‘REVEGETATION BY DESIGN’ guidebook

A guide to using selected native plants to reduce pests and diseases in the horticulture region of the Northern Adelaide Plains

Australian Government
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A guide to using selected native plants to reduce pests and diseases in the horticulture region of the Northern Adelaide Plains

Peter Taverner Glenys Wood Dijana Jevremov Bill Doyle

Produced: 2006

Author Details

Peter Taverner[1], Revegetation by Design Project Leader, Glenys Wood[2], Project Research Officer, Dijana Jevremov[3], Project Communications Officer, Bill Doyle[4], Project Revegetation Consultant.
[1 2 3] Members of the Revegetation by Design Project team. South Australian Research and Development Institute (SARDI), Waite Research Precinct, Entomology Unit, Urrbrae, South Australia. [4]City of Playford, 12 Bishopstone Rd, Davoren Park, South Australia.

Cover images: before and after photographs taken at the main research site of the Revegetation by Design project; the Greenhouse Demonstration Site, Angle Vale Road, Virginia, South Australia.

This publication is also downloadable electronically from the following website:
http://www.sardi.sa.gov.au
follow the links to Entomology - Horticultural Pests - Revegetation by Design.

This guidebook has been printed on Recycled Paper with Soy Based Inks.

In particular, we would like to acknowledge Dr. Nancy Schellhorn as the principal architect of the 'Revegetation by Design' concept and project. Tony Burfield (SARDI Western flower thrips IPM Adoption Coordinator) for being instrumental in integrating revegetation into horticultural IPM on the Northern Adelaide Plains. For contribution to early scientific support and advice in using insect borne pollen as a marker – Dr Tish Silberbauer. For the taxonomy, field work and insect culturing – Dr. Richard Glatz, Dr. Claire Stephens, Nathan Luke, Julie Lindner, Judy Bellati, Karen Geyer, Nola Lucas, Kym Perry, and Susan Ivory. For statistical assistance - Susan Gehrig.

Special thanks goes to growers Mr Thien Vu and Mr Minh Pham for their generosity and cooperation shown while allowing us to grow native plants on their properties.

The preparation of this guidebook, and the technical program that underpins it, involved capturing a wealth of experience from the following people; Adrian Marshall (City of Playford), Domenic Cavallaro (Horticultural Consultant), Van Le (formerly Greenhouse Modernisation Project Manager), Kylie Robinson (formerly of the Virginia Horticulture Centre), John Stafford (Revegetation Services Consultant), Mike Redmond (Virginia Horticulture Centre), and John Hutson (Flinders University).

This project would not be possible without our funding partners and collaborators:

- Rural Industries Research and Development Corporation (RIRDC) was part of a larger program funded by the Department of Transport and Regional Services Sustainable Regions Programme
- Horticulture Australia Limited (HAL)
- The Australian Government Natural Heritage Trust and ENVIROFUND
- City of Playford
- Virginia Horticulture Centre.

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General Disclaimer

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Foreword

The most striking feature of the landscape on the Northern Adelaide Plains is the almost total loss of indigenous plant species, and the ephemeral nature of the vegetation that has replaced it. Large areas of horticulture involve growing meticulously maintained vegetables on seasonal rotation. Meanwhile, annual weedy species rampantly colonise the remaining areas of the property and nearby road verges. In a sense, the weeds provide a conservation benefit by increasing biodiversity. However, their capacity to harbour large numbers of Western flower thrips and host Tomato Spotted Wilt Virus, far outweighs any benefits to agricultural biodiversity.

It is often forgotten that horticultural producers do not enjoy spraying insecticides and would change if they could see a viable alternative. However, faced with the present situation; where is the choice to not spray with insecticides? We think that part of the answer lies in the areas beyond the crop boundary.

In the first instance, the removal of nearby weeds and replacement with plant species less favourable to key pests should reduce the overall pest pressure. A more sustainable system would include the biologically rational use of selective insecticides, which allows beneficial insects to successfully colonise crops. The establishment of appropriate plants should favour pest management by suppressing pest populations and providing refuge for these beneficial insects. We have looked to establish native plant and grass species suited to the Northern Adelaide Plains region to provide the means to test some of these outcomes.

At this stage, the work is still in the early evaluation phase. As such, this guide is not intended to provide all the answers to this dilemma. However, it does suggest an alternative and broader approach, which includes other benefits (aesthetics and conservation). In this sense, the term ‘guide’ is very appropriate.

The preparation of this guidebook, and the technical program that underpins it, involved capturing the labour, talents and experience from many people. I would encourage you to read the acknowledgements to appreciate their contribution. However, I must especially acknowledge the contribution of my co-authors. Many have contributed to the ‘Revegetation by Design’ program, but a few stand out because of their involvement throughout the whole project. These people have distinguished themselves, not only for their individual contributions, but also for their conviction and doggedness in completing a difficult task, literally, from the ground up. I offer my sincere thanks; to Bill Doyle for his pivotal knowledge, enthusiasm and advice in establishing the native plant sites; to Dijana Jevremov for her expertise as communications officer and leadership in producing this guidebook; and to Glenys Wood for balancing a vast array of technical activities and providing the constancy on which this project was built.

We hope this guide will prove useful, not only for horticultural producers on the Northern Adelaide Plains, but also for IPM consultants, educators, local councils and anyone establishing native vegetation near horticulture.

Dr Peter Taverner
Project Leader

Introduction

Background

This Guidebook is a product of the 'Revegetation by Design' program conducted from February 2003 till November 2006. This program aims to create awareness that local vegetation 'outside the crop' has an impact on the pest and disease pressure 'within the crop'. Broadly, 'Revegetation by Design' aims to promote a landscape that will reduce pest pressure on nearby crops. The horticulture-growing region of the Northern Adelaide Plains provided an appropriate opportunity to evaluate this concept. It is an area that has lost most of its native vegetation, and has increasing pest and disease issues that pose a genuine threat to the future viability of horticulture.

One of the major insect problems is Western flower thrips (WFT), *Frankliniella occidentalis*, Tomato thrips *Frankliniella schultzei* and Onion thrips *Thrips tabaci*. These introduced thrips are important because they transfer Tomato Spotted Wilt Virus (TSWV) to a range of horticultural crops. Since the 1995 arrival of the exotic Western flower thrips, the horticulture sector has suffered estimated crop losses and management overheads in the vicinity of $25 million annually, with the figure rising sharply in the worst affected years.

This figure is based on increased pesticide use, reduction in saleable produce partly from suspending summer cropping due to peak pest pressure, and the cost of clearing weeds to reduce pest and disease levels. The result is minimal investment in modernisation and expansion in vegetable production. Since 1997 the region has experienced major economic and related social hardship.

Numerous weeds provide the preferred refuge habitat for some of those insect pests and the plant diseases that are carried by them onto the crops. Clearing weeds and leaving bare earth is a primary management tool to provide a buffer around horticultural crops. However, a bare earth approach has negative implications for natural resource management, such as reduced water quality through top soil loss and chemical contamination. Bare earth is also a hostile environment for beneficial insects; a major component in an integrated pest management (IPM) program.

An alternative is to consider 'revegetation by design' and replace weeds with deep-rooted perennial native plants that harbour few pests and diseases of horticulture and in some cases can provide profit.

An integrated approach to pest and disease management is the modern way to farm. A single approach to combating crop invasions (such as chemical application) is no longer accepted as best practice. Beneficial insects and predators are an important and cost effective tool to employ. It requires a change in mentality from total exclusion/elimination of all insects in crops, to view some insects and other fauna as beneficial to farm production.

The Research

The project was founded on the premise of finding native plants that do not harbour pest thrips, and may then be suitable to create an alternative natural buffer around horticultural crops, replacing bare earth and weed management.

To achieve this objective the research focussed on answering two major questions; (1) can native plants grow near crops without harbouring pest thrips, and (2) are there differences in the capacity of individual native plant species to attract and support various beneficial insects.

We began knowing that perennial native vegetation provides an undisturbed habitat and food source to maintain populations of beneficial insects such as lacewings, predatory mites, parasitic wasps and a wide range of spiders. Many beneficial insects that prey on horticultural pests are native.

Our research was conducted predominantly during Spring; the key pest pressure season. Both seeds and tube-stock were used to establish the plants. Mulch and weedmatting were also used on some of the plants.

Three sites in Virginia on the Northern Adelaide Plains were modified as native plant research and demonstration plots. The major site is at the Greenhouse Modernisation Project with the remaining sites on two grower properties nearby. There are native plant species from the Myrtaceae, Chenopodiaceae and Mimosaceae along with native grasses across the three sites.

The plots have been established adjacent to horticulture for demonstration purposes and to survey these plants for the presence of the relevant pest and beneficial invertebrates.

This Guidebook relays information on 14 indigenous species studied. They were selected from an original 23 species based on performance criteria such as profit potential from cut flowers, seed or fruit, and for establishment performance. Some of the 14 were grown from seeds of local remnant plants. 19 weed species were also assessed for the range of insect abundance and variety that visit them.

Using the researched information, the selection of 'best bet' plants for the design and establishment of native plantings that reduce pests and disease in horticulture, have been captured in this Guidebook.

Interpreting the Information

The format of the information provided is intended to guide the reader to select for themselves the 'best bet' plants they wish to use. We appreciate that growers will have preferences for plants based on their own needs and desires. What the research provides is information about what the likely outcomes from the plant choices will be.

However any choice provides an element of risk. For example there is a possibility that some native plants selected because they are attractive to natural enemy insects of thrips, could also be attractive to insects that will emerge as pests after a longer period of establishment.

The project recorded insects that were present at the time of survey. We did not research *all* the possible insect pests that may pose a risk to horticulture in the region. The effect of additional native plants in the landscape on the distribution and abundance of a wide range of insects, is unknown. The native plants described in this publication are primarily assessed for their relationship to the pest thrips.

The biological environment is a constantly changing one. New incursions of insects, secondary pests becoming primary pests, and new diseases emerging, could all make a difference to the 'best bet' plant selection in future. Our research is relevant for the current state of dominant pest and disease affecting particularly greenhouse growers. This may appear to limit the usefulness of the guide over time. However, we would argue that the principles for plant selection would remain the same, and restoring the balance should become easier as greater knowledge of plant and insect interactions is gained. In short; it is a choice between excessive pesticide use, which provides short-term gain and likely to cause serious long term consequences, or IPM, which provides short-term uncertainty and likely to lead to long-term viability.

Conservation biological control and habitat manipulation in agricultural areas for pest suppression and sustainability are emerging fields globally. There is relatively little information available for native vegetation as habitat for beneficial insects in Australian conditions.

It is hoped that this Guidebook and the Revegetation by Design project research papers, form a baseline for expansion in the area of plant biological control for pest and disease management in horticulture.

By integrating native vegetation with pest control it allows us to move towards sustainable agricultural systems with benefits for the environment, industry and the community.

Copies of reports from the current project can be accessed via the websites of various funding partners by initially visiting the SARDI Website at www.sardi.sa.gov.au (follow the links to Entomology, then Horticultural Pests, then Revegetation by Design).

The Future

The Revegetation by Design project has another phase beginning with continued funding from January 2007. The final page of the *Resources Glossary Tab* section of this Guidebook gives a brief description of the future research direction.

Integrated pest management

This guidebook assists the vegetable growing industry to understand the behaviour of pests and natural enemies in relation to plant habitat. This understanding fits directly with the modern form of pest and disease control called 'integrated pest management' or IPM.

Pest control in horticultural production is in transition; moving away from relying almost solely on the intensive use of chemical pesticides. This reliance has often caused major problems including the development of pesticide resistance, the risk of toxic residue levels in produce, contamination of the environment, along with inherent health risks for users. The use of pesticides has been habitual, overly reactive and often excessive in the hope of short-term protection.

The arrival of Western flower thrips (WFT) on the Northern Adelaide Plains region has highlighted the weaknesses in pest management practices. Despite increased pesticide use since the arrival of the thrips, they remain a major threat to the industry.

