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Rural Industries Research and Development Corporation

# Establishing Perennial Pastures

*The foundation for sustainable organic farming systems*

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RIRDC Innovation for rural Australia

Australian Government
Rural Industries Research and Development Corporation

# Establishing Perennial Pastures

## The foundation for sustainable organic farming systems

by Viv Burnett

July 2008

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# Foreword

Dryland farming systems require perennial species to be environmentally and economically sustainable. Perennial species are needed to address the water imbalance in agricultural systems, reduce nitrate leaching that contributes to soil acidification, and reduce annual species invasion if managed appropriately.

The aim of this project was to determine sustainable methods of perennial pasture establishment for organic farming systems. Primary producers are the principal beneficiaries of the research.

The key findings are that perennial pastures can be established successfully in organic farming systems with appropriate attention to seedbed preparation and basic agronomy. Organic producers are aware of the importance of perennial species, including native grasses, and have developed specific formulas for perennial establishment that are suitable to their own farms and conditions.

New entrants to organic farming should take advantage of the information generated from the project to assist them with perennial pasture establishment and management. Policy makers, including organic certification agencies, should encourage best practice perennial pasture establishment is conducted on organic farms through the annual audit process.

This project was funded from RIRDC Core Funds which are provided by the Australian Government.

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**Peter O'Brien**
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# Abbreviations

| | |
|---|---|
| **ACO** | **Australian Certified Organic** |
| **DM** | **Dry Matter** |
| **DSE** | **Dry Sheep Equivalent** |
| **DPI** | **Department of Primary Industries Victoria** |
| **NASAA** | **National Association for Sustainable Agriculture Australia** |
| **NEEF** | **North East Ecological Farmers** |
| **OFA** | **Organic Federation of Australia** |
| **ROFO** | **Riverina Organic Farmers Organisation** |
| **STIPA** | **STIPA Native Grass Association** |

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# Executive Summary

**What the report is about**
This report is about understanding the requirements to establish and manage introduced perennial pastures, and to increase the perennial grass component of native pastures, in dryland organic farming systems. This report is important because experienced organic producers and new entrants to organic production need to know the best methods to establish and manage a perennial system for both productivity and long term persistence.

**Who is the report targeted at?**
The report is targeted at organic primary producers, those producers contemplating conversion to organic systems and organic certification agencies.

**Background**
Dryland farming systems require perennial species in order to be environmentally and economically sustainable. Perennial pasture species have the potential to address the water imbalance in current agricultural systems, reduce nitrate leaching that contributes to soil acidification and, once established, are competitive and can reduce annual weed species invasion thereby assisting in chemical-free weed management.

**Aims/objectives**
The objective of the research was to determine sustainable methods of establishing introduced perennial pastures for organic and in-conversion farming systems. The principal beneficiaries of the research are primary producers.

**Methods used**
The aims and objectives were achieved through four strategies:

1. Conduct a biophysical and sociological survey of organic producers to assess the status of perennial pastures (native and/or exotic) on farm and to understand the barriers to perennial pasture establishment and/or improvement
2. In partnership with producer groups, determine the most appropriate perennial pasture establishment strategies
3. Highlight and communicate successful perennial pasture systems to producers through an organised study tour
4. Investigate late-germinating weed species and their effects on perennial pasture establishment (PhD study).

**Results/key findings**
The survey showed that the major barriers to perennial pasture establishment in organic systems were available moisture at the right time, management of weeds and cost. The availability of moisture and the management of weeds are related in that successful establishment will depend on the management of competition. Experimental results were affected by low rainfall at critical times, especially at Yarrawonga. Where direct drilling was used and competition from weeds was not managed (Yarrawonga), perennial species failed to establish but at Rutherglen, a cultivated seedbed resulted in successful establishment. Strategic grazing management of the native species, red grass (*Bothriochloa macra*), that included a low stocking rate (5 DSE/ha) with livestock exclusion in late summer and autumn, resulted in better productivity and persistence.

**Implications for stakeholders**
Perennial establishment will remain low until weeds can be effectively managed. For successful establishment, a prepared seedbed is required so there is a trade off between the short term costs of soil structure damage because of cultivation and the longer term benefits of improved soil management under a perennial system. Enhancing pastures through the encouragement of existing native perennial species offers significant potential and ought to be investigated more thoroughly.

**Recommendations**
Competition must be managed for successful establishment so a prepared seedbed is required. If organic producers want to direct drill, then lucerne is the best species to use, preferably at higher sowing rates with targeted fertiliser application. Under-sowing should be avoided as the cereal crop competes with the pasture species for moisture, fertility and light. Standard sowing rates for pastures are recommended as higher rates don't result in increased density after establishment. Management of pastures to encourage existing native species is encouraged but it is recognised that this is a long term option. Organic producers, and those considering conversion, need to take further advantage of the existing extension material and training packages in the learning process. Future work should include pasture evaluation under organic conditions and the collation and interpretation of existing pasture data for the 'Organic Knowledge Hub'.

# 1. Introduction

Dryland farming systems require perennial species in order to be environmentally and economically sustainable. Perennial pasture species have the potential to address the water imbalance in current agricultural systems. Their deep roots are able to extract water to depths of 3-4 metres and dry the soil profile during spring, summer and autumn. This slows down the movement of rainfall through the profile thereby reducing the risk of leakage to ground water and the possible onset of salinity. Whilst all perennial species are beneficial, the water imbalance is most effectively addressed with warm-season species such as lucerne or many of the native grasses. Perennial species can also be effective in reducing nitrate leaching that contributes to soil acidification. Once established, perennial pastures are competitive and with appropriate management, can reduce annual weed species invasion thereby assisting in chemical-free weed management.

In a survey of certified organic producers conducted in 2000, 59% of respondents indicated that annual species were the predominant pasture species on their farms. Anecdotal evidence from organic farms has shown that annual pasture and weed species often prevail, with little evidence of perennial pasture establishment programs.

In conventional dryland farming systems, one of the major barriers inhibiting the establishment of perennial pastures includes the cost of establishment. This means not just the cost of seed, but fertiliser, soil preparation and the cost of keeping a paddock out of production whilst the perennial pasture is establishing. So there is considerable interest amongst producers, both organic and conventional, in the potential to avoid costly re-establishment through enhanced grazing management to stimulate the perennial component of their pasture swards.

The length of time before return on investment is achieved from sown perennial pastures is another barrier. It can be up to five years before a superior return on investment, compared to retaining an existing annual pasture, is achieved with a newly established phalaris (Figure 1.1) pasture in a beef cattle enterprise. This time is reduced with perennial ryegrass as it establishes more rapidly, but there are few environmental benefits in terms of water balance or N leaching with this species. In a prime lamb enterprise this delay can be shortened to three years but these are significant effects on cash flow for any farming business.

**Figure 1.1: Phalaris (*Phalaris aquatica*)**

Sowing management and general agronomy is also challenging in many systems. Perennial pasture seed is small and generally uncompetitive and much effort is required to prepare the appropriate seedbed and get the timing right. This process can often be thwarted by seasonal conditions with late break rainfall, insufficient rainfall or unsuitable soil conditions. Insect attack can also be another issue, especially with lucerne (Figure 1.2) establishment.

**Figure 1.2: Lucerne (*Medicago sativa*)**

Management of the perennial pasture in the first twelve months is critical to ensure its long term persistence. This management is often compromised by the need to ensure feed for livestock, especially during the winter months, which can result in poor pasture persistence and weed invasion.

Perennial pasture establishment in organic farming systems has additional barriers and constraints including the absence of herbicides to manage weeds during the establishment process, and a limited range of fertiliser products that can be used.

Given the critical importance of the perennial pasture base for productive and sustainable organic farming systems this project was designed to achieve the multiple outcomes of increased awareness of perennial pastures amongst primary producers, increased rate of successful perennial pasture establishment when using acceptable organic practices, improved sustainable management of existing native pastures and improved understanding of the influence of weed species on perennial pastures.

The project involved a range of people including individual producers and producer groups, as well as co-operation with another research project focused on native grass grazing management. This final report covers results from a producer survey, experimental program, communication and extension activities, and research as part of a PhD thesis.

# 2. Objectives

The project research objective was:

- To determine sustainable methods of perennial pasture establishment for organic and in-conversion farming systems.

The strategies used to achieve the objective were:

- Conduct a biophysical and sociological survey of organic producers to assess the status of perennial pastures (native and/or exotic) on farm and to understand the barriers to perennial pasture establishment and/or improvement
- In partnership with producer groups, determine the most appropriate perennial pasture establishment strategies
- Highlight and communicate successful perennial pasture systems to producers through an organised study tour
- Investigation of late-germinating weed species and their effects on perennial pasture establishment and development (PhD thesis).

# 3. Methodology

## 3.1 Biophysical and sociological survey

### 3.1.1 Survey background

An accurate assessment of the status of perennial pastures on organic farms through a survey will provide knowledge that may be shared amongst other organic producers, methods that organic farmers use to establish pastures and the reasons, if any, as to why perennial species are not being established.

### 3.1.2 Survey aims

The survey had four aims:

- To determine the amount and status of perennial pastures (exotic and native) on certified organic dryland farms in Victoria, New South Wales and South Australia
- To understand the barriers to perennial pasture establishment and/or improvement on organic farms
- To understand current, and discover new methods, of perennial pasture establishment that may have wider applicability in organic systems
- To understand current perennial pasture management on organic farms.

### 3.1.3 Survey area

Survey respondents were located predominantly in the dryland agricultural regions west of the Great Dividing Range in New South Wales, in most regions of Victoria, and in the south east agricultural belt in South Australia. A map of the approximate survey area is presented in Figure 3.1.

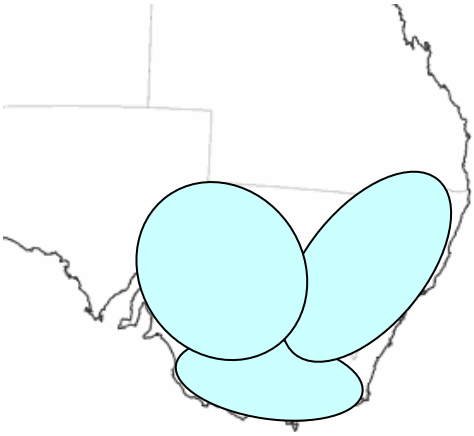

**Figure 3.1: Map of survey area in Victoria, New South Wales and South Australia**

### 3.1.4 Producer population

The total population of producers was identified from organic certification websites (*www.nasaa.com.au* and *www.bfa.com.au*) based on their production enterprise which included beef, dairy, sheep/lamb or cropping. The total number of producers (291) identified by state and by certification agency is presented in Table 3.1.

