferred location) is presented below:

Botanical name	Name	Size	Area to plant
Eucalyptus camaldulensis	Red Gum	Large tree	Wet area
Eucalyptus leucoxylon	Blue Gum	Large tree	Any
Acacia pycnantha	Golden Wattle	Tree	Top or middle bank
Allocasuarina verticillata	Drooping sheok	Tree	Top or middle bank
Acacia melanoxylon	Blackwood	Small tree	Wet area
Leptospermum continentale	Prickly tea tree	Shrub/ small tree	Wet area
Bursaria spinosa	Bursaria	Shrub/ small tree	Any
Acacia acinacea	Wreath wattle	Shrub	Top bank
Acacia myrtifolia	Myrtle wattle	Shrub	Top bank
Acacia paradoxa	Kangaroo thorn	Shrub	Top or middle bank
Dodonea viscosa	Dodonea	Shrub	Top or middle bank
Melaleuca decussata	Totem poles	Shrub	Damp/wet
Myoporum viscosum	Bobialla	Shrub	Any
Olearia ramulosa	Twiggy daisy bush	Shrub	Top bank
Hardenbergia violacea	Native lilac	Creeper	Top bank
Baumea rubiginosa	Soft-twig rush	Tussock	Creekbed
Cyperus vaginatus	Stiffleaf sedge	Tussock	Creekbed
Isolepeis nodosa	Knobby club rush	Tussock	Any

The location of the plantings is important and some species have been more successful than others.

Future focus

In the future the following tasks will be carried out:

- Consolidation of the current plantings including weed control around existing tube stock,
- Maintain the integrity of the creek banks,
- Control invasive weeds such as phalaris, in and around the creek, and continue the removal of ash trees along the northern end of the creek line,
- Continue to enhance the biodiversity of the site by planting a ground cover of native grasses by preparing the ground and broadcasting seed by hand, and
- Revegetate the area around and under old remnant red gums.

GEMTREE VINEYARD AND WETLAND

Contact: Melissa Brown

Project: Management of remnant vegetation at Gemtree Vineyard and revegetation of the adjacent Gemtree Wetlands.

Location: McLaren Flat (McLaren Vale Wine Region)

Gemtree Vineyard

The Gemtree Vineyard is managed organically (in conversion from July this year) and biodynamically. There is a large amount of native vegetation spread throughout the vineyard. Some of the biodiversity benefits include lower bird damage and light brown apple moth pressure within the vineyard.

Sheep are run in the creek area during summer and in the vineyard during winter. The grazing pressure helps to keep ground cover down without slashing, with the benefit of adding manure into the vineyard. There are no immediate plans to return the creek line to its original condition but this compromise works well from a vineyard management perspective.

Gemtree Wetlands

Approval was required from the Native Vegetation Board to remove some red gums prior to planting the vineyard in 2001. Part of this agreement was that an area needed to be set aside for revegetation. This started the process of reclaiming a 10-hectare parcel of land called the Gemtree Wetlands, located adjacent to the vineyards. In 2005, a joint venture was developed with Greening Australia. Greening Australia have provided technical expertise in developing a five year management plan, species selection, access to alternative sources of funding, volunteer planting services; and have helped with initiatives such as 'Arbor Day' where there is a community tree planting day held each year. The NRM Board has also been involved in this project. More than 30,000 plants have now been planted at the wetland site. Recently secured funding from a range of sources will go towards the continued revegetation of the site, the development of walking trails, interpretive signage, brochures etc.

Native grasses were planted in June 2009 using a range of tube stock and broadcasting seed by hand (incorporated in sand). A range of species, including winter-growing species like spear grass (*Austrostipa* spp), wallaby grass (*Austrodanthonia* sp), tall wheat grass (*Elymus scaber*) and summer growing kangaroo grass (*Themeda triandra*), were used. The take has been very promising and this will provide a local source of seed in the future. There are a range of threatened fauna, which are strongly associated with grasslands including plains-wanderer, Australian bustard, pigmy blue tongue lizard and many woodland birds. The Gemtree Wetlands will be opened to the public from April 2011.

Native grasses planted in the wetland area.

Revegetation along the creek line.