What is IPM

Integrated pest management is the term used for a wide range of tactics to prevent pests of all kinds from reaching damaging levels in crops. A pest can be an insect, mite, vertebrate such as birds, a disease, or weed.

By using a range of tactics to deal with pests, it removes the reliance on any single method of control, such as chemical sprays.

IPM tactics generally fall into the following categories:

- Biological – the protection or release of natural enemies such as parasitoid insects, pathogens or predators.
- Cultural or managerial – such as crop rotation, trap cropping or perimeter 'designed' planting, and using healthy transplants.
- Chemical – use of pesticides when necessary but choosing products that conserve natural enemies.
- Physical or mechanical – barriers such as crop covers and screens, light traps, and vacuums.
- Genetic – pest resistant crop varieties.

An integral part of IPM is regular crop inspections to observe the effect of the tactics, and also to enable optimally timed action.

Revegetating the surrounding crop environment with selected plants, falls into the category of both a biological and a cultural or managerial manipulation. By including revegetation, a plant mass is created specifically to serve as a beneficial species refuge. This refuge can be for supporting a biological control release, or providing habitat for a resident colony of beneficials.

The Benefits of IPM

IPM benefits growers, the environment and consumers. It is equally about both the economic and the social sustainability of growing food.

There is an increasing supermarket demand for safe and clean food with new safeguards and standards being implemented widely. Consumers have an expectation that their food does not compromise their health nor that of the environment. The steady increase in demand for organically grown food is evidence of this.

Increasingly the competitive advantages of food being produced in an environmentally sustainable way are becoming important in the export market. The advent of the EurepGAP Protocol (www.eurepgap.org) has raised the standards for food growing to incorporate stewardship of the land.

Eurepgap is a global partnership for safe and sustainable agriculture. In responding to the demands of consumers, retailers and their global suppliers have created and implemented a series of sector specific farm certification standards. The aim is to ensure integrity, transparency and harmonisation of global agricultural standards. This includes the requirements for safe food that is produced respecting worker health, safety and welfare, environmental and animal welfare issues.

The EurepGAP standards are highly likely to become commonplace for both local and export producers in the future. IPM fits with the EurepGAP Protocol.

By using an integrated approach to pest and disease control, crises are minimised or avoided and panic measures are less likely to be needed. IPM growers often report a peace of mind that comes from knowing that multiple tactics are being used to provide crop health and that the system functions 24 hours a day even when they themselves are not providing direct input. The natural enemies become allies in problem control.

Some of the on-farm benefits from using an IPM system are listed below:

- By inspecting crops regularly, potential problems are noticed in the early stages making remedial action more likely to be successful and cost effective: ie. spot spraying as opposed to full crop treatment.
- IPM results in strategic use of chemicals, which reduces health risks to producers, their families and staff as well as consumers. It also minimises the chance of pests developing resistance to chemicals.
- Reduces negative impacts on the immediate environment such as farm dams.
- It encourages natural enemy populations to help manage pests.
- IPM leads to a more robust system since it doesn't rely on one control method.
- Money can be saved from a more cost effective use of treatments and a consistent production of market-quality produce.

What is needed for IPM to work?

Inspecting crops regularly is the cornerstone of a successful IPM program.

IPM requires growers and their consultants to have knowledge of key components in the field that will guide sound decisions and forecasts. These include:

- Accurate pest and natural enemy identification.
- Understanding the pest lifecycle, biology and ecology - such as the preferred habitat and food sources.
- Understanding the effects of pest damage on crop quality and market value at different levels of the pest population.
- Knowing the effects of control measures on both the pest and other organisms.

Much of the essential knowledge can be gained from regular crop inspection (often called monitoring or scouting) and good record keeping, together with readily available published information. Some references are provided in the Resources and Glossary Tab section of this Guidebook.

Why was IPM developed?

The history of IPM can be traced back to the late 1800's when ecology was scientifically identified as the foundation for plant protection. The catalyst for modern IPM began in the 1950's when over-reliance on chemicals led to pests developing resistance rapidly. Secondary pests became primary pests and producers were left with few methods of control.

Chemical resistance has exposed the fact that sole reliance on chemicals for pest problems in horticulture is not a long-term solution. There are many examples in Australia where the serious challenge of pests developing resistance to chemicals has initiated a 'sea-change', where advanced IPM practices have been successfully implemented.

Where is IPM practiced?

IPM is widely practiced by Australian fruit and vegetable growers to varying degrees. Some growers have even developed their own IPM marketing and promotion.

Most countries of the world practice IPM to some degree. It is widely accepted as the modern approach to agricultural pest management.

Where to find more information

References are provided in the Resources and Glossary Tab section of this Guidebook.

Revegetation by Design - why it should work in horticulture.

By Dr. Nancy A Schellhorn, Research Scientist, Team Leader, CSIRO Entomology

In horticultural systems numerous species of weeds are known to harbour pests and diseases of crops. Controlling the weeds can often be costly, short-term and cause environmental problems such as erosion, excessive dust, and changes in soil moisture. However, leaving the weeds can result in reservoirs of pests and diseases.

Revegetation by Design involves the integration of native vegetation with horticultural production systems, with a focus on replacing weeds and ultimately manipulating vegetation to disadvantage pests and disease at a farm scale.

The native plants chosen must meet a range of criteria to be suitable for revegetation and the primary criteria include those plants that:

1) are not the host plants for horticultural pests and diseases (eg. pest and diseases can not develop and populations can not increase on these plants),
2) provide habitat for a range of natural enemies of pests so that they are available for early colonisation into the crop,
3) are workable around farm practices and containment facilities, and
4) native to the region.

The secondary criteria is that the native plants provide an additional source of income for the farm such as bush tucker, native cut flowers, and native seed for the revegetation industry. The outcome of Revegetation by Design is long term farm benefit and cost savings for weed, pest and disease control.

Replacing weeds with particular species of native plants has the potential to improve pest control for two main reasons. Firstly, many Australian native plants are not likely to be host plants for these exotic pests, hence pest populations can not develop on them. This is particularly true for Australian plants in the Myrtaceae family. All major horticultural crops (with the exception of Macadamias) and 90% of their insect pests are exotic.

Secondly, native plants can provide habitat (eg. shelter, alternative food and alternative prey) for natural enemies of insect pests. This may allow for the build up of natural enemy populations close to the crop resulting in more individuals colonising the crop earlier. However, demonstrating that on-farm vegetation manipulation disadvantages the pest and results in lower pest populations and lower pest control costs still needs rigorous testing. The work to date both in Australia and overseas certainly suggest that the Revegetation by Design approach is a promising and important component of pest management.

Some aspects of Revegetation by Design are similar to work being done in other parts of Australia and other parts of the world, yet at the same time quite unique. In Europe and the USA, native remnants and hedge rows have been shown to play an important role in pest population reduction. Two approaches have been taken. The first has been to suggest that diversifying vegetation within a field, among fields and across farms can reduce pest population build up as long as the pests of interest can not use the majority of the vegetation as host plants to feed, reproduce and grow populations.

Alternatively, if the pests are generalists and use a wide range of host plants, manipulating vegetation to disadvantage the pests is not likely to result in the reduction of pest populations. However, if the pests are more specialised in their diets, then diversifying the vegetation may result in reduced populations.

The second approach has been to manipulate vegetation in a field, on field margins or on-farm to advantage the natural enemies. In the UK, this has been done by creating perennial grass islands in the middle of grain crops, which allow for the build up of predatory beetles that forage on soft bodied insect pests such as aphids and grubs.

There has also been work in the US that has shown how the edge of a native forest adjacent to crops provides habitat for parasitic wasps that are natural enemies of grubs. In Australia, some researchers have planted exotic plants in mid rows to provide nectar for natural enemies with the hope of having them live longer and kill more pests.

Furthermore, there is work in Germany and the Netherlands that shows that a high proportion of non-crop vegetation such as woodlands and perennial grasslands in an agricultural landscape results in natural enemies eating and attacking more pests. Hence numerous researchers from around the world are focusing on ways to manipulate vegetation on-farm and in surrounding landscapes to disadvantage the pests and advantage the natural enemies that attack and eat them.

Some aspects of the Revegetation by Design project are unique. Australia has amazing floral and faunal diversity, and many plants are very distantly related to the horticultural plants we grow. Furthermore, approximately 90% of the insect pests are exotic. This is not necessarily the case in other parts of the world, where a wide range of insect pests are native to the region and feed on a wide range of host plants. Australia's floral diversity appears to be one of the key ingredients of the Revegetation by Design concept.

As new industries develop in Australia, for example olives and persimmons, they will face new challenges from native insects that prior to large scale production had not reached pest status. To generate long term predictions about the success and wide scale application and adoption of Revegetation by Design, a current project is conducting a risk analysis about the integration of native vegetation and horticultural production.

Although the outcome of Revegetation by Design is for long term cost savings for pest and disease control, there are numerous flow-on benefits. These include the potential to capture consumer loyalty through market differentiation, enhancing the value of farms by increasing aesthetics, conserving additional natural resources on the farm such as plant and animal biodiversity, maintaining top-soil and minimising erosion through the use of deep-rooted native perennials, and maintaining soil moisture content and soil structure.

Revegetation by Design integrates good science with community values and action to protect and enhance natural resources and progress the Australian horticultural industry.

INTERPRETING THIS PROPERTY PLANS SECTION

We recommend that growers study these property plans as the first stage of plant selection for their property. The plans in this guide are 'typical' of many grower's properties and contain the buildings and land use usually associated with the production of covered horticultural crops.

The 'before' plan

The 'before' plan is straightforward, and shows areas of bare earth and weeds typical of many properties. Weeds host a number of pests and readily colonise nearby crops. The images shown in circular insets depict actual properties on the northern Adelaide plains and common weeds.

The 'after' plan

The 'after' plan shows the same property after native plants have been established. It includes all the native plant types on the one property to show as many options as possible for attracting a variety of beneficial insects. Growers should consider their property layout and identify plant types (e.g., shrubs, groundcovers or grasses) suited to different areas of their property.

The text in boxes explains some benefits of establishing those plant types in that situation. For example, low grasses and groundcovers are more suited to areas around greenhouses because they allow and tolerate occasional vehicle access. Some of the images shown in circular insets have come from demonstration plots used on the project.

How to use the property plans

The property plans are an example of how to implement the 'Revegetation by Design' approach. The native plants are arranged and associated with different property uses. They are indicative plans and will not be appropriate for all situations.