**Table 1 Number of Organic Producers by State and Agency**

| | ACO | NASAA | Total |
|---|---|---|---|
| **NSW** | 141 | 22 | **163** |
| **SA** | 16 | 25 | **41** |
| **VIC** | 25 | 62 | **87** |
| **Total** | **182** | **109** | |

### 3.1.5 Sample selection process

A stratified sampling method was used to select a representative sample from the total population of 291 producers. The relevant sample size by state and agency resulted in a total of 161 producers (in parentheses) from the total population of 291, and is presented in Table 3.2.

**Table 2 Number of organic producers by state and agency and the relevant sample size (*)**

| | ACO | NASAA | Total |
|---|---|---|---|
| **NSW** | 141 (57) | 22 (18) | **163** |
| **SA** | 16 (13) | 25 (20) | **41** |
| **VIC** | 25 (20) | 62 (38) | **87** |
| **Total** | **182** | **109** | |

### 3.1.6 Survey method

The survey was tested on a sample of eight producers before final adjustments were made in December 2004. The telephone survey was conducted during the period January 2005-March 2006 of certified organic producers in New South Wales, Victoria and South Australia. Producers were contacted by telephone and asked if they would participate in the survey. Some producers received faxed copies of the survey which were completed and sent back, but the majority participated via the telephone. If producers were not able to be contacted after three attempts or declined to participate, this was recorded as 'no contact' or 'declined'. Survey questions are presented in Appendix I.

### 3.1.7 Data analysis

Survey data was analysed using Genstat Version 8™ to produce state, certification agency or combined means with standard errors. Quantitative data are presented in tables whilst qualitative data are presented graphically in order to reveal the main trends in pasture establishment and management occurring on certified organic farms. An overall response rate of 74% (119 producers surveyed out of 161) was achieved on the survey.

## 3.2 Perennial pasture establishment experimental program

### 3.2.1 Producer groups

The project engaged two producer groups to participate in the design of the experimental program to investigate perennial pasture establishment in dryland organic farming systems. The two producer groups were the Riverina Organic Farmers' Organisation (ROFO) and the North East Ecological Farmers (NEEF). The project investigator met with NEEF (16 producers, 15/2/2005) and with ROFO (16 producers, 5/3/2005) to identify the major issues with perennial pasture establishment in organic systems. The research objective, 'To determine sustainable methods of perennial pasture establishment for organic and in-conversion farming systems' was presented to the groups and two questions were asked; firstly, 'What are the main issues with perennial pasture establishment in organic systems?'; and 'What would be the sowing strategies that you would employ for successful establishment?' Results from the group consultations are presented in Table 3.3.

**Table 3 Group consultation with NEEF and ROFO in February and March 2005**

| Producer groups | North East Ecological Farmers | Riverina Organic Farmers Organisation |
|---|---|---|
| **What are the main issues with perennial pasture establishment in organic systems?** | • Competition with annual species<br>• Soil disturbance<br>• Cultivation to reduce weeds<br>• Selection of appropriate species<br>• Soil fertility<br>• Cover cropping<br>• Mixtures<br>• Grazing management. | • Weeds – annuals<br>• Soil structure<br>• Perennials more attractive to pests<br>• Native pastures more resilient than introduced<br>• Grazing management, especially with native grasses. |
| **What sowing strategies would you use to establish perennial pasture?** | • Direct drill after drought<br>• Use a roller behind combine<br>• Sow out of season to beat weeds<br>• Broadcast and roll on to cultivated seed-bed<br>• Sow phalaris in spring and sub clover in autumn | • Under-sow with barley, oats or wheat<br>• So at low rates so that a mix of species can be achieved<br>• Inoculate and lime coat legume seed<br>• Broadcast seed on to surface |

Treatment options were developed from the producer consultation and confirmed with DPI pasture agronomists and biometricians. These included cultivation and direct drilling (two separate sites), three establishment methods (row sown, broadcast, under-sown), two sowing rates (conventional and organic) and three pasture mixes.

### 3.2.2 Experimental sites

Two sites were selected, firstly Rutherglen (36° 06' 45.67" S; 146° 31' 20.17" E; elevation 177 m) for the cultivated seed-bed experiment and Yarrawonga (36° 02' 49.16" S; 145° 57' 07.17" E; elevation 134 m) for the direct drilling experiment. Seed-bank data were collected from both sites to investigate the level of competition from other species in the establishment phase. Thirty-two soil cores (50 mm diameter) were randomly sampled from each site and the seed-bank was allowed to germinate three times (May 2005, October 2006 and January 2007) and plant species recorded.

### 3.2.3 Perennial species selection

Experiments were sown in 2005 (first establishment year) and in 2006 (second establishment year) at both sites. Three mixes of exotic pasture species were devised including a standard mix of phalaris (*Phalaris aquatica* L. cv. Sirosa (Rutherglen) or Holdfast (Yarrawonga)) and subterranean clover (*Trifolium subterranean* L. cvs. Goulburn and Riverina (Rutherglen) or Riverina and Seaton Park (Yarrawonga)), an all year feed mix of fescue (*Festuca arundinaceae* schreb. cv. Flecha Max P) and lucerne (*Medicago sativa* L. cv. Genesis), and a novel mix of lucerne (*Medicago sativa* L. cv. Genesis) and plantain (*Plantago lanceolata* L. cv. Ceres Tonic). Sowing methods included row sown, broadcast on to the surface or under-sown with oats (*Avena sativa* L. cv. Echidna) and sowing rate included the standard conventional sowing rate and an organic rate which was typically double the conventional rate. The sowing rate of oats in the under-sown treatment was determined by current recommendations of reducing the standard cereal sowing rate for the crop (usually by half) (Hirth 1987). All treatments were sown with 20 kg/P/ha (172 kg/ha of Guano Gold Kwik Start™ 11.6% P ) each year and rolled to maximise seed soil contact. Plots were 10 m long and 1.4 m wide with 8 rows (if row sown), replicated four times. Sowing rates for the species are shown in Table 3.4.

**Table 4 Sowing rates (kg/ha) for the pasture species sown at Rutherglen and Yarrawonga sites**

| Species | Cultivar and site | Conventional rate | Organic rate |
|---|---|---|---|
| Phalaris | Sirosa (Rutherglen) | 3 | 6 |
| | Holdfast (Yarrawonga) | 3 | 6 |
| Subterranean clover | Goulburn (Rutherglen) | 4 | 8 |
| | Riverina (Rutherglen and Yarrawonga) | 4 | 8 |
| | Seaton Park (Yarrawonga) | 4 | 8 |
| Lucerne | Genesis | 7 | 14 |
| Plantain | Ceres Tonic | 3 | 6 |
| Fescue | Flecha Max P | 10 | 20 |
| Oats | Echidna | 30 | 30 |

### 3.2.4 Measurements

Measurements included emergence counts completed six weeks after sowing. This was accomplished by counting 5 quadrats (992 $cm^2$) per plot and recording sown and weed species. Dry matter (DM) yield of sown species was assessed by using a scoring and calibration methodology where two people scored each plot three times for DM yield based on a 1-5 scale, recorded the percentage of sown species in each score, then sampled 15 calibration cuts per site. These data were then used in a spreadsheet to calculate the DM yield of the sown species in each plot. This methodology is also used to measure pasture plots in the CRC for Dryland Salinity projects. Persistence was measured using the same methodology as emergence. Oat yield was assessed when plots were harvested using an experimental plot header.

## 3.3 Tarrawingee native grass experiment

This experiment, 'Managing perenniality in permanent pastures to improve catchment hydrology', funded jointly by the Department of Primary Industries (DPI), the Department of Sustainability and Environment (DSE) and Charles Sturt University (CSU) through the Co-operative Research Centre for Plant-Based Management of Dryland Salinity (CRC), investigated different grazing strategies on the production and persistence of native grasses. This research site was located on an organic producer's property (not certified) and was incorporated into the project work to provide additional information for organic producers. This chapter reports on field results from these three experimental sites.

The CRC site was established at Tarrawingee (36° 23' 22.93" S; 146° 27' 18.27" E, elevation 166 m) in September 2003. The site consisted of a native pasture consisting of red grass (*Bothriochloa macra*). The density of red grass was 6.5 plants/$m^2$, with weed invasion comprising mostly sweet vernal grass (*Anthoxanthum odoratum* L.). The treatments imposed were: 1. Continuous grazing at the 'local' average stocking rate of 5 DSE/ha (Dry Sheep Equivalent) to demonstrate the potential detrimental effect of set stocking on native grass management; 2. No grazing; 3. Hard grazing in spring (September to November) at 23 DSE/ha to reduce annual species seed set, reverting to 5 DSE/ha; 4. High spring utilisation at 23 DSE/ha, with sheep exclusion over summer-autumn to promote perennial seed set and recruitment; 5. Continuous grazing at 5 DSE/ha with sheep exclusion over summer-autumn to promote perennial seed set and recruitment. Botanical composition was assessed every 6 weeks and results for the native grass species and the annual weed composition are presented in the results chapter.

## 3.4 Producer study tour and workshop

### 3.4.1 Introduction

Communication of successful perennial pasture establishment and management systems was the third strategy used to achieve the research objective. Consultation with producer groups and individuals resulted in the organisation of a one-day study tour and workshop to highlight and communicate perennial pasture systems to producers (Figure 3.2). This was held on 16 March 2006 and was titled: 'Promoting Perennial Pastures – for long term farming system sustainability'.

**Figure 3.2: Promoting perennial pastures workshop and study tour**

### 3.4.2 Methods

A combined one-day study tour and workshop was organized and conducted from the central location of DPI Rutherglen on 16 March 2006. Advertising for the workshop was conducted through organic and conventional producer networks and through the local and regional media. The program involved contributions from both producer and DPI speakers in a workshop format, then travel to three field sites during the afternoon. The presenters included the Project leader and Meredith Mitchell for DPI, Rutherglen. A producer contribution from the North East Ecological Farmers was provided by Terry and Jerry Browning who spoke about perennial pasture establishment and management on their

property at Yarrawonga. The STIPA Native Grass Association provided two speakers including George Taylor and Sue Rahilly, both of whom farm at Welllington, NSW. George Taylor spoke about his native perennial grass grazing management program and Sue Rahilly spoke about the novel concept of 'pasture cropping' where annual cereal crops are grown in existing native grass (C4) pastures. After lunch, participants were transported to three field sites including the 'Naturally Victorian Organic Prime Lamb Project' perennial pastures and the experimental establishment site at DPI Rutherglen and lastly, to the native grass grazing management site at Tarrawingee. Participants completed an evaluation at the conclusion of the day. The program is provided in Table 3.5.