THE TERRACES

Contact: Troy Elliker

Project: Alyssum is being trialled in the vineyard mid row to provide food and shelter for beneficial insects.

Location: McLaren Flat (McLaren Vale Wine Region)

The Terraces have been involved in trialling an introduced species, *Alyssum* in the vineyard mid row to provide food and shelter to beneficial insects. *Alyssum* is a perennial species and is planted in preference to buckwheat, which is an annual. However, the seed can be difficult to source and is quite expensive. The seed is small which makes it hard to sow using commercial seeding equipment.

Shallow subsurface irrigation was installed in the mid row to encourage establishment of the *Alyssum*. This may prove useful to encouraging the flowering time to promote beneficials. The seed was broadcast by hand in late spring 2009 with a light raking to cover the seed just below the surface.

Alyssum planted in the mid row last spring is starting to establish with the assistance of underground irrigation.

The Alyssum seed is very small and hard to sow using conventional equipment.

The establishment has been patchy. This may be in part due to the preparation of the site using Roundup and Striker, which may have suppressed the growth of the *Alyssum* and thus made it hard to get a good germination. It is important not to use herbicides with residual activity if planting seed. Bare areas will be replanted in April 2010 to provide a continuous cover, which in time, will consolidate.

Flowering *Alyssum* is a perennial species and will regenerate over time.

New inflorescences will develop into flowers and seed as they mature.

THE WETLANDS VINEYARD

Contact: Sami Gilligan

Project: Revegetation of an area next to the California Road Wetlands and adjacent to a new vineyard/winery development.

Location: Tatachilla and Willunga (McLaren Vale Wine Region)

The property is located between California Road and Victor Harbor Road at Tatachilla. It was purchased in 2004 and is about 9 hectares in size. The creek line running along the north of the property is part of the California Road Wetlands. The property was originally a strawberry farm with a grid of bamboo shelterbelts running throughout the property (right).

One of the first jobs was to remove the shallow rooted bamboo windbreaks using an excavator. Spot spraying of bamboo is an ongoing process.

There was little remnant vegetation on the site when it was first purchased, except for some mature trees along the creek line and property borders.

There was no mid-level vegetation or

native ground cover. In the past the volunteer weed growth was slashed, leaving a bare surface with no mid level vegetation. A three hectare vineyard has recently been planted to the following varieties; Grenache, Mataro, Roussanne, Marsanne, Vermentino and Tempranillo.

The goals of this project are to increase the biodiversity in the vineyard. This includes attracting the right kind of bird activity by targeting territorial species such as magpies and lorikeets that are predominantly insect eating species. Their territorial nature helps to deter pest bird species from entering the vineyard and causing damage to fruit. Aesthetics are also important as a winery and cellar door facility are currently being constructed to welcome visitors in the future.

Initially, Sami approached the Water Catchment management Board (which is now the Adelaide and Mount Lofty Ranges Natural Resources Management Board) for assistance. They have been able to provide expertise, develop a property action plan, and provide funding and volunteer labour to carry out the revegetation work on the ground.

A range of mid-level vegetation and trees were planted using tube stock around the wetland area, and as a windbreak along the southern border of the vineyard. Some of these species developed quickly while others took several seasons to prosper (especially during drought conditions).

Hayed off grasses provides a good mulch (and moisture retention) for tube stock to grow through.

Remnant trees with revegetated understorey.

Where tube stock were planted into hayed off grass this has provided a good mulch layer. It also hid the growth of some of the shrub species. The success of the planting has become more evident as the plants grew high enough to see above the grass. The success of establishment to date has been very good.

Old tree line with bamboo removed and young seedlings starting to fill out the understorey.

Shelterbelt between vineyards is establishing well with a number of different species providing a good habitat for a range of fauna.

The next part of the project is to control the phalaris and couch. This area will then be planted using a mixture of native grasses to enhance the biodiversity value of the revegetation area at all strata levels.

Treatment of the areas of bamboo, which keep sprouting up, is ongoing. Other areas of problem weeds are progressively spot sprayed using roundup. Grazing pressure has been low with a small amount of rabbit damage observed. No stakes or tree guards were used, and seedlings weren't watered.