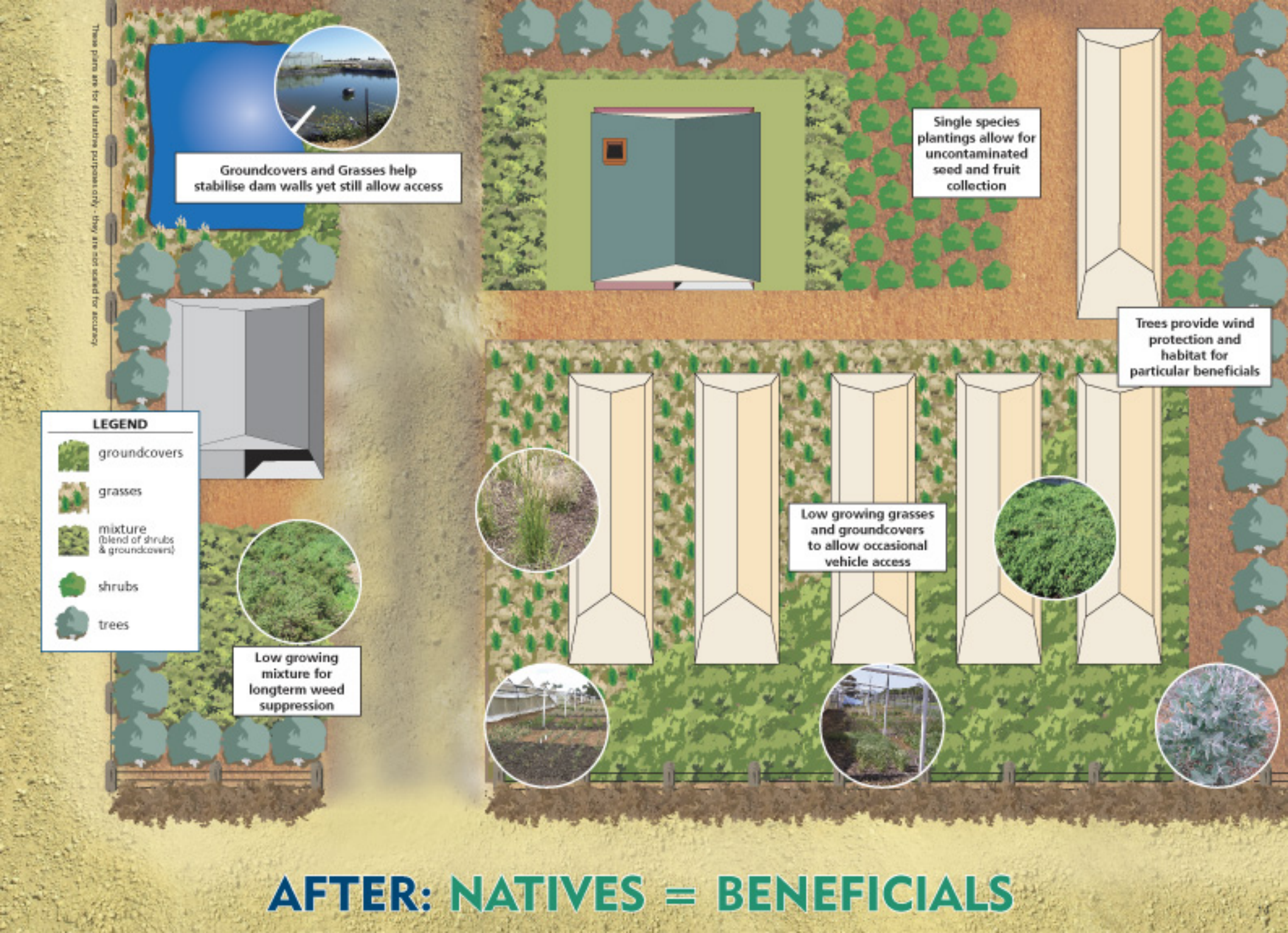
Don't necessarily follow the 'after' plan exactly. Instead; consider the layout of your property. Then, use the property plan to support the decisions for plant selection according to your needs.

Once plant types have been determined, then the plant species selection process begins. Each of these plant species supports a unique set of insects. It is important to try and match the native plant species that provides the least risk, and/or greatest benefit, to the horticultural crop. The Plant Data Sheets provided later in this guide can be used to select plant species most suited to the situation.

Please note that the information in this guide is predominantly aimed at reducing the presence of Western flower thrip.

These plants are for illustrative purposes only - they are not scaled for accuracy

BEFORE: WEEDS = PESTS


These plans are for illustrative purposes only - they are not scaled for accuracy.
Groundcovers and Grasses help stabilise dam walls yet still allow access
Single species plantings allow for uncontaminated seed and fruit collection
Trees provide wind protection and habitat for particular beneficials
LEGEND
groundcovers
grasses
mixture (blend of shrubs & groundcovers)
shrubs
trees
Low growing mixture for longterm weed suppression
Low growing grasses and groundcovers to allow occasional vehicle access
AFTER: NATIVES = BENEFICIALS

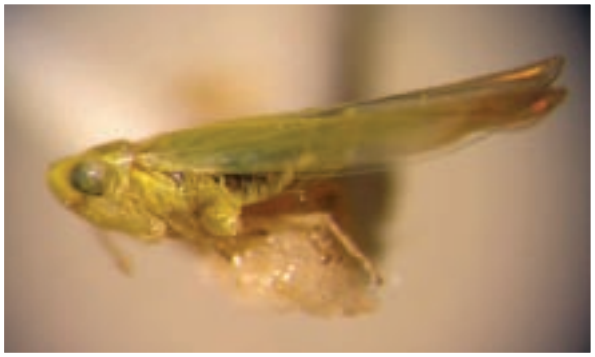
PEST & NATURAL ENEMY information

Commonly found crop pests

Description of the most abundant pest types found during Spring 2005

Leafhoppers from the family Cicadellidae are small (3-5mm), wedge shaped bugs ranging in colour from yellow or bright green through to brown. The adults tend to leap when disturbed and can travel long distances.

Both adults and nymphs cause feeding damage such as dots or spots and leaf burn by using their mouthparts to suck nutrients from plants. Some species can transmit plant diseases, adding to overall reduction of plant health.



Mirid Bugs from the family Miridae mainly feed on plant tissues but some species are predators of soft-bodied invertebrates or eggs. Pest species tend to be about 8mm long and cause damage to new shoots and flower buds.

Mirids use piercing mouthparts to penetrate plant tissue and also release enzymes that destroy surrounding plant cells causing parts of the plant to wilt and die.

Rutherglen bugs (*Nysius vinitor* pictured right) are small (5mm) sap sucking bugs that damage plants and seed heads.

They are dark coloured, highly mobile and adults can migrate in swarms causing heavy infestations on crops as well as a broad range of non-crop plants and weeds.

Chinch bugs from the family Lygaeidae are often known as seed bugs, they feed on ripe seeds or plant sap. They come in various colours and sizes (on average 5mm).

Adult bugs hibernate in protected places and lay eggs in leaf sheaths and on grass roots. Most damage is made in summer, mostly by the nymphs.

Commonly found crop pests

Description of the most abundant pest types found during Spring 2005

Aphid adults are up to 5mm in size and can be winged or non-winged and nymphs feed on plant sap, preferring young leaves. This insect produces honeydew that can cause sooty mould which inhibits photosynthesis and affects plant growth.

Many plant viruses, for example Carrot Virus Y can be transmitted by aphids. Large populations of aphids can build up and affect crops at any stage.

Whiteflies are very small (1-5mm) sap sucking insects. Nymphs are pale scale-like insects that occur mainly on the underside of leaves. Whiteflies produce honeydew that can cause sooty mould. There are native whiteflies as well as pest species, however differences are often subtle making it difficult to identify between species.

Thrips adults and nymphs cause damage by using their piercing mouthparts to penetrate plant tissue and suck sap from the plant. They can be between 1-2mm long.

Pictured from Left to Right;

****Western flower thrips*** *(Frankliniella occidentalis)*

****Tomato thrips*** *(Frankliniella schultzei)*

****Onion thrips*** *(Thrips tabaci)*

Plague thrips *(Thrips imaginis)* a common native thrips that causes feeding damage to crops

* An introduced thrips that can transmit Tomato Spotted Wilt Virus (TSWV)

Commonly found crop beneficials

Description of the most abundant beneficial types found during Spring 2005

Parasitic wasps (parasitoids) are generally very small (1mm) and use insect larvae (grubs/caterpillars) to complete their life cycle. The parasitoid lays her egg into the larvae of the insect. The grub stops development as the parasitoid egg hatches and begins to feed within the host grub. Finally a parasitic wasp emerges. One female wasp can kill numerous pests in her lifetime and many eggs can emerge from one host.

Vegetation that supports parasitic wasps can make a difference to their survival and improve the amount of eggs that are laid.

Pictured are three examples of the 25 prominent wasp families commonly seen on the native plants.

Predatory mite species (like the common example pictured) tend to be small (1mm) fast-moving, robust species with mouth parts capable of capturing and macerating their prey. They target small invertebrates, including their eggs and larvae that are of manageable size. Beneficial mites target nymphs of whitefly, thrips and other mites.

Spiders have eight legs and all produce silk. Commonly seen spiders are flower spiders, wolf spiders and jumping spiders. They range in size from 2mm upwards and are generalist predators of prey small enough for them to handle. Prey can include leafhopper nymphs and other crop pests. They have chewing mouthparts and poison their prey then liquefy the victim for ease of consumption.

Commonly found crop beneficials

Description of the most abundant beneficial types found during Spring 2005

Haplothrips are a predatory species common on the flowers of native and introduced plant species in south-eastern Australia. Adults are approximately 2mm long and dark coloured and the bright orange larvae are also predators.

Haplothrips victoriensis (pictured) has been observed to feed on eggs and larvae of two spotted mites and Western flower thrips.

Brown lacewings *Micromus tasmaniae* are widespread natives of southern Australia. They are often seen foraging on low vegetation and can have more than one generation per spring.

Adults (8mm) and larvae (5mm) (both pictured) are very mobile generalist predators of small invertebrates such as aphids, scales, whitefly, mites, and leaf-hopper nymphs.

Commonly found non target invertebrates

Description of the most abundant non target types found during Spring 2005

Flies are a diverse group of insects that are distinguished from wasps in that they have only one pair of functional wings. This group can be large (over 20 mm) or minute, such as midges that are 6-8mm. Some species can transmit disease but many are recyclers and form part of the food chain. Fly maggots (larvae) usually prefer a damp environment like grass clippings or compost.

Springtails like those pictured left, are the most abundant insect on the planet. They are small to very small and soft bodied (0.25-3mm), and are coloured from black through greys to white. Many species will leap when disturbed. Their diet consists mainly of fungi, lichen, algae or soil organic matter. The adults and their eggs can be prey for several other species.

Mites are abundant throughout Australia. Many species are recyclers that decompose organic matter in litter and soil. They are very small (1mm) and absorb food from dissolved organic material, fungi and lichens.

Commonly found non target invertebrates

Description of the most abundant non target types found during Spring 2005

Seed eating thrips such as *Chirothrips manicatus* (pictured) are an introduced species. They are less than 2mm long and commonly found on grasses, where they breed in the flowers. Some species can cause seed loss in grain crops. They can be confused with the darker pest thrips, like tomato thrips.

Book lice are small insects (2mm) found indoors or outside. They favour a moist environment such as damp paper, mulch or mouldy dead vegetation.

They are recyclers that eat fungi and also play a part in the food chain as prey for larger invertebrates and small animals.

Beetles are a diverse group that range in size from 3mm upwards. They vary in colour, shape and preferred food.

Many beetles are predators, however, many species are not, such as the one pictured. These are often found in leaf litter and mulch associated with native grasses and low growing plants.

This species is most probably foraging on fungi growing on organic material.

Thrips and Whiteflies in this group vary in abundance and are of unknown importance

INTERPRETING THE PLANT DATA SHEETS IN THIS SECTION

The red section shows the percentage of known pests of horticulture that have visited this plant during peak pest activity months. **Not all of the red bar is representative of a risk to all crops.** It is important to look at the 'Common Species List' below the bar to indicate the risk to each crop. For example if a crop is vulnerable to Tomato Spotted Wilt Virus, then the plants that have the least thrips that transmit the virus would be more suitable choices.

You will see on most charts, the red portion is significantly larger than the green 'beneficials' proportion. This is to be expected and is not necessarily cause for concern. It is usually the case that a much smaller number of beneficial insects is capable of controlling a much larger number of pests. So a low number of beneficials may still offer effective control.

Overall Pest, Beneficial and Non Target Proportions

Non-target species are those of unknown consequence on the Northern Adelaide Plains. They are not currently recognised as pests, and have not been studied to confirm any beneficial status.

The most common species in each group

Pest	Beneficial	Non Target
Leafhoppers • •	Parasitic wasps • • •	Flies • • • •

Look in this list to find a pest that is specific for a crop, and then look at the number of dots to determine the abundance, and therefore the risk to you as a grower, specific to your crop.

For example, comparing the numbers of Western flower thrips on Giant mustard weed (the first sheet) as opposed to native plants, indicates the weed has much higher numbers of the thrips and therefore poses a greater risk even though the percentage of total pests may be similar.

INTERPRETING THE PLANT DATA SHEETS IN THIS SECTION - continued

The following 15 Plant Data Sheets summarise the plant specific information about the invertebrate species that have visited the plants during the assessment period of Spring 2005.