**Table 5 Promoting Perennial Pastures – for long term farming system sustainability – program of presentations**

| Time | Topic | Presenter |
|---|---|---|
| 9:15 | Welcome, introduction and overview | Viv Burnett, DPI, Project leader |
| 9:30 | Principles of grazing management in perennial systems | Gary McLarty, DPI, Catchment and Agriculture Services |
| 10:00 | Greening the Brownings | Terry and Jerry Browning, Yarrawonga |
| 10:30 | Morning Tea | |
| 11:00 | Grazing management for native grasses | George Taylor, STIPA Native Grass Association |
| 11:30 | Pasture Cropping | Sue Rahilly, STIPA Native Grass Association |
| 12:00 | Lunch | |
| 12:45 | Organic perennial pastures | Viv Burnett |
| 1:30 | Bus to Tarrawingee | |
| 2:15 | Native grass grazing management | Meredith Mitchell, DPI, Rutherglen |
| 3:15 | Evaluation and afternoon tea | Viv Burnett |
| 3:45 | Bus to DPI, Rutherglen | |

## 3.5 Influence of late-germinating weed species on perennial pastures – PhD experiments

### 3.5.1 Introduction

The PhD study aimed to investigate the biology and ecology of the weed species, *Polygonum aviculare* L. (wireweed), in dry-land pasture systems in south-east Australia in order to develop non-chemical management strategies suitable for organic farming systems. Wireweed is a late-germinating weed species and has the potential to seriously affect the establishment of many perennial pasture species. This species was observed by the project leader to have increased under organic management at Rutherglen and is currently listed in the top twenty weeds of dryland cropping systems. The PhD study is investigating how wireweed competes with establishing lucerne and wheat, and how different fertility regimes may affect its ability to compete.

The thesis plan so far is organised into eight chapters consisting of an introduction (Chapter 1), a literature review (Chapter 2), field observations including preliminary observations in an established phalaris pasture, a 'decline over time' study and a survey of organic perennial pastures (Chapter 3), density experiments (Chapter 4), fertility experiments (Chapter 5), timing experiment (Chapter 6), management options (Chapter 7) and a conclusion (Chapter 8). Three experiments are reported in this final report, one from each of Chapters 3, 4 and 5.

### 3.5.2 Wireweed survival study

A wireweed survival study was established in 2004 to trace the survival of marked plants in an un-grazed situation in an established phalaris pasture. Five pasture cages were placed in the phalaris pasture with 20 marked wireweed plants in each cage, giving a total of 100 plants. The area of the pasture cage was 0.77 $m^2$. Six observations were made between August, November, December in 2004, and January, February and May in 2005.

### 3.5.3 Effect of fertility regimes on wireweed germination

There is limited information about how wireweed responds to different soil fertility regimes only that it can grow in a wide pH range (King 1966). Dorado *et al*. (1998) found that wireweed took up more nutrients than other weed species in a conventional tillage situation compared with a no tillage system. It has also been observed that over 10 years on the certified organic site at DPI Rutherglen, wireweed has become the most populous weed after annual ryegrass in cropping situations. It is not known whether this is a result of soil fertility factors, cultivation practices, the species' ability to take advantage of favourable seasons (late spring or summer rainfall) and develop a large seed bank, or less competition from other species, or a combination of these factors. In order to answer the question about wireweed's response to fertility, a germination experiment where different rates of N and P (in forms that would have been used in an organic farming situation) was conducted.

A germination experiment was established using potting media treated with P, N or a combination of both. The experiment was a factorial design with two treatments, N and P, each at five rates in factorial combination and 4 replicates. Phosphorus was applied in the form of Guano™ at the rates of 0, 5, 10, 20 or 50 kg P/ha equivalent. N was applied in the form of Dynamic Lifter™ at the rates of 0, 10, 20, 50 or 100 kg N/ha equivalent. The rates of P and N were chosen to represent the two extremes of the likely response curve (0 and 50 for P and 0 and 100 for N) plus rates in between that could represent the range of P input levels in current farming systems. It is recognized that the analysis of Dynamic Lifter™ includes some P (1.9% soluble) which may have confounded the results although Guano™ has three times the amount (5.8%) of soluble P. The fertiliser was ground using a mortar and pestle and mixed with the potting media before placing in petri dishes. Ten seeds that had been refrigerated for 5 months were sown into each petri dish and then placed in an incubator at 23°C for 18 hours light and 18°C for 6 hours dark. Germination was observed after 4, 7 and 11 days. Germination was recorded when the emergence of the radicle was observed.

### 3.5.4 Competition effects between lucerne and wireweed in glasshouse studies.

Glasshouse pot experiments were conducted from October 2005 until February 2006 to investigate competition effects between wireweed and lucerne (Figure 3.3). The experimental design was a modified additive design where a specific density of the productive species (lucerne) was chosen and increasing densities of the target weed species were added. This design has some limitations, the major one being that the overall density of the two species changes which can make interpretation of results difficult. The design was chosen in order to answer the basic question of the effect of the wireweed on the lucerne. There were four levels of wireweed density (D0, D1, D3, D6 plants per pot), four levels of lucerne density (0, 1, 2, 3 plants per pot), four replicates and three times of harvest (vegetative, first branching, and maturity).

**Figure 3.3: Experimental pots containing wireweed, lucerne and wheat**

Pots (20 cm diameter) were filled with 5 litres of a commercial seed raising mix consisting of fine sand and organic matter. Each pot was administered with a slow release complete fertiliser of Osmocote™, mixed through the profile. The pots were then wetted and planted with emerged seedlings of wireweed and lucerne. Pots were randomly placed on tables in the glasshouse and rotated on a weekly basis. Average daily temperatures were recorded with an average minimum temperature of 14.8°C and an average maximum temperature of 38.3°C during the experiment. The wireweed-lucerne experiment was harvested 36 days, 64 days and 99 days after sowing. Dry weight in grams was recorded for wireweed and lucerne.

Data was analysed using Genstat Version 8™ analysis of variance producing mean values for treatments and the Least Significant Difference (l.s.d.).

# 4. Results

## 4.1 Perennial pasture producer survey

### 4.1.1 Summary

A survey was conducted in 2005-2006 to assess the status of perennial pastures on organic farms and to understand the barriers to establishment. The survey had four aims: To determine the amount and status of perennial pastures (exotic and native) on certified organic dryland farms in Victoria, New South Wales and South Australia; To understand the barriers to perennial pasture establishment and/or improvement on organic farms; To understand current, and discover new methods, of perennial pasture establishment that may have wider applicability in organic systems; and, To understand current perennial pasture management on organic farms.

An average of 74%, 72% and 52% of the surveyed property was under pasture in 2005 in NSW, Victoria and South Australia respectively. The remaining portion of the properties was either cropped or bushland/creek frontage which were not used for agricultural purposes. Of the area under pasture, NSW respondents indicated that an average of 73% consisted of perennial pasture whilst in Victoria, perennial pasture was estimated at 43% and in SA, at 48%. Lucerne (*Medicago sativa* L.) and phalaris (*Phalaris aquatica* L.) were the most common perennial species on organic farms. The most common reason for not establishing perennial pasture was the availability of sufficient moisture for sowing and germination, closely followed by the management of weeds, the cost of establishment and having the time to do the work required. The two most common reasons for not establishing a perennial pasture, moisture and weeds, are closely related because it is the competition for moisture between plants that will result in a successful or a failed establishment. The key to successful establishment will be the management of competition between plants with the available moisture.

The majority of perennial pastures were established using a cultivated seed-bed, after conducting a soil test to determine nutrient status. Seed was broadcast on to the cultivated surface and fertiliser used at sowing. The type of fertiliser used was not specifically asked in the questionnaire but many producers stated a variety of currently allowed inputs ranging from reactive phosphate rock to compost products. After sowing, no further weed management was conducted. Many variations on this recipe were recorded but there were no exceptionally different establishment techniques. It is likely that successful establishment within an organic context will rely on sound seed-bed preparation, agronomy, monitoring and management for persistence. A majority of producers indicated that they managed native grasses the same way that introduced perennial species were managed and that they had a sound understanding of grazing management practice and the need for rest periods with perennial pastures.

There is a need to provide extension material on weed management methods available to prepare for a successful perennial pasture establishment and information on the identification and management of native grass species so that these can be fully utilised, thereby reducing the necessity for costly pasture establishment programs. An example of the weed management methods that are suitable for use in an organic farming system may include:

- strategic cutting/topping to reduce seed set
- providing effective competition with other plant species to reduce the impact of specific weeds
- strategic grazing management
- timely targeted cultivation to kill weeds when they are most vulnerable
- autumn cultivation to encourage weed germination prior to crop or pasture establishment
- new technologies for collection of weed seeds at crop harvest.

## 4.1.2 Farm size, organic certification history and demography

### 4.1.2.1 Farm size

The average size of a certified organic property in New South Wales (NSW) and South Australia (SA) was 596 and 515 ha respectively. This contrasted with the smaller average property size in Victoria (VIC) of 229 ha (Table 4.1).

**Table 6 Mean farm size (ha) of survey respondents**

| State | No. of observations | Mean (ha) | s.e. |
|---|---|---|---|
| **NSW** | 42 | 596.1 | ± 128.6 |
| **SA** | 23 | 515.2 | ± 135.0 |
| **VIC** | 46 | 229.3 | ± 45.0 |

### 4.1.2.2 Organic certification history

Producers had been farming organically longest in Victoria with an average of at least 18 years farming experience, followed by SA producers with 16 years and NSW producers farming organically for an average of almost 14 years (Table 4.2a). An average of 1.13 years was taken to achieve the first level of organic certification (in conversion). The time taken to achieve full organic certification was lowest in NSW with an average of 2.2 years, 2.3 years in SA and almost three years (2.9) in Victoria. Properties had been fully certified organic longest in Victoria at an average of almost nine years (8.9), followed by NSW at 8.1 years and SA at 6.5 years (Tables 4.2b to 4.2d).

**Table 7 Organic farming and certification history of survey participants**

***4.2a. How many years have you been farming organically?***

| State | No. of observations | Mean (years) | s.e. |
|---|---|---|---|
| **NSW** | 42 | 13.7 | ± 1.4 |
| **SA** | 23 | 16.1 | ± 3.2 |
| **VIC** | 45 | 18.3 | ± 2.0 |

***4.2b. How long did it take to achieve conversion certification?***

| State | No. of observations | Mean (years) | s.e. |
|---|---|---|---|
| **NSW** | 40 | 1.10 | ± 0.15 |
| **SA** | 23 | 1.26 | ± 0.17 |
| **VIC** | 46 | 1.02 | ± 0.11 |

***4.2c. How long did it take to achieve full organic certification?***

| State | No. of observations | Mean (years) | s.e. |
|---|---|---|---|
| **NSW** | 38 | 2.24 | ± 0.21 |
| **SA** | 19 | 2.32 | ± 0.32 |
| **VIC** | 46 | 2.94 | ± 0.48 |

***4.2d. How many years has your farm been fully certified organic?***

| State | No. of observations | Mean (years) | s.e. |
|---|---|---|---|
| **NSW** | 39 | 8.10 | ± 0.92 |
| **SA** | 22 | 6.50 | ± 1.32 |
| **VIC** | 46 | 8.96 | ± 1.06 |

#### 4.1.2.3 Demography

The majority of the surveyed producers were in the 40-49 year age bracket (42 respondents), closely followed by the 50-59 years bracket (36 producers) (Figure 4.1).