The wetlands are heavily vegetated by reeds but these are performing a service and help to filter the water. In the past, silky tea trees were planted in the wetland area with variable success. They will be replanted in the future, as they are a significant species to this area. A total area of about 0.5 ha is dedicated to biodiversity on the property.

OLD RIFLE RANGE VINEYARD

The Old Rifle Range Vineyard is located between Hunt and Edwards Road at Willunga. It is about four hectares in size and is planted to Shiraz. There are a number of significant trees around the vineyard and this is all that remains of the remnant.

The mid and understorey were non-existent when the property was purchased, due to the traditional broad acre method of slashing the grass under the trees.

The area was direct seeded about twelve years ago with seed laid on the ground with the soil mounded over the top. The area is now heavily wooded with a diverse range of species and bird life present.

Echidnas are now found on the site. There is no ongoing maintenance required of the revegetated area and the system appears to be self-sustaining.

Lower bird damage and LBAM activity are two of the many benefits gained by having the vineyard located near the revegetation site. The only down side is the prevalence of red gum seedlings which regrow in the vineyard; however this is a minor issue.

Revegetation of a remnant stand of vegetation by broadcasting seed (carried out 12 years ago).

Remnant and rehabilitated vegetation surrounding the vineyard.

1.8. Identification of Native Grasses found in Vineyards - Ute Guide

Wallaby grass	Austrodanthonia sp.
Wallaby grass species commonly used in vineyards	**Common wallaby grass** *Austrodanthonia caespitosa* (white top) **Wallaby-grass** *Austrodanthonia racemosa* **Brown-back wallaby grass** *Austrodanthonia duttoniana* **Wallaby-grass (LIG 179)** *Austrodanthonia fulva* **Small flower wallaby grass,** Austrodanthonia setacea **Purplish wallaby grass** *Austrodanthonia tenuior*
Overview	Wallaby grasses are a widespread and valuable species due to their persistence and productivity. There are about 33 native species of wallaby grass. There are usually a number of species growing alongside one another and populations are seldom monocultures.
Description	Wallaby grasses are erect tufted perennials with fine leaves, which remain green throughout the year. The seed heads vary considerably, but are usually about 0.3–0.8 metres above the ground and have an attractive white fluffy top when mature.
Key features	Known for its distinctively white tufted seed heads. A range of different wallaby grasses has been successfully established in the mid rows of vineyards from seed.
Height	30 to 80cm tall.
Flowering time	Spring and sometimes in autumn, depending on the climate.
Fuel Load	Minimal fuel load.
Response to fertiliser	Increases in frequency in response to fertiliser. Most Austrodanthonia sp respond positively to nitrogen.
Frost tolerance	High
Drought tolerance	High
Weed suppression	Mature stands of wallaby grass are very effective at suppressing wireweed or caltrop.
C_3 photosynthetic pathway	Winter active C_3 grass. Most wallaby grasses prefer not to be waterlogged.
Distribution	Australia wide as well as south-east Asia and New Zealand.
References	*Fact sheet: Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA.* *Waters, C., Whalley, W., and Huxtable, C. (2002) Grassed up - guidelines for revegetating with Australian native grasses. NSW Ag.*

Wallaby grass	Austrodanthonia sp.

Photographs: Chris Penfold (top left), Mary Retallack (all other photos)

Weeping rice-grass	Microlaena stipoides
Alternative name	Weeping grass, meadow rice grass or rice grass.
Overview	*A tufted perennial with a short rhizome, it remains green throughout the year and is a highly competitive species. It is more commonly seen in damp or semi-shaded areas.*
Description	Characterised by slender weeping seed stalks and short non-adventurous (underground runner) root system. A year round green perennial grass, which can be spread by dividing clumps and replanting. Often found around rocky areas (which trap water) on south-facing slopes. Resilient, low maintenance ground cover that provides good protection to soil from heavy traffic and water erosion.
Key features	*The seed stalks have a* distinctive arching /weeping appearance.
Height	30 to 70cm (to top of seed head). The growth habit is quite variable, from prostrate to erect.
Flowering time	Summer to autumn.
Fuel Load	Minimal.
Response to fertiliser	Responds well to increased soil fertility.
Salt tolerance	Medium salt tolerance.
Frost tolerance	High frost tolerance.
Drought tolerance	High drought tolerance.
C_3 photosynthetic pathway	Winter active C_3 grass. High tolerance to acid soils, drought and frost. Growth may be impaired by excessive exposure to radiant heat. Warm season establishing grass (growth spurts in spring and autumn).
References	*Fact sheet: Weeping Rice-Grass. Native Grass Resources Group Inc, Mt Barker, SA.* *Fact sheet: Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA.* *Waters, C., Whalley, W., and Huxtable, C. (2002) Grassed up - guidelines for revegetating with Australian native grasses. NSW Ag.*