The first data sheet is a weed comparison sheet; the Giant mustard weed. This weed is a common Brassica weed on the northern Adelaide plain and was selected as an ideal comparison to the native plants. This weed has a long flowering period and pest thrips are known to be attracted to them. A stand of this weed was adjacent to the native plants at the main research site providing the opportunity for thrips to visit both types of plants within a short distance. We sampled both the native plants and the weed at the same time to assess the relative diversity and abundance of the thrips that visited each plant species.

These Plant Data Sheets represent the snapshot of one season. Surveys in following seasons may not reveal exactly the same proportions of invertebrates. For instance, in spring 2005 there were unusually high numbers of Rutherglen bugs recorded on the Northern Adelaide Plains. These bugs are quite mobile and were recorded on local crops and on many of the plants surveyed.

Legend

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

<1% = Rare - the invertebrate species was rarely, if ever seen on this plant.

1-10% = Occasional - the invertebrate was occasionally or infrequently seen.

11-50% = Common - the invertebrate was seen on the plant.

51-100% = Abundant - the invertebrate was numerous and if a pest, then plant selection would need to be thoughtfully considered depending on the crops to be grown nearby.

Tomato Spotted Wilt Virus (TSWV)

Some plants presented in this section have been tested for TSWV presence. Of those that have been tested, the virus has not been detected.

These are marked; ***Tested negative for Tomato Spotted Wilt Virus.**

Giant mustard weed

(Rapistrum rugosum)

Please note:

This sheet is for comparison only, we are not recommending planting of Giant mustard weed.

This common Brassica weed on the Northern Adelaide Plains was selected as an ideal comparison to the native plants since it has a long flowering period and pest thrips are known to be attracted to them.

We sampled both the native plants and this weed at the same time to assess the relative diversity and abundance of the thrips that visited each plant species.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	•	Parasitic wasps	• • • •	Flies	• • •
Mirids	•	Predatory mites	• •	Springtails	•
Rutherglen bugs	• • •	Spiders	• •	Mites	• •
Chinch bugs	•	Haplothrips	• •	Thrips	• • •
Aphids	• • •	Brown lacewings	• •		
Whiteflies	•				
Plague thrips	• • • •				
Western flower thrips **(V)**	• •				
Tomato thrips **(V)**	•				
Onion thrips **(V)**	• •				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Windmill grass

(Chloris truncata)

Description:
A small, low-growing grass to 25cm [50cm with heads]. **Summer active.** The seeds dry on the 'windmill' inflorescence and blow off. Shortlived to about 3 years but a prolific seeder.

Establishment & Maintenance:
As for grass species in the next tab section.

Notes:
Space at 30cm. Use herbicide carefully around this plant. This species does NOT strongly resist weed incursions – mulching or matting essential. **Trim once to 10cm in Spring** to encourage new, low growth.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

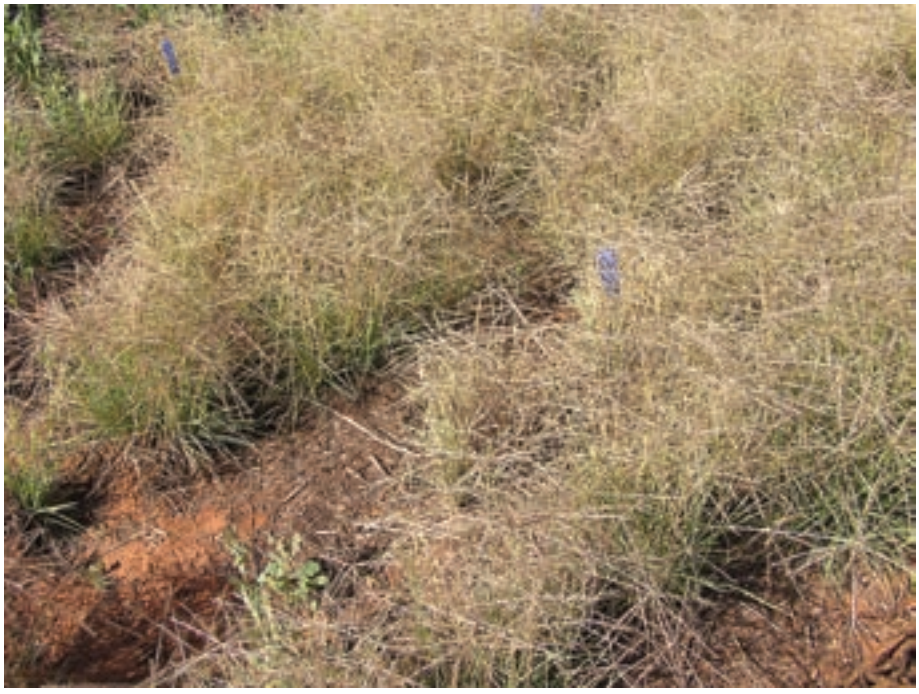
The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • •	Flies	• •
Mirids	•	Predatory mites	• • •	Springtails	• • • •
Rutherglen bugs	• •	Spiders	• • •	Mites	• •
Chinch bugs	• •	Haplothrips	• •	Seed eating thrips	• •
Aphids	• • •	Brown lacewings	• •	Thrips	•
Whiteflies	• •			Book lice	• •
Plague thrips	• • •			Whiteflies	•
Western flower thrips **(V)**	Nil			Beetles	•
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005



Wallaby grass

(Austrodanthonia linkii)

Description:
A small grass to 25cm [40cm with heads].
Winter active.

Establishment & Maintenance:
As for grass species in the next tab section. Space at 30cm.

Notes:
Seeds dry on inflorescences and these should be left until late Autumn. Then **trim once** to 15 - 20cm to encourage low growth habit. This species resists weed incursions – mulching or matting beneficial to plant growth.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • •	Flies	• •
Mirids	Nil	Predatory mites	• • •	Springtails	• • • •
Rutherglen bugs	• •	Spiders	• •	Mites	• •
Chinch bugs	• •	Haplothrips	• •	Seed eating thrips	•
Aphids	• • •	Brown lacewings	• •	Thrips	•
Whiteflies	• •			Book lice	•
Plague thrips	• • •			Whiteflies	•
Western flower thrips **(V)**	•			Beetles	•
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005


REVEGETATION BY DESIGN
Research and Education Site

Blackhead grass

(Enneapogon nigricans)

Description:
A small grass to 25cm [40cm with heads]. **Summer active.** Heads go dark green or black before drying out to creamy seeds.

Establishment & Maintenance:
As for grass species in the next tab section. Space at 30cm.

Notes:
May produce seed several times in a season depending on rainfall or watering. **Trim once or twice to 15cm in Spring** to encourage growth. This species does NOT strongly resist weed incursions – mulching or matting essential. Water in Summer to encourage seeding.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • •	Flies	• •
Mirids	•	Predatory mites	• •	Springtails	• • • •
Rutherglen bugs	• •	Spiders	• •	Mites	• •
Chinch bugs	• •	Haplothrips	• •	Seed eating thrips	• •
Aphids	• • • •	Brown lacewings	• •	Thrips	•
Whiteflies	• •			Book lice	•
Plague thrips	• • •			Whiteflies	•
Western flower thrips **(V)**	•			Beetles	• •
Tomato thrips **(V)**	•				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Kangaroo grass

(Themeda triandra)

Description:
A substantial grass to 1m [1.5m with heads]. **Summer active.** Spectacular copper-coloured heads in Summer.

Establishment & Maintenance:
As for grass species in the next tab section. Spacing 1m.

Notes:
Trim once to 30cm at the beginning of Autumn to encourage new shoots before Winter dormancy, and to remove dried thatch. **Trim once to 20cm in Spring** to encourage lush new growth. If season is dry, water if trimming in Spring.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

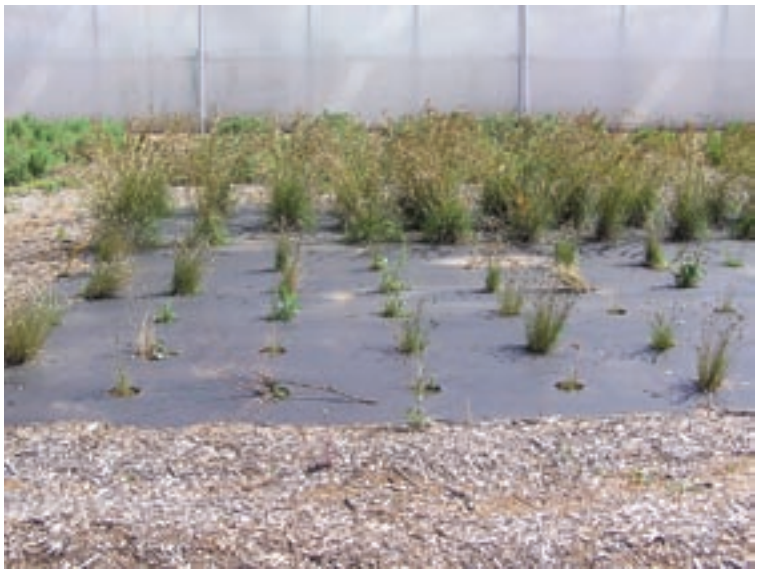
The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	•	Parasitic wasps	• • •	Flies	• •
Mirids	•	Predatory mites	• • •	Springtails	• • • •
Rutherglen bugs	• •	Spiders	• •	Mites	• •
Chinch bugs	•	Haplothrips	• •	Seed eating thrips	•
Aphids	• •	Brown lacewings	• •	Thrips	•
Whiteflies	• •			Book lice	•
Plague thrips	• • • •			Whiteflies	•
Western flower thrips **(V)**	•			Beetles	•
Tomato thrips **(V)**	•				
Onion thrips **(V)**	Nil				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005



Berry saltbush

(Atriplex semibaccata)

Description:
Dense, hardy, salt-tolerant groundcover to 30cm H and 2m W. This species is very effective at screening out weeds. Will grow into and between other saltbush species. Also acts as a living mulch below other species.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1 – 1.2m

Notes:
Do not trim this species for height, trim only to constrain horizontal sprawl. This species is relatively short lived (less than 2 yrs).

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• • • •	Parasitic wasps	• • • •	Flies	• •
Mirids	• •	Predatory mites	• • •	Springtails	• • • •
Rutherglen bugs	•	Spiders	• •	Mites	• •
Chinch bugs	•	Haplothrips	• •	Seed eating thrips	•
Aphids	•	Brown lacewings	• •	Thrips	•
Whiteflies	•			Book lice	•
Plague thrips	• •			Whiteflies	•
Western flower thrips **(V)**	•			Beetles	•
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Grey coastal saltbush

(Atriplex cinerea)

Description:
Dense, hardy, salt-tolerant shrub to 1m H and 1.5m W. Tends to sprawl when grown inland. Attractive silver foliage. This species is very effective at screening out weeds.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1 – 1.5m. Trim if desired to constrain horizontal sprawl.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• • •	Parasitic wasps	• • • •	Flies	• • •
Mirids	• • •	Predatory mites	• •	Springtails	• •
Rutherglen bugs	•	Spiders	• •	Mites	• •
Chinch bugs	•	Haplothrips	• • •	Seed eating thrips	Nil
Aphids	•	Brown lacewings	•	Thrips	• • •
Whiteflies	•			Book lice	•
Plague thrips	• •				
Western flower thrips **(V)**	•				
Tomato thrips **(V)**	•				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Marsh saltbush

(Atriplex paludosa)

Description:
Salt-tolerant shrub to 1.2m H and 1.2m W.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1 - 1.5m. Trim to no lower than 1m overall height. Remove straggly tops only.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• • •	Parasitic wasps	• • • •	Flies	• • • •
Mirids	• • •	Predatory mites	• •	Springtails	•
Rutherglen bugs	• •	Spiders	• •	Mites	Nil
Chinch bugs	•	Haplothrips	•	Seed eating thrips	Nil
Aphids	•	Brown lacewings	• • •	Thrips	•
Whiteflies	•				
Plague thrips	• •				
Western flower thrips **(V)**	Nil				
Tomato thrips **(V)**	•				
Onion thrips **(V)**	Nil				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Small leafed saltbush