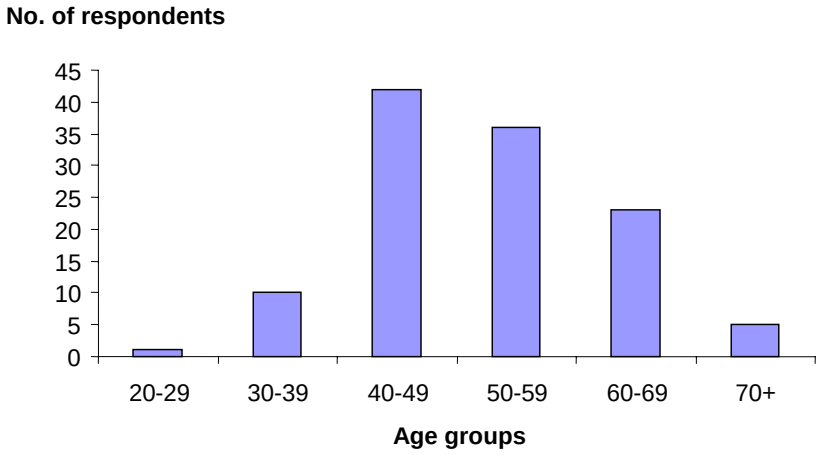


**Figure 4.1: Age groups of survey respondents**

### 4.1.3 Status of perennial pastures

#### 4.1.3.1 Area of farm under pasture

An average of 74%, 72% and 52% of the property was under pasture in 2005 in NSW, Victoria and South Australia respectively (Table 4.3).

**Table 8 Average area (ha) under pasture on certified organic farms in 2005**

| State | No. of observations | Mean (hectares) | s.e. |
|---|---|---|---|
| **NSW** | 42 | 442.2 (74%) | ± 118.0 |
| **SA** | 23 | 266.6 (52%) | ± 71.4 |
| **VIC** | 46 | 164.8 (72%) | ± 36.8 |

#### 4.1.3.2 Area under perennial pasture

Of this area under pasture, NSW respondents indicated that an average of 73% consisted of perennial pasture whilst in Victoria, perennial pasture was estimated at 43% and in SA, at 48% (Table 4.4).

**Table 9 Area of pasture under perennial pasture**

| State | No. of observations | Mean (hectares) | s.e. |
|---|---|---|---|
| **NSW** | 41 | 324.2 (73%) | ± 95.7 |
| **SA** | 23 | 128.3 (48%) | ± 53.1 |
| **VIC** | 45 | 70.3 (43%) | ± 17.7 |

### 4.1.3.3 Perennial species present

Producers were asked what pasture species were present on their farms and the species recorded were sorted into annual and perennial, with perennial species observations (all states) sorted from most to least frequently mentioned (Figure 4.2). Lucerne (*Medicago sativa* L.) and phalaris (*Phalaris aquatica* L.) were the species most frequently mentioned with 37 observations each. The next most frequent species included perennial ryegrass (*Lolium perenne* L.) (27), cocksfoot (*Dactylis glomerata* L.) (23), white clover (*Trifolium repens* L.) (18) and paspalum (*Paspalum dilatatum* L.) (17). A total of 19 observations were recorded for the category of native grasses. Some specific native grass species such as kangaroo grass (*Themeda triandra*) (10), wallaby grass (*Austrodanthonia spp*.) (5), weeping grass (*Microlaena spp*.) (3) and umbrella grass (*Chloris spp*.) were also mentioned (Figure 4.2).

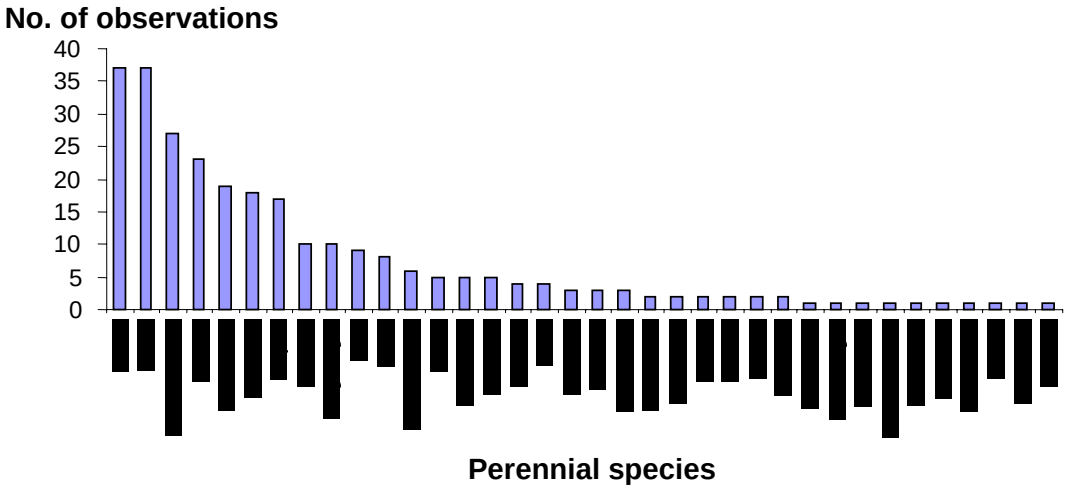


**Figure 4.2: Perennial species frequency – all states**

In Victoria, phalaris was the most frequently mentioned perennial species (17), followed by lucerne (13), cocksfoot (12), perennial ryegrass (11) and white clover (9) (Figure 4.3).

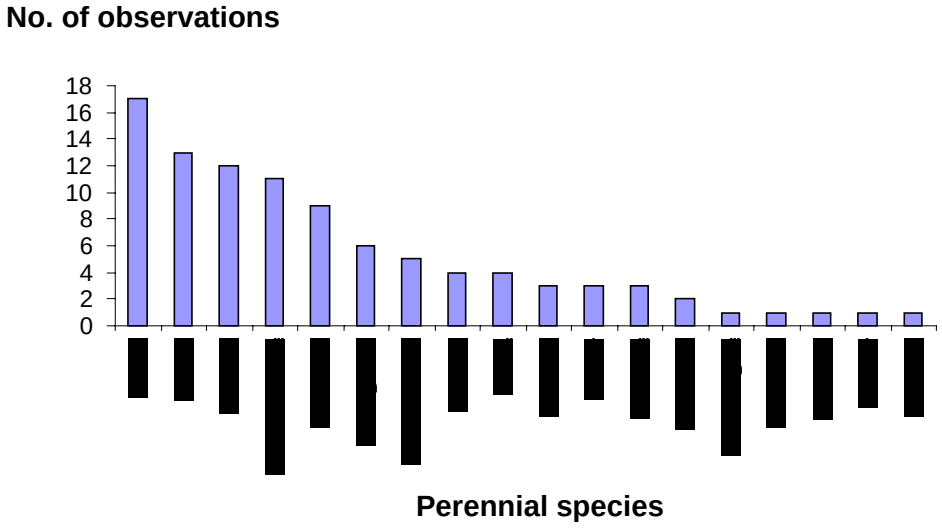


**Figure 4.3: Perennial species frequency in Victoria**

In NSW, phalaris was also the most frequently mentioned perennial species with 14 observations, followed by paspalum (13), lucerne and perennial ryegrass (11 each) and kikuyu (*Pennisetum clandestinum*) (9) (Figure 4.4). The paspalum and kikuyu observations were mostly associated with properties located on the northern coast of NSW.

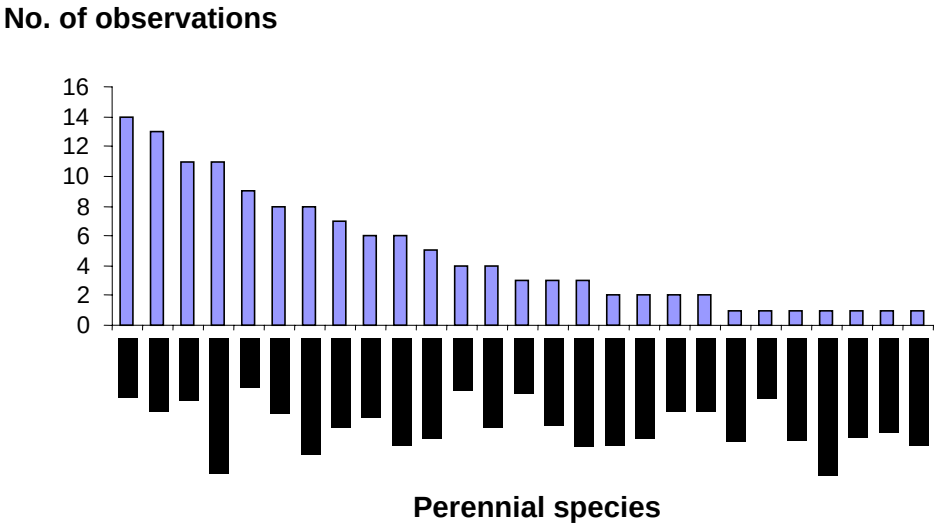


**Figure 4.4: Perennial species frequency in New South Wales**

In South Australia, lucerne had the highest number of observations (13), followed by native grasses (7) and phalaris (6) (Figure 4.5).

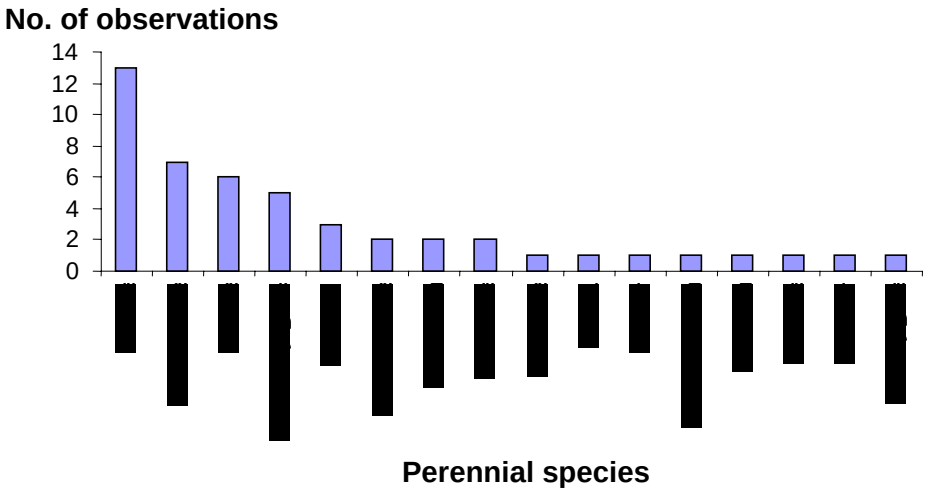


**Figure 4.5: Perennial species frequency in South Australia**

## 4.1.4 Pasture establishment

### 4.1.4.1 Perennial pasture establishment history

Fifty-five percent of survey respondents indicated that they had attempted to establish a perennial pasture since they had farmed organically. Perennial pasture establishment had occurred more frequently since 2003 than in the previous nine years (1994 - 2002) with very low levels of establishment activity during the mid to late 1990s (Figure 4.6).