Weeping rice-grass	Microlaena stipoides

Photographs: North Sydney Council (bottom left), Mary Retallack (top middle), Anon (right)

Spear grass	Austrostipa species
Overview	*Spear grasses are a year-long green, course-leafed perennial with a widespread distribution.*
Description	Leaves are rough to touch and are covered in minute hairs.
Key features	The seed has a long sharp awn with a corkscrew twist (up to 6cm long). The leaves are tightly scrolled.
Height	20 to 40cm.
Fuel Load	Minimal dry fuel load, year long green foliage.
Response to fertiliser	Decreases in frequency.
Frost tolerance	Moderate to high.
Drought tolerance	High.
C_3 photosynthetic pathway	C_3 winter active grass.
Distribution	Occurs Australia wide, as well as south-east Asia and New Zealand.
References	*Fact sheet: Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA. Species Information Sheet: Landscaping – which native grasses to grow. Native Grass Resources Group Inc, Mt Barker, SA*

Spear grass	Austrostipa species

Photographs: Mary Retallack

Kangaroo grass	Themeda triandra
Overview	*This tall, large tussock grass is one of Australia's most widespread species. A drought resistant, deep-rooted, warm season perennial.*
Description	The leaves are up to 50cm long and the leaf blades bear sparse hairs. Seed heads are relatively large, and often reddish in colour with a drooping appearance. Older leaves tend to have a red/brown appearance.
Key features	Distinctive rusty-red coloured ripe seed heads and a red/brown tinge on the older foliage. Often found regenerating in shallow soils. Common on roadsides near the freeway entry at Hahndorf.
Height	Upright foliage 40 to 90cm.
Flowering time	Flowering occurs throughout summer from December to late April.
Fuel Load	Moderate. If not removed, accumulated dry leaf matter can give rise to a significant bank of very flammable material, but spring / summer mowing or burning results in a summer persistent green sward.
Response to fertiliser	Decreases in frequency.
Frost tolerance	Low to moderate.
Drought tolerance	High drought tolerance.
C_4 photosynthetic pathway	Being a C_4 summer active grass, Themeda will only respond to warm temperatures with adequate soil moisture for seed germination. Plants tend to be dormant in winter.
Distribution	One of the most widespread native grasses in Australia growing in every state and territory.
References	*Fact sheets: Kangaroo Grass and Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA.* *Waters, C., Whalley, W., and Huxtable, C. (2002) Grassed up - guidelines for revegetating with Australian native grasses. NSW Ag.*

Kangaroo grass	Themeda triandra

Photographs: Mary Retallack

Windmill grass	Chloris truncata
Overview	*Windmill grass is a relatively short-lived (2–3 years) perennial and makes rapid growth in spring and early summer. It may persist as an annual, regenerating from seed in spring and summer. The plants are low and tussocky, with blue-green leaves and reddish-purple seed heads.*
Description	Distinguished by a seed head with 5–10 radiating spikes each to about 15 cm long radiating horizontally from a common point at the end of the stem. Leaves basal, to 14 cm long, flat or folded, bluish-green in colour.
Key features	Inflorescences resemble a windmill of radiating spikes at the end of each stem.
Height	Plants are usually 10 to 50 cm high.
Flowering time	Mainly summer but may extend into autumn.
Fuel Load	Minimal.
Response to fertiliser	Increases in frequency.
Frost tolerance	Low.
Drought tolerance	Moderate.
C_4 photosynthetic pathway	Many C_4 grasses are susceptible to frosts and plants tend to be dormant in winter. C_4 plants are better adapted to high temperatures, high light intensities and low carbon dioxide concentration when compared to C_3 plants. They tend to have a low tolerance to water logging and salinity.
Distribution	Widespread in all mainland States. Valuable warm-season grass, either scattered or dominant providing green forage when little else is available. Germinates after spring or summer rainfall.
References	*Fact sheet: Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA. Waters, C., Whalley, W., and Huxtable, C. (2002) Grassed up - guidelines for revegetating with Australian native grasses. NSW Ag.*