(Maireana brevifolia)

Description:
Hardy, salt-tolerant upright shrub to 1.5m H and 1.2m W, may become straggly. Stems are woody in mature plants.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1.5 - 2m. Trim to no lower than 40cm overall height, and always ensure there is still abundant leafy material on the plant. Recommended trim to 1m to maintain a dense appearance.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• • •	Parasitic wasps	• • • •	Flies	• • • •
Mirids	• • •	Predatory mites	•	Springtails	• • •
Rutherglen bugs	• •	Spiders	• • •	Mites	•
Chinch bugs	•	Haplothrips	• •	Seed eating thrips	•
Aphids	• •	Brown lacewings	•	Thrips	• •
Whiteflies	•			Book lice	• •
Plague thrips	• •			Beetles	•
Western flower thrips **(V)**	•				
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	• •				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Fragrant saltbush

(Rhagodia parabolica)

Description:
Very hardy, salt-tolerant dense large shrub to 1.5m H and 2- 2.5m W. Palatable to stock. This species is very effective at screening out weeds.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 2 – 2.5m. Trim to no lower than 40cm overall height. **Suggest trimming to 1m** to create a hedge in mature plants.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • • •	Flies	• •
Mirids	• • • •	Predatory mites	•	Springtails	•
Rutherglen bugs	• •	Spiders	• • •	Mites	•
Chinch bugs	•	Haplothrips	•	Seed eating thrips	•
Aphids	• •	Brown lacewings	•	Thrips	• •
Whiteflies	•			Book lice	•
Plague thrips	• • •			Whiteflies (native)	• • • •
Western flower thrips **(V)**	•			Beetles	•
Tomato thrips **(V)**	•				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Fleshy saltbush

(Rhagodia crassifolia)

Description:
A very hardy, salt-tolerant dense large shrub growing to 1.5m H & 1.5 - 2m W.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1.5 - 2m. Trim to no lower than 40cm overall height. Suggest trimming to 1m to create hedge in mature plants.

Notes:
This plant was not long lasting on our trial site but may fare better on other sites. An alternative species could be *Rhagodia candolleana* although no data on pests and beneficials was gathered for this species. It differs in that it grows to 1m H by 1.5m W, is a very effective weed screen, probably can't be hedged and should be spaced at 1-1.5m.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

70%	13%	17%

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • •	Flies	• • • •
Mirids	• • •	Predatory mites	• • •	Springtails	• • •
Rutherglen bugs	• •	Spiders	• • •	Mites	• •
Chinch bugs	•	Haplothrips	Nil	Seed eating thrips	• •
Aphids	•	Brown lacewings	• • •	Thrips	•
Whiteflies	• • •				
Plague thrips	• •				
Western flower thrips **(V)**	Nil				
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Ruby saltbush

(Enchylaena tomentosa)

Description:
Dense, hardy, salt-tolerant groundcover to 40cm H and 1.2m W. This species is very effective at screening out weeds.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 1 – 1.2m. Trim only to constrain horizontal sprawl. Will grow into and between other saltbush species. Also acts as a living mulch below other species.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

27%	18%	55%

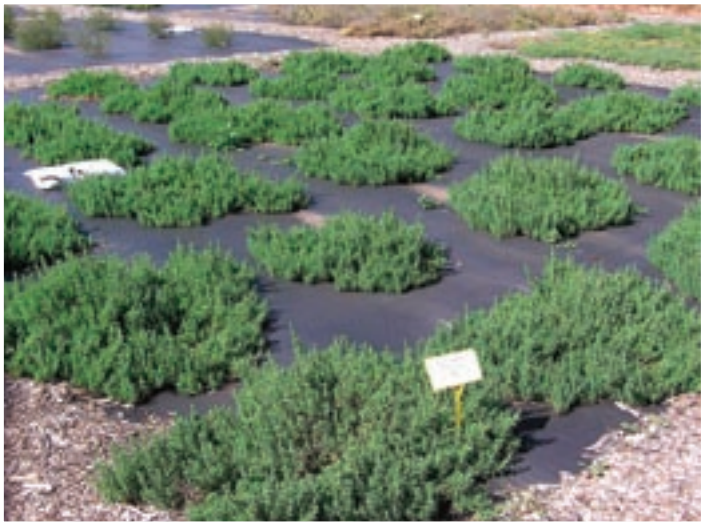
The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• • •	Parasitic wasps	• • •	Flies	• • •
Mirids	• • •	Predatory mites	• • •	Springtails	• • •
Rutherglen bugs	• •	Spiders	• • •	Mites	• •
Chinch bugs	• •	Haplothrips	• •	Seed eating thrips	•
Aphids	• •	Brown lacewings	• •	Thrips	• •
Whiteflies	• •				
Plague thrips	• •				
Western flower thrips **(V)**	Nil				
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	Nil				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005



Elegant wattle

(Acacia victoriae)

Description:
Very hardy, salt-tolerant large shrub to small tree to 4m H and 4m W. Seeds are edible [processed only – NOT raw] and are used extensively in the 'wild food' industry. Prickly, creates a virtually impenetrable hedge when densely planted.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 3m, or 2m to hedge. **Suggest horizontal trimming only** to create hedge in mature plants.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

45%	22%	33%

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • • •	Flies	• • • •
Mirids	• •	Predatory mites	Nil	Springtails	Nil
Rutherglen bugs	• •	Spiders	• •	Mites	• •
Chinch bugs	• •	Haplothrips	•	Seed eating thrips	•
Aphids	• •	Brown lacewings	• •	Thrips	• •
Whiteflies	•				
Plague thrips	• • • •				
Western flower thrips **(V)**	•				
Tomato thrips **(V)**	•				
Onion thrips **(V)**	•				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Tallerack

(Eucalyptus tetragona)

Description:
A gum tree. Hardy small mallee tree to 5m H and 5m W – though if being managed for cut flower yield, it should never attain this size. The stems are harvestable.

Establishment & Maintenance:
As for broadleaf species in the next tab section. Spacing 5m, or 3m to hedge.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • •	Flies	• • • •
Mirids	• •	Predatory mites	• •	Springtails	• •
Rutherglen bugs	• •	Spiders	• • •	Mites	Nil
Chinch bugs	Nil	Haplothrips	Nil	Seed eating thrips	Nil
Aphids	•	Brown lacewings	• • •	Thrips	• • •
Whiteflies	• •				
Plague thrips	• • • •				
Western flower thrips **(V)**	• •				
Tomato thrips **(V)**	•				
Onion thrips **(V)**	• •				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005

Muntries

(Kunzea pomifera)

Description:
Spreading or climbing groundcover – NOT dense. Grows well on trellises to 1.2m. Will sprawl on the ground to the same distance. After 3-4 seasons produces small edible fruits in Summer – these have the taste of spicy dried apples. Very high antioxidant levels (much higher than blueberries). The white Spring flowers have a pleasant smell.

Establishment & Maintenance:
As for broadleaf species in the next tab section.
Spacing 1m.
This species should NOT be trimmed. It may be trained onto trellises. **Very susceptible to herbicide** – exercise caution when spraying in vicinity.

Overall Pest, Beneficial and Non Target Proportions

(see tab divider for explanation of this bar)

49%	15%	36%

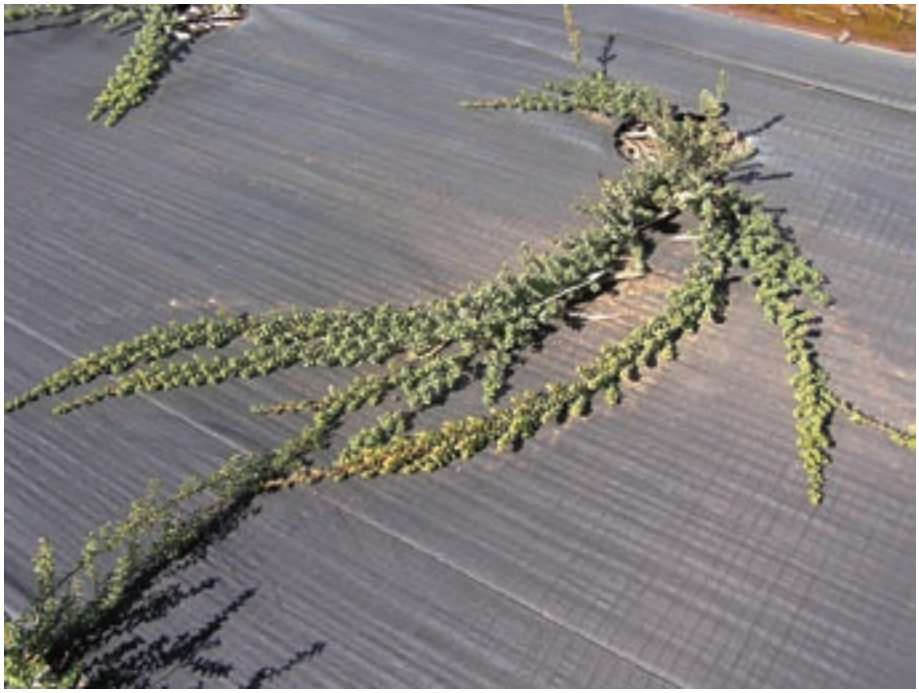
The most common species in each group

Pest		Beneficial		Non Target	
Leafhoppers	• •	Parasitic wasps	• • • •	Flies	• • • •
Mirids	•	Predatory mites	• •	Springtails	• • •
Rutherglen bugs	• •	Spiders	• • •	Mites	• •
Chinch bugs	•	Haplothrips	• •	Seed eating thrips	Nil
Aphids	• •	Brown lacewings	• •	Thrips	•
Whiteflies	• •				
Plague thrips	• • • •				
Western flower thrips **(V)**	• •				
Tomato thrips **(V)**	Nil				
Onion thrips **(V)**	• •				

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus.

LEGEND		
<1%	rare	•
1-10%	occasional	• •
11-50%	common	• • •
51-100%	abundant	• • • •

Data from surveys during peak pest activity September-December 2005



PEST THRIPS DATA sheets

The pest presence data sheets that follow, compare the average number of pest thrips on selected weed and native plant flowers.
These sheets are additional information only and should not be used in isolation for decision making. The Plant Data Sheets are the primary sheets recommended for this purpose. These sheets are intended for supporting information only.