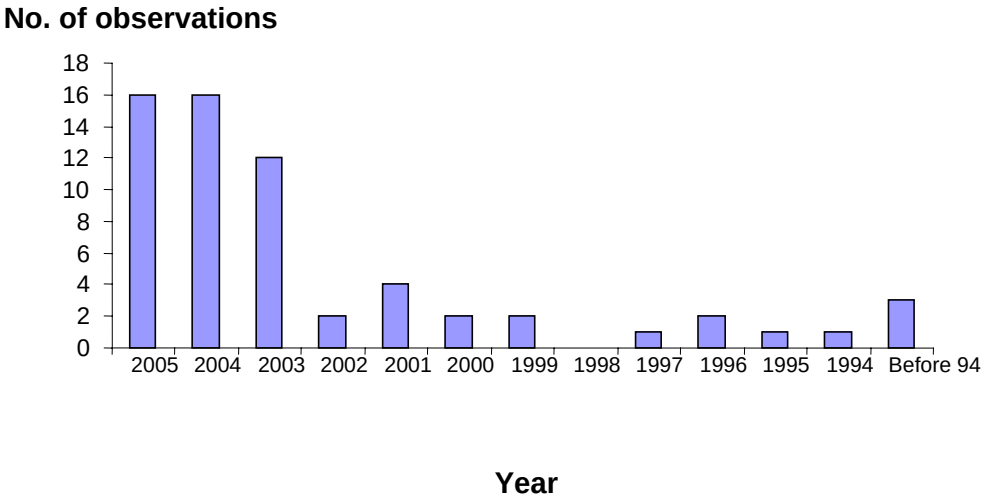


**Figure 4.6: Perennial pasture sowing history on organic farms**

## 4.1.4.2 Species sown and reasons for selection

Lucerne and perennial ryegrass were the most common perennial species sown with 33 and 19 observations respectively (Figure 4.7). Producers sowed lucerne primarily for stock feed over summer, because of its deep roots, for hay production and for its nitrogen benefits. Perennial ryegrass was sown because it was considered a proven performer in a range of environments, was good stock feed and was drought tolerant in the areas where it was sown. White clover was sown mostly because it was a proven performer in the specific area, fixed nitrogen and provided quality stock feed. Chicory was sown for a variety of reasons including internal parasite management, local adaptation, drought tolerance and agronomic advice.

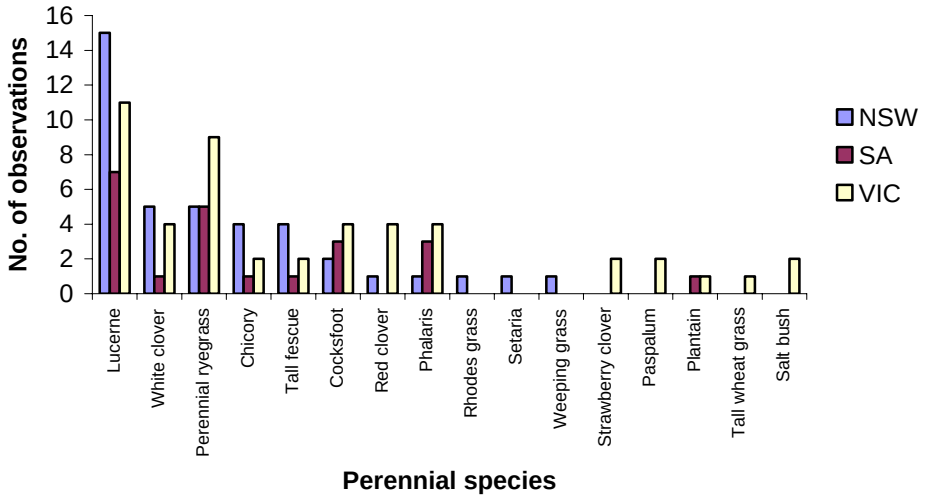


**Figure 4.7: Perennial species sown most recently by producers in all states**

#### 4.1.4.3 How was the perennial pasture sown?

Perennial pastures were established into cultivated seed-beds (75%) as opposed to being direct drilled (25%). Two-thirds of producers (66%) conducted a soil test prior to sowing pasture. More producers established perennial pasture by broad-casting seed on the cultivated surface (42%) than by sowing rows into a cultivated seed-bed (37%) or by under-sowing with a crop (21%). The majority of producers used fertiliser when they established perennial pasture (58%) and inoculated legume seed prior to sowing (64%). Cultivation was the most widely used method (49%) to manage weeds prior to establishment with heavy grazing being used by 18% of producers. Other methods to manage weeds included cropping in previous years (8%), increasing the sowing rate (7%), and using crop to provide extra competition in the establishment year (3%) and long, cultivated fallow (3%). Methods such as cutting hay or green manuring were only used by a small proportion of producers (1%). Most producers (58%) undertook no further weed management after the pasture was sown; however, some (18%) used light grazing pressure to manage weeds in the establishment year. Other methods to manage weed species post sowing included slashing or mulching (5%), topping (5%), cutting hay (5%), hand weeding (3%), further cultivation (3%), or top-dressing with fertiliser (2%).

### 4.1.5 Reasons for not establishing perennial pastures

The most common reason for not establishing perennial pasture was the availability of sufficient moisture for sowing and germination (19%). This was closely followed by the management of weeds (18%), the cost of establishment (15%) and having the time to do the work required (11%). Other minor reasons included having an establishment failure in the past (6%), appropriate machinery (7%), and the correct soil conditions (6%) (Figure 4.8). Individual state data are presented in Figures 4.9, 4.10 and 4.11.

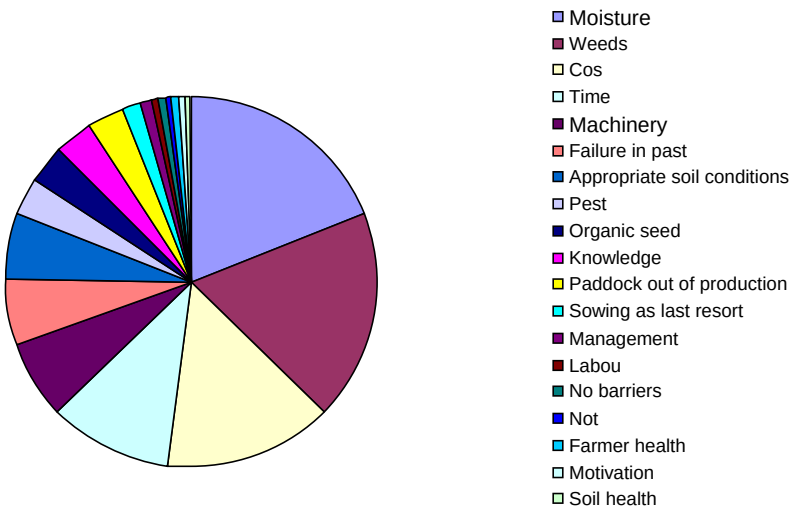


**Figure 4.8: Reasons for not sowing perennial pasture – all states**

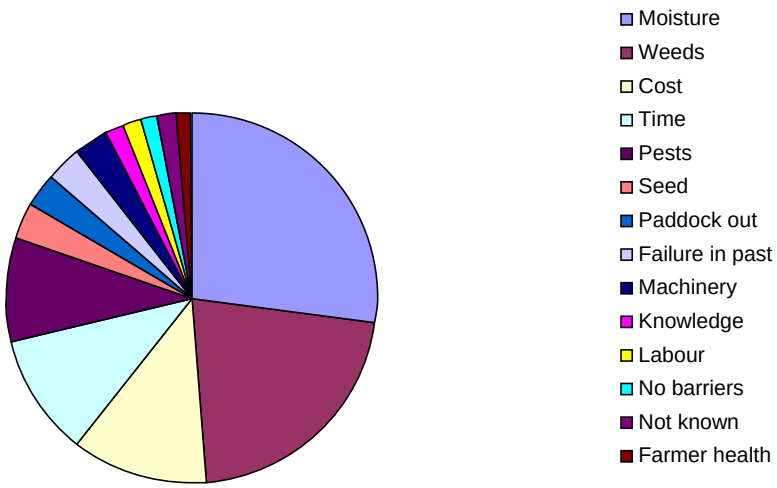


**Figure 4.9: Reasons for not sowing perennial pasture in Victoria**

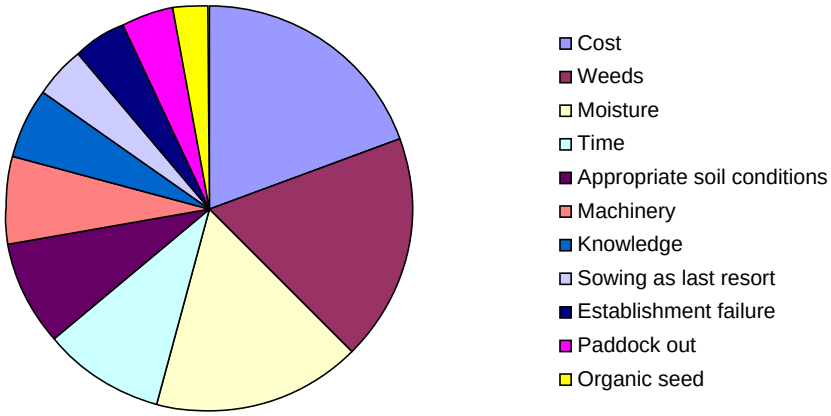


**Figure 4.10: Reasons for not sowing perennial pasture in New South Wales**

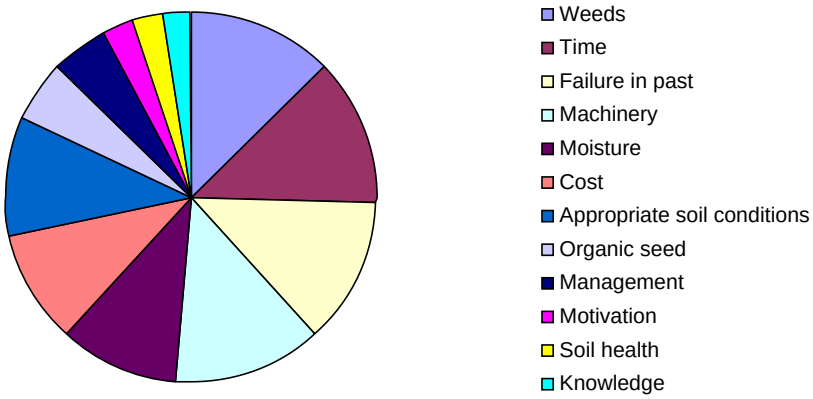


**Figure 4.11: Reasons for not sowing perennial pasture in South Australia**

## 4.1.6 Native grasses

### 4.1.6.1 Native grass species identification

Ninety-five percent of producers indicated that they were aware that native grasses existed on most farms and the majority (89%) also indicated that they had observed native grasses on their own farms. Identification of native grasses was not clear with a third of producers (31%) not knowing the names of the native species present on their farms. A quarter (24%) of the producers surveyed indicated that they had observed kangaroo grass on their properties, whilst 19% had observed wallaby grass and 8% observing weeping grass (Figure 4.12).