Windmill grass	Chloris truncata

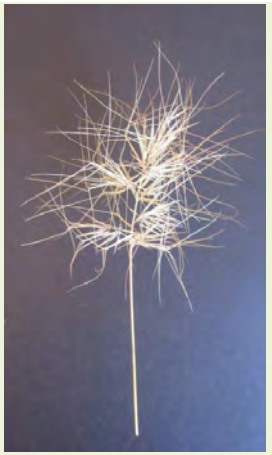
Photographs: Mary Retallack

Brush wiregrass	Aristida behriana
Overview	*Brush wire-grass is an attractive warm season perennial, which grows as a low, dense tussock, with coarse, narrow leaves. Usually found on poor shallow soils.*
Description	Short tufted perennial, forming sparse clumps, leaves rolled, stems erect and rigid, with brush-like inflorescences, often purplish in colour.
Key features	Juvenile inflorescences look like a green brush with purple tips. Bristly and cream when ripe. Seed heads are dense and brush like, turning light a golden straw colour when mature. Each flower has a three awned seed.
Height	20 to 40cm.
Flowering time	Flowers mainly in spring, but can flower at all times during the year.
Fuel Load	Minimal.
Response to fertiliser	Decreases in frequency.
Frost tolerance	Moderate.
Drought tolerance	High, usually occurs in dry areas.
C_4 photosynthetic pathway	C_4 summer active grass.
Distribution	Occurs in South Australia, New South Wales and Victoria.
References	*Fact sheet: Native Grasses for Sustainable Land Management. Native Grass Resources Group Inc, Mt Barker, SA.*

Brush wiregrass	Aristida behriana

Picture: Mary Retallack (Retallack Viticulture)

A quick reference guide to C_3 and C_4 native grasses

C_3 photosynthetic pathway (winter active)			C_4 photosynthetic pathway (summer active)		
Wallaby grass	**Weeping rice-grass**	**Spear grass**	**Kangaroo grass**	**Windmill grass**	**Brush wiregrass**
Austrodanthonia species	Microlaena stipoides	Austrostipa species	Themeda triandra	Chloris truncata	Aristida behriana
					
	 				

2. KEY REFERENCES

2.1. Publications and Articles

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Thompson, L., Hoffmann, A. (2010) Cost benefit analysis of shelterbelt establishment: Natural enemies can add real value to shelterbelts. The Australian and New Zealand Grapegrower and Winemaker, March – Issue 155. p 38-44.

2.2. Useful Websites

Native Grass Resources Group

The **Native Grass Resources Group** is interested in Australian native grasses, and they have information about available native grasses, a database of grass seed suppliers and growers, and glossy publications. For more information please visit, http://www.nativegrassgroup.asn.au/

FloraBank

FloraBank shares the best available knowledge from research and practice in native species seed management and delivers training for seed professionals, and works to assist the native seed industry to grow and develop as a national peak body advocate. FloraBank is an initiative of the Australian Government, Greening Australia and CSIRO. A range of Guidelines including basic germination and viability tests for native plant seed are provided www.florabank.org.au/default.asp?V_DOC_ID=880 along with an extensive range of practical tools. For more information please visit, www.florabank.org.au

Native Biodiversity Resource Kit - Environmental Management in Agriculture

The Victorian Government's Department of Sustainability and Environment has developed a series of worksheets designed to be used with its **Native Biodiversity Resource Kit - Environmental Management in Agriculture.**

This is a good starting point for any property owners who wish to learn more about practical steps a farmer may undertake to include native biodiversity as part of on-farm environmental management. It contains all the necessary instructions, advice and support materials to help train farmers in understanding most of the native biodiversity resources on their property, and incorporating these elements within their management program. For more information please visit,

http://www.dse.vic.gov.au/DSE/nrence.nsf/LinkView/5AD7C889DED359714A256AED000C74EFE04DDD452E997236CA2573B6001B2785#worksheets

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