WESTERN FLOWER THRIPS PRESENCE ON FLOWERS OF WEEDS AND NATIVE PLANTS

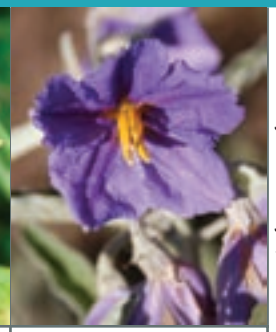
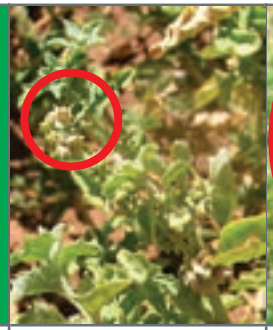
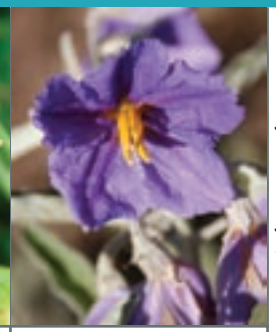
WEED FLOWER UNIT				
WEED TYPE	Giant mustard weed	Salvation Jane	Sow thistle	Silverleaf nightshade#
Average number of Western flower thrips per 100 flower units	150	14	27	119

Photo courtesy of John D. Byrd, NSW DPI

NATIVE PLANT FLOWER UNIT				
NATIVE PLANT TYPE	Lagoon saltbush *Atriplex suberecta*	Small leaved bluebush *Maireana brevifolia*	Elegant wattle *Acacia victoriae*	Tallerack *Eucalyptus tetragona*
Average number of Western flower thrips per 100 flower units	1.5	1.2	0	0

Western flower thrips
Frankliniella Occidentalis

TOMATO THRIPS PRESENCE ON FLOWERS OF WEEDS AND NATIVE PLANTS

WEED FLOWER UNIT				
WEED TYPE	Giant mustard weed	Salvation Jane	Sow thistle	Silverleaf nightshade#
Average number of Tomato thrips per 100 flower units	25	5.9	5.9	35

NATIVE PLANT FLOWER UNIT				
NATIVE PLANT TYPE	Lagoon saltbush *Atriplex suberecta*	Small leaved bluebush *Maireana brevifolia*	Elegant wattle *Acacia victoriae*	Tallerack *Eucalyptus tetragona*
Average number of Tomato thrips per 100 flower units	0	0	0	0

Photo courtesy of John D. Byrd, NSW DPI

Tomato thrips
Frankliniella schultzei

ONION THRIPS PRESENCE ON FLOWERS OF WEEDS AND NATIVE PLANTS

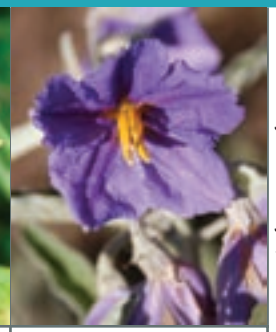
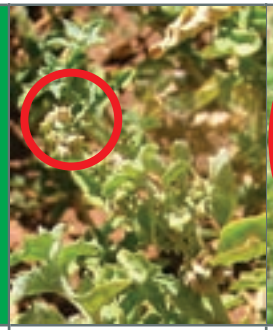
WEED FLOWER UNIT				
WEED TYPE	Giant mustard weed	Salvation Jane	Sow thistle	Silverleaf nightshade#
Average number of Onion thrips per 100 flower units	21	4	12	4

Photo courtesy of John D. Byrd, NSW DPI

NATIVE PLANT FLOWER UNIT				
NATIVE PLANT TYPE	Lagoon saltbush *Atriplex suberecta*	Small leaved bluebush *Maireana brevifolia*	Elegant wattle *Acacia victoriae*	Tallerack *Eucalyptus tetragona*
Average number of Onion thrips per 100 flower units	1.5	0	8.7	0

Onion thrips
Thrips tabaci

PLAGUE THRIPS PRESENCE ON FLOWERS OF WEEDS AND NATIVE PLANTS

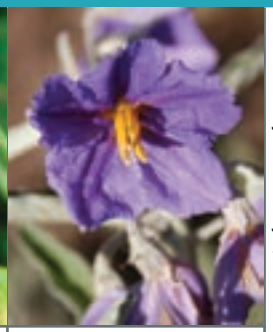
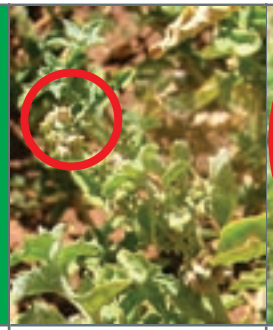
WEED FLOWER UNIT				
WEED TYPE	Giant mustard weed	Salvation Jane	Sow thistle	Silverleaf nightshade#
Average number of Plague thrips per 100 flower units	83	60	53	150

Photo courtesy of John D. Byrd, NSW DPI

NATIVE PLANT FLOWER UNIT				
NATIVE PLANT TYPE	Lagoon saltbush *Atriplex suberecta*	Small leaved bluebush *Maireana brevifolia*	Elegant wattle *Acacia victoriae*	Tallerack *Eucalyptus tetragona*
Average number of Plague thrips per 100 flower units	12	2.5	113	213

Plague thrips
Thrips imaginis

Comparison chart of pest thrips found on a brassica weed and selected native plants

Plant Species		Thrips Species			
Common name	**Species name**	**Western flower thrips (V)** *Frankliniella occidentalis*	**Tomato thrips (V)** *Frankliniella schultzei*	**Onion thrips (V)** *Thrips tabaci*	**Plague thrips (native)** *Thrips imaginis*
Giant mustard weed	***Rapistrum rugosum***	• •	• •	• •	• • • •
Windmill grass	*Chloris truncata*	•	nil	•	• •
Wallaby grass	*Austrodanthonia linkii*	nil	•	nil	• •
Black-head grass	*Enneapogon nigricans*	nil	•	•	• • •
Kangaroo grass	*Themeda triandra*	nil	nil	nil	• • • •
Berry saltbush*	*Atriplex semibaccata*	nil	nil	nil	• •
Grey coastal saltbush	*Atriplex cinerea*	•	•	•	• • •
Marsh saltbush	*Atriplex paludosa*	nil	•	nil	• •
Small leafed bluebush	*Maireana brevifolia*	• •	nil	• • •	• •
Fragrant saltbush*	*Rhagodia parabolica*	•	•	•	• •
Fleshy saltbush	*Rhagodia crassifolia*	nil	nil	• •	• •
Ruby saltbush	*Enchylaena tomentosa*	nil	nil	nil	• •
Elegant wattle*	*Acacia victoriae*	•	•	•	• •
Tallerack	*Eucalyptus tetragona*	•	•	•	• •
Muntries*	*Kunzea pomifera*	•	nil	•	• •

(V) Indicates that the thrips transmits Tomato Spotted Wilt Virus. * Tested free of Tomato Spotted Wilt Virus

Table explanation

Plant species with the most thrips scored the highest number of dots.

All pest thrips that transmit Tomato Spotted Wilt Virus (TSWV) were found on the Giant mustard weed, but they were not always seen on the native plants.

Overall, native plague thrips was the most abundant thrips, but they are not as important a pest because they do not transmit TSWV.

Plant species showing 'nil' means no thrips of this type were seen throughout the entire sampling period.

The 'best bet' to replace weeds would be plant species that have 'nil' or 'rare" thrips that transmit TSWV.

LEGEND	
Not detected	nil
Rare	•
Occasional	• •
Common	• • •
Numerous	• • • •

Averages of thrips derived from sampling September-December 2005

PLANT ESTABLISHMENT & maintenance

Plant establishment and maintenance

The Northern Adelaide Plains soil and general environment can be a difficult one for establishing some native plants. The many years of soil tilling, compaction and inputs from horticulture, vehicles and grazing, has altered the original soil structure that native plant species once grew in. Nevertheless, we have had considerable success in establishing native plants on our trial sites and would suggest that the practices written about here should offer similar success to others.

Our plant establishment and maintenance was directed and/or conducted by native plant specialists. We are only able to describe the methods we used for plant establishment and maintenance and make general statements for what is accepted as current practise.

At the end of this section you will find a cost comparison for revegetation options; those done by a contractor or grower, and compared to the cost of maintaining bare-earth. The appendix section has spreadsheets and more information for those wanting a more detailed breakdown.

Site Preparation

Please see the notes below for site preparation for both native broadleaf and grass species establishment.

Seedlings

We used tube-stock seedlings for the majority of our plantings. Seeds buried into the ground can be successful for establishing many of the larger species however we chose seedlings for control of placement and faster establishment.

Seedlings are best put into the ground no earlier than the first autumn rains. The rainfall will assist them to develop the roots they will need to survive the summer season with potentially no/low watering required.

Weedmatting

Polymer weedmatting was used on our sites. It is an artificial fibre rolled out by the metre across the area to be vegetated and pegged into the ground securely. It provides significant weed suppression by prohibiting sunlight, while still allowing water penetration.

Jute mats referred to below are natural fibre mat sections for placing around individual plants. Please read the species notes below for guidance on their use.

Both types of matting are optional for native plant establishment, but if not used, then the use of mulching is highly recommended on the Northern Adelaide Plains.

Mulching

In the project, both mulched and unmulched plants were grown. We used ‘composted forest mulch’. Other mulch types can also be successful but advice should be sought since there are some mulches that can adversely affect native plants due either to their composition being unsuitable, or from rainfall leaching elements from the mulch material that can affect soil pH and salinity.

Mulching was particularly successful on the native grasses at a depth of 5cm. Half of the grasses planted were mulched and there were distinct differences in growth. The mulched grass species grew to almost twice the size over the course of a full year compared to those that weren’t mulched.

Direct Seeding

Direct seeding is the term for planting seeds into the ground either by hand or with direct seeding machinery. In our trials we attempted direct seeding of three species of native grasses. There was not enough success with the direct seeding for us to recommend it confidently for the horticultural properties on the Northern Adelaide Plains. However native grass seedlings of the same varieties grew well.

Seed needs to be buried into the ground or covered with sufficient soil equal to the width of the seed, so the larger the seed the deeper into the ground it needs to be. Professional advice is recommended.

Seeds and seedlings are both best put into the ground no earlier than the first autumn rains. The rainfall will help them develop the roots they will need to survive the summer season with potentially no/low watering required.

Broadleaf species –

This category includes all native species from our Plant Data Sheets except the four native grasses; Wallaby grass, Windmill grass, Black-head grass and Kangaroo grass.

Establishment

NOTE: Good site preparation will considerably reduce the requirements for follow-up maintenance.

See the individual Plant Data Sheets for information on planting density. The density is determined by establishing a stand of continuous vegetation able to resist weed incursions.

Ensure the site is weed–free – or at the very least that a 50cm radius around each plant is clear. It is advisable to use a general **herbicide spray** at least twice to achieve this. Good preparation is a cornerstone to success in the process of establishing native plants.

Plant as tubestock. Spacing as indicated on the species sheet.

Dig the hole at least 20cm wide and approximately 2cm deeper than tube height. Backfill a small amount [about 1cm] of looser soil back into the bottom of the hole. Carefully remove plant and root-ball from tube. Gently squeeze the sides of the tube first to break the 'bead'. DO NOT cut the tube as these can be re-used, please rinse out and return them to your supplier.

Carefully place the plant in the centre of the hole, pushing gently into the loose soil. Back fill remaining soil around the plant, ensuring that when the soil is filled to level with the top of the root-ball, the plant lies at the centre of a shallow basin to allow for water retention – any excess soil can be mounded like a low volcanic cone around the basin. Compress soil lightly – push it in too hard and the roots will not be able to penetrate.

It is very important that these plants are NOT placed at the bottom of deep holes – they will not respond well to waterlogging. Always water plants in, unless soil is very moist and rain is expected.

Stakes, treeguards and **jute mulch mats** are strongly recommended. These will lessen weed maintenance and watering requirements.

If planting into **woven polymer weedmat**, a **jute mat** may be manoeuvred below each hole

and the plant then placed through the slit in the jute mat – though this is not an easy process, it reduces follow-up weed maintenance virtually to zero. Always ensure holes in the weedmatting are at least 20cm in diameter if attempting this. When laying weedmatting ensure it is pinned or weighted continuously as you progress across the site.

In the absence of jute mats, weeds will grow in holes in the matting until the plant is mature (at least 9 months), and will occur sporadically beyond that with the smaller species.

Mulching is strongly advised if polymer weed matting is not being used; mulching will repress weeds and encourage healthy plant growth. A layer 5-10cm thick is recommended. DO NOT pile mulch onto the stems of any plant as they may develop fungal infections. If using jute mats pile the mulch over the edges of the mat only.

Maintenance

NOTE: Good site preparation will considerably lessen any requirements for follow-up maintenance.

NOTE: Learn to distinguish desirable plants from weeds.

Hand pull emerging weeds if infestation is light, soil is moist and time is available. Or chop at the base with a hoe.

A **monocot [grass] selective herbicide** can be sprayed once grassy weeds develop a reasonable leaf area – be sure to act before seeds develop. However, this herbicide will not control broadleaf weeds. A spray shield is advisable if the native seedlings are very young since they may not tolerate these sprays.

Dense plantings of saltbushes may be maintained with a **brushcutter**, selectively decapitating weeds. While not disturbing the native plants is desirable during their first year to 18 months, the saltbush [chenopod] species will tolerate some trimming, but **never trim below 40cm overall height**. DO NOT trim the other species under any circumstances except *Acacia victoriae*. It may be cut back when mature, while the Eucalypt species may be trimmed for cut-flower requirements.