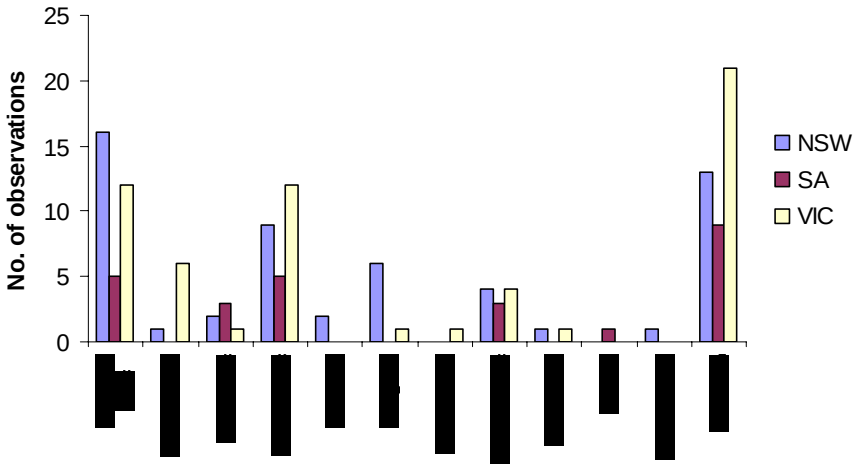


**Figure 4.12: Native grass species identified by producers on their farms**

### 4.1.6.2 Native grass management

A majority of producers (58%) indicated that they managed native grasses the same way that introduced species were managed (Figure 4.13). The most frequent responses about the management of native grasses was that there was either no grazing of them (13%) or that they were rotationally grazed (13%). Other popular management strategies included leaving native grasses to set seed (10%), light grazing (8%) and no-overgrazing (8%). Other lesser used management methods are shown in Figure 4.14.

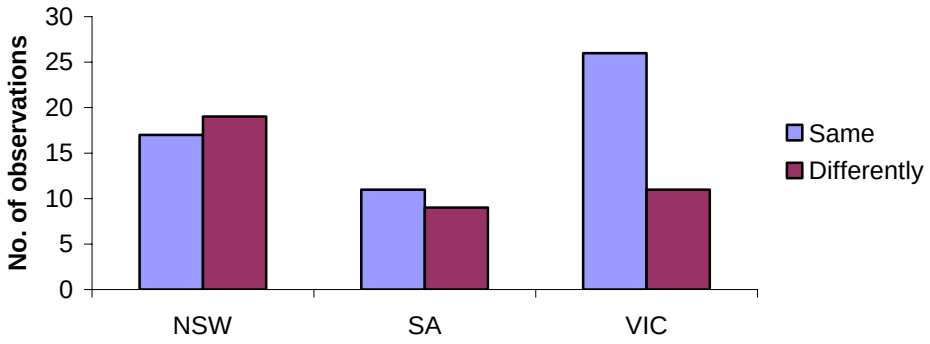


**Figure 4.13: Native grass management on certified organic farms**

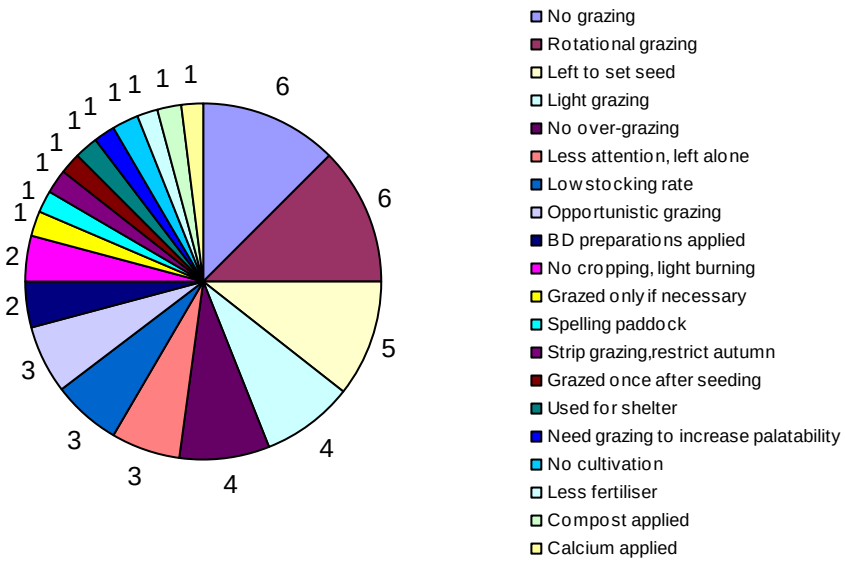


**Figure 4.14: Methods of native grass management on certified organic farms**

## 4.1.7 General perennial pasture management

Organic producers (60%) locked up perennial pastures to allow them to set seed whilst 59% of producers indicated that perennial pastures would also be locked up for hay cutting purposes. Other reasons to lock up perennial pastures included resting the paddock (7%), cleaning the paddock for worm management (6%), weed management (6%), seed harvest (2%) or because of drought (2%).

Producers were asked about their decision to move livestock out of a paddock so that an understanding of grazing management methods could be gained. There were five choices including leaf or growth stage of the pasture, pasture height, time on the pasture, the paddock is out of feed or the livestock are ready to be sold. Producers had to rank each choice with one of five alternative levels of importance, one meaning nil importance to five meaning very important. Producers indicated that both pasture growth stage and pasture height were very important in their decision to move livestock out of a paddock with a majority of respondents indicating either four or five for these categories (Figure 4.15a and 4.15b). This result contrasted clearly with two other categories, paddock has run out of feed and the stock are ready to be sold, where producers clearly indicated that these were not as important (Figure 4.15d and 4.15e). Time on the pasture was less clear with an uneven range of observations (Figure 4.15c).

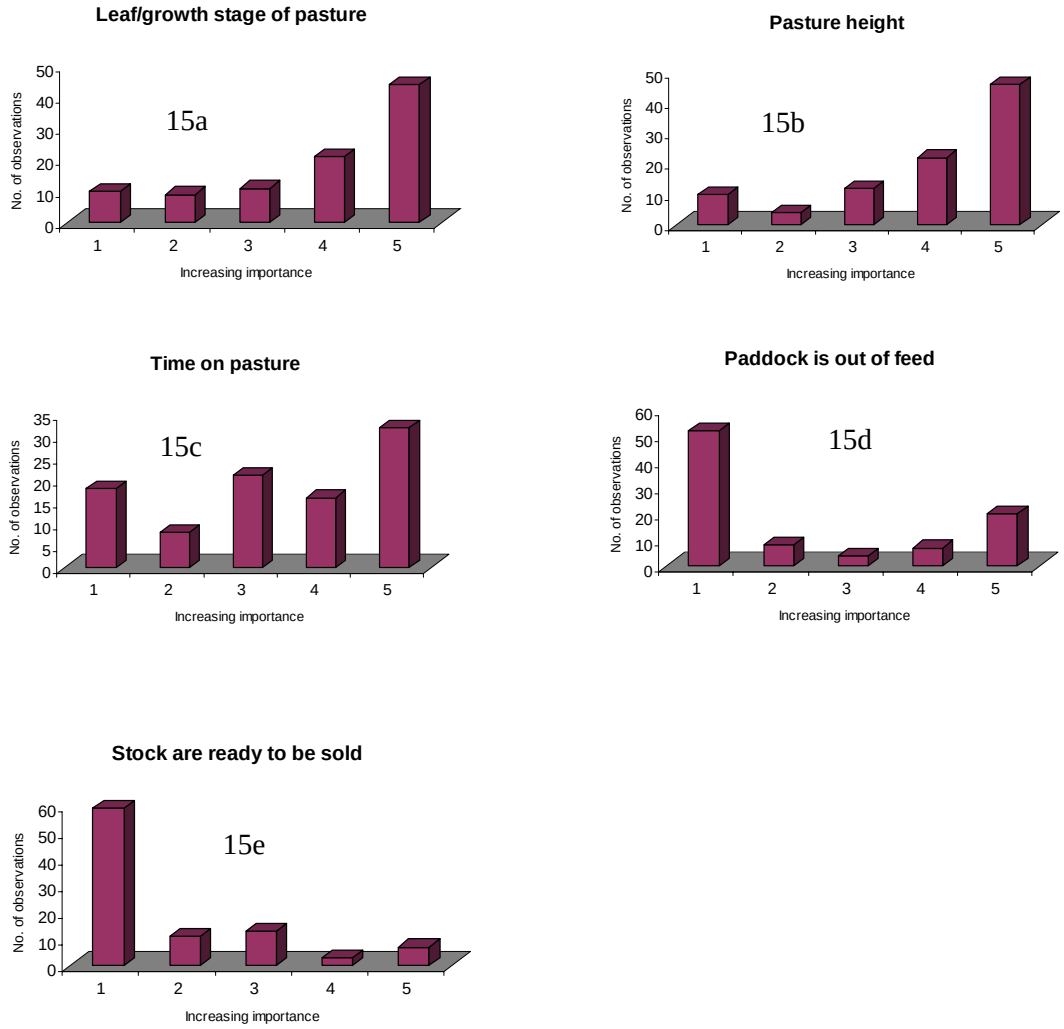


**Figure 4.15: Decision to move livestock out of a paddock based on 1(no importance) to 5 (very important)**

## 4.2 Perennial pasture establishment experiments

### 4.2.1 Summary

Perennial pasture establishment and management were investigated at three sites from 2003 until 2007, in consultation with producer groups. The Rutherglen and Yarrawonga sites investigated three perennial pasture mixes, three seeding types, two seeding rates and either, cultivated seedbed or direct drilling. The Tarrawingee site investigated the effect of strategic grazing management to increase the density and production of native grass species.

The two experimental years were characterised by challenging seasons which included late break rainfall or insufficient rainfall and results need to be understood in that context.