Chenopod species should be substantial enough to heavily limit weed incursions in 1 year to 18 months from planting. The other species may require maintenance for a longer period – or indefinitely.

Water the plantings once a month over their first summer unless substantial rain has fallen. Only in exceptionally hot and dry conditions will plants need watering in the second summer or beyond.

Grasses –

Wallaby grass, Windmill grass, Black-head grass and Kangaroo grass.

Establishment

As per the broadleaf species except as indicated below.

Plantings will need to be substantially denser – see species sheets.

NOTE: DO NOT use a **jute-mat** below polymer weed-matting with these species – it will inhibit the plants ability to spread to fill the hole. **Stakes** and **guards** are not required. Jute mats may be useful in the early stages on open sites, but should be removed as the grass establishes.

Mulching is particularly beneficial to grasses, and is highly recommended – it significantly boosts growth and markedly reduces weed incursions.

If grown without polymer matting **grasses are generally less able to resist weed incursions** than the Saltbush [Chenopod] species. Austrodanthonia (Wallaby grass), and Themeda (Kangaroo grass), are the most incursion resistant species. For this reason, again, mulching is strongly recommended.

Maintenance

As for broadleaf species except as below.

Use a **broad-leaf selective herbicide** to control broad-leafed weeds. This will not affect weed grasses. Chloris (Windmill grass) in particular, may not cope well with heavy herbicide saturations – spray carefully.

It is important to note that grasses are either **summer active** or **winter active**; details for each species are on the species sheet. Winter active grasses will begin to grow in late autumn, summer active grasses in spring.

In the case of the grass species it is extremely important to consult the individual species notes to be found on each species data sheet.

Cost comparisons of maintaining bare earth or establishing 'on farm' native vegetation designed to benefit horticultural crop production

PLANTS	
TUBE STOCK At 1.5m spacing	**TOTAL**
Contractor	**$2573.68**
Grower	**$1200.58**

PLANTS	
DIRECT SEEDED SALTBUSHES	**TOTAL**
Contractor	**$2491.28**
Grower	**$1956.28**

GRASSES	
TUBE STOCK At 0.5m spacing	**TOTAL**
Contractor	**$8711.28**
Grower	**$5287.78**

GRASSES
DIRECT SEEDED GRASSES
This method was not succesful in the project.

BARE EARTH	
MAINTAINING BARE EARTH	**TOTAL**
Contractor	**$6360.16**
Grower	**$2709.43**

Note: A complete breakdown of these costs is provided in the Appendix section

Information to support the cost comparisons was kindly provided by Ms Stacee Brouwers, Agronomy / NRM Officer, Virginia Horticulture Centre.

Cost boxes explained

The values in the model were derived from calculations based on an average two hectare farm with an area of 500 square metres of uncultivated land, and projected over a 10 year time frame. The boxes give a general idea of cost outcomes for two different revegetation approaches; direct seeding or using tube-stocks. Each is compared to the cost of maintaining bare earth around crops.

Direct seeding of grasses produced variable results and has not been included since it isn't a reliable strategy on the Northern Adelaide Plains for unknown reasons. The model is an estimate only, and will vary according to the cost of labour, seed, plants and herbicides.

Additional benefits of deep rooted perennial native plants and grasses to replace weeds and bare earth not costed in the model

- Suppression of pest thrips and the diseases they spread
- Perennial refuges for invertebrates that are beneficial to agriculture and increase IPM options
- Human health and environmental benefits from reduced contact with herbicides
- Aesthetic improvement
- Improved "Clean-Green" image for horticultural industry
- Reduction in soil loss, dust and improvement of soil quality
- Potential for profit from sale of native seeds and fruits
- Increase in biodiversity of plants and fauna
- Improved water management.

Benefits of bare earth

- Does not support weeds that are reservoirs for pest thrips and Tomato Spotted Wilt Virus
- Deterrent to pest movement.

RESOURCES & glossary

NATIVE VEGETATION

There is a large array of information to access at libraries across the State and the internet. Below are listed some good places to access services and information on native plants including the species within this guidebook.

Places to Phone or Visit:

City of Playford, Davoren Park, Ph: 8256 0333
For information on locations to view stands of native vegetation in the local area.

State Flora, Dept. Water, Land & Biodiversity Conservation, Belair Nursery, Ph: 8278 7777
State Flora, Dept. Water, Land & Biodiversity Conservation, Murray Bridge Nursery, Ph: 8539 2105
These government owned nurseries grow and sell indigenous plants of South Australia. They are great locations for viewing species. References are available to show the species that are indigenous to the different areas of the State.

Trees For Life, contact via www.treesforlife.org.au
This organisation uses volunteers to grow native plants for landholders to order. A cost competitive means of purchasing and/or growing your own native plants.

Adelaide Botanic Gardens, North Terrace, Adelaide, Ph: 8222 9311
The native plant section of the gardens has a large variety of South Australian species to meander through and appreciate.

Revegetation Services:

There are many good service providers for native revegetation in this State. Many buy and sell local seed and seedlings or can direct you to people who do. The services they provide range from weed control, site assessment and advice, to seedling planting and direct seeding. Followup services are often available and some guarantee their results. Often local Landcare groups can direct you to a provider, or visit 'Revegetation Consultants & Contractors' in the Yellow Pages Phone Directory.

World Wide Web:

Adelaide Botanic Gardens, www.environment.sa.gov.au/botanicgardens/adelaide
Search for general information with a view to visiting the gardens to observe South Australian native plant species growing on display.

Images of South Australian Native Flora, www.geocities.com
This site has links to other interesting botanical sites of Australia including the National Botanical Gardens in Canberra.

Revegetation Consultants & Contractors, www.yellowpages.com.au
or printed in the Yellow Pages Phone Directory.

Books:

Pre-European Vegetation of Adelaide: A Survey from the Gawler River to Hallett Cove by Darrell Kraehenbuehl. Published by the Nature Conservation Society of SA Inc. 1996.

This book depicts in maps, text and images what the plant associations of the Adelaide Plains were in 1836 and good descriptions of actual locations of remaining species.

NATIVE VEGETATION - continued -

Plants of the Adelaide Plains and Hills by Gilbert Dashorst and John Jessop, Published by the Botanic Gardens of Adelaide (soon to be released 3rd edition).

The Native Plants of Adelaide - Returning the vanishing natural heritage of the Adelaide Plains to your Garden by Phil Bagust and Lynda Tout-Smith, published by the SA Urban Forest Biodiversity Program, Department of Environment and Heritage 2005.

It's Blue With Five Petals - Wildflowers of the Adelaide Region by Ann Prescott, published by Ann Prescott 1988.

INTEGRATED PEST MANAGEMENT (IPM) RESOURCES

There are many good websites and publications on IPM. Here are a few:

World Wide Web:

www.brisbane.tafe.net/Library/horticulture
General growing information, one-stop-shop site that acts like a library catalogue.

www.goodbugs.org.au
Biological control of pests in Australasia.

www.nre.vic.gov.au/farming/index
Department of Natural Resources and Environment Victoria website.

www.dpi.qld.gov.au

www.nysaes.cornell.edu/ent/biocontrol
Offers a tutorial on the concept and practice of biological control and integrated pest management from Cornell University, USA.

Books:

Most State Departments of Agriculture or Primary Industries have bookshops or libraries that can be used. Universities are good sources of IPM books. A couple of titles to begin with are below:

IPM in Practice: Principles and Methods of Integrated Pest Management by Mary Flint 2001, University of California DANR Publication 3418.

What Garden Pest or Disease is That? by Judy McMaugh 1986, Landsdowne Press.

Australian Vegetable Growing Handbook by John Salvestrin 1998, Scope Publishing Victoria.

GLOSSARY OF TERMS

B

Beneficial insects – those species that offer some advantage to crop management. In our context it means those that offer pest control as a supplement or replacement to insecticide use.

Biological – of a living nature. Not inert. Organic and derived from the natural world.

C

Cultural – those activities directly involved in growing and tending healthy plants eg. crop rotation or 'designed' revegetation.

E

Endemic – plants that are present or associated with that area.

Ephemeral – a short-lived organism such as a plant that completes its lifecycle in usually less than six months.

Erosion – the removal of soil by the action of water and wind.

Exotic – a plant or invertebrate originating in another country; not native to Australia.

F

Forage – the act of searching for food.

G

Generalist – is a plant or insect that either supports or preys on a wide range of organisms; opposite to 'specialist'.

H

Habitat – the environment in which a plant or animal normally lives or grows.

Harbour – to provide shelter, food, or other benefits for invertebrates.

Host – a plant or animal that provides a location for reproduction of invertebrates.

I

Inflorescence – the part of the grass plant that consists of the flower bearing stalks.

Integrated Pest Management (IPM) – see the section on IPM in the early introduction pages section of this guidebook.

Invertebrate – any animal lacking a backbone, usually insects, mites, and spiders.

N

Native – plants and invertebrates that have evolved in Australia.

Non-targets – invertebrates that are not known to be either a pest or beneficial species.

P

Parasitoid – an insect that survives on a living host when immature but becomes free-living as an adult.

Perennial – a plant lasting throughout the year or many years.

Pest – a plant or invertebrate that is not wanted due to its adverse economic effect on vegetable production.

Predator – any carnivorous invertebrate.

Prey – an invertebrate hunted or captured by another for food.

Provenance – a plant that is in its place of origin.

R

Revegetation – planting native vegetation of a type that existed prior to clearing of the land.

S

Specialist – an organism that has specific prey preference that is limited to a small range of similar species; opposite to 'generalist'.

Species – a member of a group of animals or plants sharing main characteristics enabling interbreeding.

T

Tomato Spotted Wilt Virus – a virus that causes rapid deterioration and marks on many vegetable types. It is transferred to crops through thrips feeding. Western flower thrips is particularly efficient in this regard.

Transmit – the transfer of a virus from one plant to another by insects.

V

Vector – is an insect that is capable of carrying the live virus and infecting plants during feeding.

The Future of 'Revegetation By Design' on the Northern Adelaide Plains

"Revegetation by Design' aims to suppress pests in nearby horticulture by the selective use of native plants. The current 'Revegetation by Design' project has provided valuable information about invertebrate composition on several native plant species on the Northern Adelaide Plains. This guidebook is the culmination of this project, and uses the information gained to support the use of selected native plants as replacement for weeds and cleared land near horticulture.

However, work is still required to evaluate the value of native vegetation on a property scale. In this regard, future survey work will be greatly enhanced by growers planting larger areas of native vegetation. It will also be important to assess the ability of various native plants to support a full breeding cycle of Western flower thrips (WFT). No thrips reproduction on plants is important in suppressing local WFT numbers, but also because thrips must breed on infected plants to acquire Tomato Spotted Wilt Virus.

Our surveys indicated the diversity of beneficial invertebrates on both native plants and grasses, and studies to explore the benefit they have in pest control on the Northern Adelaide Plains are warranted. In particular, identifying those specialist wasp species that will target pest thrips, and studies of brown lacewings on native plants. Brown lacewing movement between native vegetation and agricultural crops should provide an indication of the potential value of lacewing populations as biological control agents.

Glenys Wood, SARDI, will be conducting a research program to examine some of these opportunities from 2006 to 2009. This work on the Northern Adelaide Plains and complimentary studies conducted in different locations of Australia will continue to refine and improve the "Revegetation by Design" approach.

APPENDICES

1. Chart - NATIVE PLANTS APPROXIMATE FLOWERING, SEEDING AND FRUITING PERIODS.
2. Chart - WEED FLOWERING AND SEED-SET PERIODS - Critical Slashing/Clearing Times.
3. Cost Comparison for Revegetation Options - Further information and spreadsheets.