- Perennial establishment was successful at Rutherglen where the seedbed was cultivated, but not at Yarrawonga, where species were direct drilled and there was almost no rainfall in 2006 during establishment.
- Where moisture was available (2005) sowing the perennials in rows resulted in better emergence, DM yield and persistence (sufficient plant density in the years after sowing).
- Where moisture was limiting (2006, especially at Yarrawonga) under-sowing resulted in reduced perennial establishment, dry matter yield and persistence.
- Increased seeding rates resulted in more DM yield in the first year but did not affect long term persistence.
- Continuous grazing with a summer/autumn exclusion period proved to be the best treatment to ensure native perennial grass production and persistence.

These results demonstrate that the least risky option for perennial pasture establishment is full seedbed preparation. This option will be more expensive than direct drilling but it will provide control against competition from weeds which is critical in the establishment phase. After establishment, only light grazing is recommended to ensure sufficient root growth for longer term persistence.

### 4.2.2 Soil analyses and rainfall

Soil analysis results (0-10 cm) for both years and sites are shown in Table 4.5. For perennial pasture establishment purposes, the pH of both sites in 2006 was satisfactory, being 6.0 or above in $CaCl_2$. However in 2005, pH was weakly acidic at both Rutherglen (5.7) and more so at Yarrawonga (5.3). Optimal pH for most exotic perennial species is 5.5 or above in $CaCl_2$ with lucerne being particularly sensitive to low pH. The pH recorded in 2005 at Yarrawonga may have affected lucerne establishment.

Available P levels were low at both sites in both years, especially at Yarrawonga in 2006 (4 ppm, Olsen P). All plots were sown with 20 kg P/ha which should have provided sufficient P for germination and initial establishment.

Rainfall differed markedly between 2005 and 2006 at both establishment sites. Rainfall at Rutherglen in 2005 was 741.9 mm (Table 4.6) which was 147 mm above the long term average of 595 mm. In contrast, in 2006, rainfall recorded was 244.6 mm which was 350 mm below average, although it was close to average in the critical winter months for establishment (but not for longer-term survival). At Yarrawonga, rainfall recorded in 2005 was 469.6 mm which was about 20 mm above average, and in 2006, only 97.8 mm was recorded, 352 mm below average (Table 4.6). Sowing was delayed until June in both years at Rutherglen and in 2005 at Yarrawonga because of low rainfall which may have affected establishment. Sowing was delayed even further until July in 2006 at Yarrawonga due to insufficient rainfall, but even then rainfall was only 20 mm, and winter rainfall totalled just 24 mm (with no follow up rain for 5 months).

**Table 10 Soil analysis results (0-10 cm) for 2005 and 2006 at Rutherglen and Yarrawonga**

| | 2005 | | 2006 | |
|---|---|---|---|---|
| **Measure** | **Rutherglen** | **Yarrawonga** | **Rutherglen** | **Yarrawonga** |
| pH ($H_2O$) | 6.2 | 5.9 | 6.5 | 6.6 |
| pH ($CaCl_2$) | 5.7 | 5.3 | 6.0 | 6.1 |
| Extractable P (mg/kg) | 12.4 | 9.9 | 11.8 | 4.0 |
| Mineral N (ppm) | 26.1 | 15.7 | 20.2 | 4.0 |
| Exchangeable K (ppm) | 343.2 | 382.2 | 308.1 | 432.9 |
| Exchangeable S (ppm) | 1.3 | 1.5 | 1.5 | 1.5 |
| Exchangeable Ca (ppm) | 1106 | 618 | 1106 | 1030 |
| Exchangeable Mg (ppm) | 147.6 | 237.6 | 148.8 | 447.6 |
| Organic matter (%) | 3.0 | 3.0 | 3.5 | 2.6 |

**Table 11 Monthly rainfall totals (mm) for Rutherglen and Yarrawonga during 2005, 2006 and 2007**

| | Rutherglen | | | Yarrawonga | | |
|---|---|---|---|---|---|---|
| **Long term average** | **595** | | | **450** | | |
| **Month** | **2005** | **2006** | **2007** | **2005** | **2006** | **2007** |
| January | 47.2 | 15.4 | 14.8 | 68 | 14 | 9.8 |
| February | 146.3 | 8.5 | 22.8 | 0 | 5.4 | 40.2 |
| March | 11.8 | 17.2 | 31.8 | 7 | 15.4 | 33.8 |
| April | 5.3 | 30.6 | 24.6 | 8.4 | 18 | 25.6 |
| May | 6.4 | 14.7 | 84.1 | 6.8 | 21 | 40.4 |
| June | 93.4 | 35.6 | 30.3 | 68 | 0 | 16.8 |
| July | 57.7 | 40.7 | 81.3 | 37 | 20 | 59 |
| August | 84.1 | 19.1 | 11.8 | 56.4 | 4 | 5.8 |
| September | 57.9 | 26.7 | 11.4 | 63.8 | 0 | 5.2 |
| October | 97.2 | 1.3 | 19.3 | 81.6 | 0 | 5.8 |
| November | 85.2 | 34.8 | 44.2 | 50 | 0 | 41.2 |
| December | 49.4 | 0 | 54.2 | 22.6 | 0 | 56.6 |
| **Total** | **741.9** | **244.6** | **430.6** | **469.6** | **97.8** | **571.6** |

### 4.2.3 Seed-bank results

There were very high levels of germinable seeds at Rutherglen for silver grass, toad-rush and loosestrife (Table 4.7). At Yarrawonga, silver grass, stonecrop and wallaby grass were the major species at the first germination (Table 4.8). There was more diversity in species at Yarrawonga (16 species) compared with Rutherglen (9 species). As the Rutherglen site was cultivated, perennial species were sown into a clean seed-bed providing maximum opportunity for the perennial species to establish and this is reflected in the results. At Yarrawonga, perennial species had to contend with an established stand of wallaby grass, with many onion grass plants and germinating silver grass plants. This increased competition was reflected in the reduced number of perennials that germinated at Yarrawonga. Whilst only part of the seed-bank would have germinated when the perennial species were sown, the numbers are significant and may have reduced potential perennial establishment at both sites.

**Table 12 Seed-bank results (emerged plants/m$^2$) for Rutherglen site assessed in May 2005, October 2006 and January 2007**

| Common name | Scientific name | Plants/m$^2$ | | |
|---|---|---|---|---|
| | | 18/5/2005 | 19/10/2006 | 30/1/2007 |
| Sub clover | *Trifolium subterraneaum* | 0 | 16 | 350 |
| Fumitory | *Fumaria parviflora Lam.* | 0 | 16 | 0 |
| Loose strife | *Lythrum hyssopifolia L.* | 717 | 0 | 1, 258 |
| Silver grass | *Vulpia bromoides (L.) S.F. Gray* | 10, 621 | 0 | 1, 019 |
| Pigeon Grass | *Setaria verticillata (L.) P.Beauv.* | 0 | 0 | 64 |
| Toad-rush | *Juncus bufonius L.* | 0 | 1, 322 | 0 |
| Erect Chick-weed | *Stellaria media (L.) Vill.* | 80 | 0 | 159 |
| Great Brome | *Bromus diandrus Roth* | 0 | 0 | 191 |
| Brome | *Bromus mollis L.* | 0 | 0 | 207 |

**Table 13 Seed-bank results (emerged plants/m$^2$) for Yarrawonga site assessed in May 2005, October 2006 and January 2007**

| Common name | Scientific name | Plants/m$^2$ | | |
|---|---|---|---|---|
| | | 18/5/2005 | 19/10/2006 | 30/1/2007 |
| Cluster clover | *Trifolium glomeratum L.* | 159 | 16 | 143 |
| Windmill grass | *Chloris spp.* | 0 | 16 | 589 |
| Wallaby grass | *Danthonia spp.* | 239 | 191 | 0 |
| Erodium | *Erodium botrys (Cav.) Bertol.* | 0 | 0 | 96 |
| Eragrostis | *Erogrostis cilianensis (All.) Vignolo ex Janchen* | 48 | 0 | 0 |
| Erogrostis elongatum | *Erogrostis elongatum* | 64 | 0 | 0 |
| Fumitory | *Fumaria parviflora Lam.* | 0 | 0 | 64 |
| Heliotrope | *Heliotropium europaeum L.* | 0 | 16 | 80 |
| Onion grass | *Romulea rosea (L.) Eckl. Var. australis (Ewart) de Vos* | 191 | 0 | 0 |
| Silver grass | *Vulpia bromoides (L.) S.F. Gray* | 2548 | 0 | 80 |
| Saffron Thistle | *Carthamus lanatus L.* | 0 | 16 | 0 |
| Stonecrop | *Crassula sieberana (Schult.)* | 2500 | 32 | 0 |
| Toad-rush | *Juncus bufonius L.* | 0 | 796 | 0 |
| Erect chick weed | *Stellaria media (L.) Vill.* | 111 | 0 | 0 |
| Hogweed | *Polygonum aviculare L.* | 96 | 16 | 0 |
| Great Brome | *Bromus diandrus Roth* | 48 | 0 | 0 |

## 4.2.4 Emergence and persistence at Rutherglen

### 4.2.4.1 Species Mix 1 – Phalaris and Subterranean Clover

Phalaris emerged well at the Rutherglen site in both years, with only minor differences between row planting, broadcasting and under-sowing. However, under-sowing resulted in poor persistence in both years, especially in the drier year of 2006. Increased sowing rate increased establishment but the resultant populations were similar one year later (Table 4.9). The results stress the importance of managing competition, whether it comes from pasture, or from a cover crop which cannot be recommended at the sowing rate used.

### 4.2.4.2 Effect of weed competition in species mix 1

Weed emergence in 2005 consisted of 8 plants/$m^2$ of wireweed and 144 plants/$m^2$ of annual grasses. There was no difference between seeding types with wireweed, however, the row sown treatment had less annual grasses than the broadcast treatment (62 compared with 177) (data not shown). There was no difference between seeding rates with either wireweed or annual grasses. Weed emergence in 2006 consisted of 11 plants/$m^2$ of annual grasses but there were no differences between seeding types or seeding rates.

**Table 14 Emergence (plants/$m^2$) and persistence (plants/$m^2$) of phalaris and subterranean clover sown at Rutherglen in 2005 and in 2006**

| Treatment | 2005 establishment year | | | | 2006 establishment year | | |
|---|---|---|---|---|---|---|---|
| | Plants/$m^2$ | | | | Plants/$m^2$ | | |
| | Phalaris emergence Jul 05 | Sub clover emergence Jul 05 | Phalaris persistence May 06 | Phalaris persistence Mar 07 | Phalaris emergence Jul 06 | Sub clover emergence Jul 06 | Phalaris persistence May 07 |
| **Seeding type** | | | | | | | |
| Row sown | 161 | 176 | 57 | 50 | 169 | 271 | 59 |
| Broadcast | 104 | 164 | 31 | 43 | 172 | 242 | 109 |
| Under-sown | 103 | 166 | 28 | 23 | 150 | 196 | 9 |
| l.s.d. | 43.1 | 36.5 | 17.0 | 18.8 | 42.8 | 21.9 | 109.1 |
| **Seeding rate** | | | | | | | |
| Organic | 156 | 187 | 44 | 39 | 216 | 268 | 68 |
| Conventional | 88 | 150 | 34 | 39 | 111 | 206 | 50 |
| l.s.d. | 35.2 | 29.8 | 13.9 | 15.4 | 34.9 | 17.9 | 89.0 |

### 4.2.4.3 Species Mix 2 – Plantain and Lucerne

*Plantain*
Overall, the results show that plantain can be established readily, but its persistence was poor through the dry summer of 2006/07 (Table 4.10), a period when phalaris had survived well (Table 4.9).