NATIVE PLANTS APPROXIMATE FLOWERING, SEEDING AND FRUITING PERIODS

Common Name	Plant Species	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May
		Winter			Spring			Summer			Autumn		
	Chenopodiaceae												
Berry saltbush	*Atriplex semibaccata*												
Lagoon saltbush *	*Atriplex suberecta* *												
Grey coastal saltbush	*Atriplex cinerea*												
Marsh saltbush	*Atriplex paludosa*												
Small leafed bluebush	*Maireana brevifolia*												
Fragrant saltbush	*Rhagodia parabolica*												
Fleshy saltbush	*Rhagodia crassifolia*												
Sea Berry saltbush *	*Rhagodia candolleana* *												
Ruby saltbush	*Enchylaena tomentosa*												
	Mimosaceae												
Elegant wattle	*Acacia victoriae*												
	Myrtaceae												
Muntries	*Kunzea pomifera*												
Silver broom *	*Baeckea behrii* *												
Tallerack	*Eucalyptus tetragona*												
	Poaceae												
Wallaby grass	*Austrodanthonia spp.*												
Windmill grass	*Chloris truncata*												
Blackhead grass	*Enneapogon nigricans*												
Kangaroo grass	*Themeda triandra*												

KEY	
flowering period	flowering + seeding / fruiting
seeding / fruiting only	* Extra species observed

WEED FLOWERING AND SEED-SET PERIODS - The Most Critical Slashing/Clearing Times

Common Name	Plant Species	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May
		Winter			Spring			Summer			Autumn		
	Azioaceae												
Blanket weed	*Galenia pubescens*	■	■	■	■	■	■	■	■	■	■	■	■
	Asteraceae												
Cape weed	*Arctothea calendula*				■	■	■						
Sow thistle	*Sonchus oleraceus*	■	■	■	■	■	■	■	■	■	■	■	■
Scotch thistle	*Cirsium vulgare*								■				
	Brassicaceae												
Wild radish	*Raphanus raphanistrum*				■	■	■	■	■	■	■	■	■
Giant mustard weed	*Rapistrum rugosum*	■	■	■	■	■	■	■	■	■	■	■	■
Sand rocket	*Diplotaxis tenuiufolia*								■	■	■	■	
Indian hedge mustard	*Sisymbrium orientale*				■	■	■	■	■	■	■	■	■
	Boraginaceae												
Salvation Jane	*Echium plantagenum*				■	■	■	■	■	■	■	■	■
	Chenopodiaceae												
Fat hen	*Chenopodium album*	■	■	■	■	■	■	■	■	■	■	■	■
	Malvaceae												
Mallow	*Malva parviflora*	■	■	■	■	■	■	■	■	■	■	■	■
	Oxalidaceae												
Soursob	*Oxalis pes caprae*	■	■	■	■	■	■						■
	Polygonaceae												
Wire weed	*Polygonum aviculare*	■					■	■	■	■	■	■	■
	Portulacaceae												
Portulaca	*Portulaca oleraceae*								■	■	■	■	
	Solanaceae												
Black nightshade	*Solanum nigrum*								■	■	■	■	■
Silverleaf nightshade	*Solanum elaeagnifolium*						■	■	■	■	■	■	
	Umbelliferae												
Fennel	*Foeniculum vulgare*							■	■	■	■	■	
	Urticaceae												
Nettle	*Urtica urens*	■	■	■	■	■	■					■	■
	Zygophyllaceae												
Calthrop	*Tribulus terrestris*							■	■	■	■	■	■

Cost comparisons of maintaining bare earth or establishing 'on farm' native vegetation designed to benefit horticultural crop production

(Further detail of final sheet in Plant Establishment and Maintenance section.)

The values used in the spreadsheets that follow in the next pages were derived from calculations based on an average two hectare farm with an area of 500 square metres of uncultivated land and projected over a 10 year time frame. They are intended to give a general idea of cost outcomes for two different revegetation approaches compared to maintaining bare earth around crops. The figures are an estimate only, and will vary according to the cost of labour, seed, plants and herbicides.

Contractor rates were estimated at $70/hr including the cost of fuel and equipment depreciation. Grower rates used were $27.70/hr taking into account CPI and also including fuel plus depreciation. Spraying, hoeing, slashing and watering were all estimated at 2.5hr/500m^2.

Tubestock planting was based on average plant price in the ground with tree guards.

- Native plants were planted at 1.5m centres and native grasses at 0.5m centres.
- Contractor tubestock planting at $3.40 per plant.
- Grower tubestock planting at $2.30 per plant.

Direct seeding (saltbush plants only)

- Seed cost was calculated as an average cost for commonly used saltbush seeds ($75/kg at 8kg/ha).
- Contractor machine planting cost $175.
- Grower planting cost (using a fertiliser spreader to disperse seeds) cost $69.25.
- An additional weed spot spray was added for the first year.

Chemical weed spray

- Based on standard 20 litres herbicide at $212 at 2 litres per hectare or 3 litres per hectare for spot spraying in 200 litres water.
- Time was 2.5hrs for 500m^2.

Hoeing, Slashing and Watering was calculated at contractor and grower hourly rates as stated above, with costs and depreciation for machinery included.

Discounting

On the spreadsheets that follow you will see a 'Discounted' price. Discounting of natural assets is a process of determining the present value (net worth) of assets by applying a discount rate to the expected net benefits from future uses of those assets. The discount rate reflects social preferences for current (as compared with future) uses. This is standard economic practise.

Information to support the cost comparisons was kindly provided by Ms Stacee Brouwers, Agronomy / NRM Officer, Virginia Horticulture Centre.

NATIVE PLANTS - TUBE STOCK

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
CONTRACTOR											
Plant Establishment	$462.40	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$350.00	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	
Total	$987.40	$350.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	**$2,737.40**
Inflation adjusted	$987.40	$360.50	$185.66	$191.23	$196.96	$202.87	$208.96	$215.23	$221.68	$228.34	**$2,998.83**
Discounted	**$987.40**	**$342.48**	**$167.56**	**$163.95**	**$160.43**	**$156.98**	**$153.60**	**$150.30**	**$147.07**	**$143.91**	**$2,573.68**
BARE EARTH METHOD											
Rotary Hoeing	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Chemical weed spray	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Total	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	**$7,000.00**
Inflation adjusted	$700.00	$721.00	$742.63	$764.91	$787.86	$811.49	$835.84	$860.91	$886.74	$913.34	**$8,024.72**
Discounted	**$700.00**	**$684.95**	**$670.22**	**$655.81**	**$641.71**	**$627.92**	**$614.42**	**$601.21**	**$588.28**	**$575.63**	**$6,360.16**

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
GROWER											
Plant Establishment	$312.80	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$69.25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$159.70	$101.05	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing		$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	
Total	$541.75	$170.30	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	**$1,266.05**
Inflation adjusted	$541.75	$175.41	$73.47	$75.67	$77.94	$80.28	$82.69	$85.17	$87.72	$90.36	**$1,370.46**
Discounted	**$541.75**	**$166.64**	**$66.30**	**$64.88**	**$63.48**	**$62.12**	**$60.78**	**$59.48**	**$58.20**	**$56.95**	**$1,200.58**
BARE EARTH METHOD											
Rotary Hoeing	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	
Chemical weed spray	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	
Total	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	**$2,982.00**
Inflation adjusted	$298.20	$307.15	$316.36	$325.85	$335.63	$345.70	$356.07	$366.75	$377.75	$389.08	**$3,418.53**
Discounted	**$298.20**	**$291.79**	**$285.52**	**$279.38**	**$273.37**	**$267.49**	**$261.74**	**$256.11**	**$250.61**	**$245.22**	**$2,709.43**

Electronic 'active' version of this spreadsheet is available at www.sardi.sa.gov.au - follow the links to Entomology - Horticultural Pests - Revegetation by Design.

NATIVE GRASSES - TUBE STOCK

CONTRACTOR	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Plant Establishment	$6,600.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$350.00	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	
Total	$7,125.00	$350.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	**$8,875.00**
Inflation adjusted	$7,125.00	$360.50	$185.66	$191.23	$196.96	$202.87	$208.96	$215.23	$221.68	$228.34	$9,136.43
Discounted	**$7,125.00**	**$342.48**	**$167.56**	**$163.95**	**$160.43**	**$156.98**	**$153.60**	**$150.30**	**$147.07**	**$143.91**	**$8,711.28**
BARE EARTH METHOD											
Rotary Hoeing	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Chemical weed spray	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Total	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	**$7,000.00**
Inflation adjusted	$700.00	$721.00	$742.63	$764.91	$787.86	$811.49	$835.84	$860.91	$886.74	$913.34	$8,024.72
Discounted	**$700.00**	**$684.95**	**$670.22**	**$655.81**	**$641.71**	**$627.92**	**$614.42**	**$601.21**	**$588.28**	**$575.63**	**$6,360.16**

GROWER	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Plant Establishment	$4,400.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$69.25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$159.70	$101.05	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing		$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	
Total	$4,628.95	$170.30	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	**$5,353.25**
Inflation adjusted	$4,628.95	$175.41	$73.47	$75.67	$77.94	$80.28	$82.69	$85.17	$87.72	$90.36	$5,457.66
Discounted	**$4,628.95**	**$166.64**	**$66.30**	**$64.88**	**$63.48**	**$62.12**	**$60.78**	**$59.48**	**$58.20**	**$56.95**	**$5,287.78**
BARE EARTH METHOD											
Rotary Hoeing	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	
Chemical weed spray	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	
Total	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	**$2,982.00**
Inflation adjusted	$298.20	$307.15	$316.36	$325.85	$335.63	$345.70	$356.07	$366.75	$377.75	$389.08	$3,418.53
Discounted	**$298.20**	**$291.79**	**$285.52**	**$279.38**	**$273.37**	**$267.49**	**$261.74**	**$256.11**	**$250.61**	**$245.22**	**$2,709.43**

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DIRECT SEEDING - SALTBUSH SPECIES

CONTRACTOR	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Plant Establishment	$205.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$525.00	$175.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing	$0.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	
Total	$905.00	$350.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	$175.00	**$2,655.00**
Inflation adjusted	$905.00	$360.50	$185.66	$191.23	$196.96	$202.87	$208.96	$215.23	$221.68	$228.34	**$2,916.43**
Discounted	**$905.00**	**$342.48**	**$167.56**	**$163.95**	**$160.43**	**$156.98**	**$153.60**	**$150.30**	**$147.07**	**$143.91**	$2,491.28
BARE EARTH METHOD											
Rotary hoeing	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Chemical weed spray	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	$350.00	
Total	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	$700.00	**$7,000.00**
Inflation adjusted	$700.00	$721.00	$742.63	$764.91	$787.86	$811.49	$835.84	$860.91	$886.74	$913.34	**$8,024.72**
Discounted	**$700.00**	**$684.95**	**$670.22**	**$655.81**	**$641.71**	**$627.92**	**$614.42**	**$601.21**	**$588.28**	**$575.63**	$6,360.16

GROWER	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Plant Establishment	$99.25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Watering	$69.25	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Chemical weed spray	$228.95	$101.05	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
Slashing		$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	
Total	$397.45	$170.30	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	$69.25	**$1,121.75**
Inflation adjusted	$397.45	$175.41	$73.47	$75.67	$77.94	$80.28	$82.69	$85.17	$87.72	$90.36	**$1,226.16**
Discounted	**$397.45**	**$166.64**	**$66.30**	**$64.88**	**$63.48**	**$62.12**	**$60.78**	**$59.48**	**$58.20**	**$56.95**	$1,056.28
BARE EARTH METHOD											
Rotary Hoeing	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	$138.50	
Chemical weed spray	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	$159.70	
Total	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	$298.20	**$2,982.00**
Inflation adjusted	$298.20	$307.15	$316.36	$325.85	$335.63	$345.70	$356.07	$366.75	$377.75	$389.08	**$3,418.53**
Discounted	**$298.20**	**$291.79**	**$285.52**	**$279.38**	**$273.37**	**$267.49**	**$261.74**	**$256.11**	**$250.61**	**$245.22**	$2,709.43

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