Plantain emerged well in 2005 with an average of 155 plants/$m^2$ and row sown was better than under-sown ($P<0.05$) (Table 4.10). The organic seeding rate resulted in more plantain establishing than the conventional rate in both years. In 2006, broadcasting plantain resulted in better emergence than seeding in rows, but not under-sown. An average of 59 plantain plants/$m^2$ was present in May 2006 after the 2005 establishment year, but there were no differences between seeding types. Despite higher establishment in 2005 with the organic seeding rate, there was no difference between rates by 2006 in plant density. By 2007, plantain had ceased to persist with only one plant/$m^2$ persisting in the broadcast and under-sown treatments. Persistence from the 2006 establishment year was also very poor with about one plant/$m^2$ persisting into 2007.

### 4.2.4.4 Effect of weed competition with species mix 2

Weed emergence in 2005 in the plantain/lucerne mix consisted of an average of 49 subterranean clover plants/$m^2$, 141 annual grass plants/$m^2$ and 13 wireweed plants/$m^2$. There was no difference between seeding types in weed emergence with subterranean clover or annual grasses, but under-sowing plantain and lucerne resulted in lower wireweed densities (7 compared with 15) (data not shown).

**Table 15 Emergence (plants/m$^2$) and persistence (plants/m$^2$) of plantain, sown as a lucerne/plantain mix, at Rutherglen in 2005 and in 2006**

| Treatment | 2005 establishment year | | | 2006 establishment year | |
|---|---|---|---|---|---|
| | Plants/m$^2$ | | | Plants/m$^2$ | |
| | Plantain emergence Jul 05 | Plantain persistence May 06 | Plantain persistence Mar 07 | Plantain emergence Jul 06 | Plantain persistence May 07 |
| **Seeding type** | | | | | |
| Row sown | 182 | 59 | 0 | 142 | 2 |
| Broadcast | 146 | 57 | 1 | 196 | 1 |
| Under-sown | 137 | 61 | 1 | 178 | 0 |
| l.s.d. | 41.5 | 14.0 | 0.9 | 38.5 | 3.6 |
| **Seeding rate** | | | | | |
| Organic | 192 | 64 | 0 | 229 | 2 |
| Conventional | 118 | 54 | 2 | 116 | 1 |
| l.s.d. | 33.9 | 11.4 | 0.8 | 31.4 | 2.9 |

*Lucerne*

Overall, as with phalaris, lucerne emerged well from any of the sowing methods, but the population rapidly fell over the ensuing summer to about 10 plants/m$^2$. This density is considered a good stand of lucerne in the lower rainfall districts (300-370 mm annual rainfall) (Stanley *et al.* 2002). The decline in the 2006 establishment year was most severe when lucerne had been planted with a cover crop.

Sowing lucerne in rows resulted in better emergence ($P<0.05$) than either broadcast or under-sown methods in 2005 (Table 4.11). In 2006, broadcasting lucerne was better ($P<0.05$) than sowing in rows, but not better than under-sowing. The organic seeding rate resulted in more lucerne establishment in both years. Persistence of lucerne from the 2005 sowing in this mix resulted in 10 plants/m$^2$ present in 2006 and 13 plants/m$^2$ present in 2007. Persistence of lucerne from the 2006 establishment year was better with an average of 40 plants/m$^2$. This density is considered an excellent stand with high competitive ability against weeds (Stanley *et al.* 2002). Under-sowing lucerne in 2006 in this mix resulted in reduced lucerne density. There were no differences in lucerne persistence with seeding rate in either establishment year.

**Table 16 Emergence (plants/m$^2$) and persistence (plants/m$^2$) of lucerne, sown as a lucerne/plantain mix, at Rutherglen in 2005 and in 2006**

| Treatment | 2005 establishment year | | | 2006 establishment year | |
|---|---|---|---|---|---|
| | Plants/m$^2$ | | | Plants/m$^2$ | |
| | Lucerne emergence Jul 05 | Lucerne persistence May 06 | Lucerne persistence Mar 07 | Lucerne emergence Jul 06 | Lucerne persistence May 07 |
| **Seeding type** | | | | | |
| Row sown | 315 | 13 | 12 | 234 | 58 |
| Broadcast | 186 | 7 | 19 | 272 | 52 |
| Under-sown | 213 | 11 | 9 | 246 | 11 |
| l.s.d. | 64.8 | 13.4 | 21.8 | 34.7 | 23.3 |
| **Seeding rate** | | | | | |
| Organic | 307 | 12 | 20 | 309 | 42 |
| Conventional | 169 | 9 | 7 | 192 | 39 |
| l.s.d. | 52.9 | 11.0 | 17.8 | 28.3 | 19.1 |

### 4.2.4.5 Species Mix 3 – Fescue and Lucerne

*Fescue*
Once again, fescue was readily established with only minor differences between seeding methods, but populations declined steeply to an apparent 'equilibrium' population for this environment, of about 50 plants/$m^2$. The adverse effect of under-sowing was not as pronounced as with phalaris and lucerne.

An average of 317 fescue plants/$m^2$ in 2005 and 400 plants/$m^2$ in 2006 emerged with the lucerne (Table 4.12). Under-sowing fescue in 2005 resulted in less emergence than row sowing. The organic seeding rate resulted in greater emergence of fescue in both years. Persistence of the fescue component of the mix averaged 88 plants/$m^2$ in 2006 and 58 plants/$m^2$ in 2007. More fescue plants persisted into 2006 with row seeding than with broad-casting, however, there was no difference between treatments by March 2007. Similarly with the organic seeding rate, more plants persisted into 2006 but by 2007, there was no difference. By 2007, there was no difference between seeding rates with the 2006 establishment although persistence measurements showed row sowing to have higher ($P<0.05$) plant numbers than under-sowing.

**Table 17 Emergence (plants/$m^2$) and persistence (plants/$m^2$) of fescue, sown as a fescue/lucerne mix, at Rutherglen in 2005 and 2006**

| Treatment | 2005 establishment year | | | 2006 establishment year | |
|---|---|---|---|---|---|
| | Plants/$m^2$ | | | Plants/$m^2$ | |
| | Fescue emergence Jul 05 | Fescue persistence May 06 | Fescue persistence Mar 07 | Fescue emergence Jul 06 | Fescue persistence May 07 |
| **Seeding type** | | | | | |
| Row sown | 388 | 107 | 50 | 409 | 87 |
| Broadcast | 306 | 74 | 51 | 449 | 52 |
| Under-sown | 256 | 83 | 51 | 343 | 35 |
| l.s.d. | 93.0 | 28.1 | 25.0 | 99.5 | 27.7 |
| **Seeding rate** | | | | | |
| Organic | 406 | 100 | 59 | 518 | 65 |
| Conventional | 227 | 77 | 43 | 283 | 50 |
| l.s.d. | 76.0 | 22.9 | 20.4 | 81.2 | 22.6 |

### 4.2.4.6 Effect of weed competition in species mix 3

An average of 61 subterranean clover plants/$m^2$ emerged with the fescue and lucerne mix in 2005 with less emerging in the under-sown, than the row sown treatment (45 compared with 83). Wireweed (8 plants/$m^2$) and annual grasses (159/$m^2$) were also present but there were no differences between seeding types or rates with these species. In 2006 more annual grasses emerged in the under-sown treatment (27 compared with 11 for row sown and 7 for under-sown), and there were less annual grasses with the organic seeding rate (8 compared with 22).

*Lucerne*
Lucerne averaged 210 plants/$m^2$ emergence in 2005 and 244 plants/$m^2$ emergence in 2006 in this mix (Table 4.13). Sowing the lucerne by broadcasting in 2005 and under-sowing in 2006 resulted in lower lucerne emergence than for row sown. The organic sowing rate resulted in greater emergence of lucerne in both years. An average of 37 lucerne plants/$m^2$ persisted into 2006 after the 2005 establishment with row sown lucerne being less ($P<0.05$) than both broadcast and under-sown treatments. This density had stabilised to 35 plants/$m^2$ by 2007 with no difference between sowing methods. There was no difference in lucerne persistence with sowing rate. An average of 16 lucerne plants/$m^2$ persisted into 2007 from the 2006 establishment year, with under-sowing resulting in less ($P<0.05$) persistence than row sown and broadcast. There was no difference in sowing rate with lucerne persistence.

**Table 18 Emergence (plants/m$^2$) and persistence (plants/m$^2$) of lucerne, sown as a fescue/lucerne mix, at Rutherglen in 2005 and 2006**

| Treatment | 2005 establishment year | | | 2006 establishment year | |
|---|---|---|---|---|---|
| | Plants/m$^2$ | | | Plants/m$^2$ | |
| | Lucerne emergence Jul 05 | Lucerne persistence May 06 | Lucerne persistence Mar 07 | Lucerne emergence Jul 06 | Lucerne persistence May 07 |
| **Seeding type** | | | | | |
| Row sown | 250 | 25 | 30 | 254 | 23 |
| Broadcast | 176 | 42 | 36 | 270 | 19 |
| Under-sown | 204 | 44 | 39 | 207 | 7 |
| l.s.d. | 48.6 | 15.9 | 22.2 | 53.0 | 7.9 |
| **Seeding rate** | | | | | |
| Organic | 246 | 35 | 30 | 307 | 19 |
| Conventional | 174 | 38 | 39 | 180 | 14 |
| l.s.d. | 39.7 | 13.0 | 18.1 | 43.3 | 6.5 |

## 4.2.5 Dry Matter Production at Rutherglen

Overall, the most important result was that in most instances, under-sowing resulted in reduced DM production of the sown species. Minor differences in establishment were reflected in larger differences in DM production.

### 4.2.5.1 Species Mix 1 – Phalaris and Subterranean Clover

Sowing phalaris in rows produced more DM yield in May, August and October 2006 but not in November 2005 (Tables 4.14-4.17). In November 2005 and in October 2006, the organic seeding rate also produced more DM yield. The drought conditions in 2006 resulted in reduced DM yield with the under-sown treatment by October 2006.

### 4.2.5.2 Species Mix 2 – Plantain and Lucerne

Results for this pasture mix were less clear than for phalaris. At two harvests, there was no difference between seeding types, however in May 2006, the under-sown and broadcast treatments produced more DM yield ($P<0.05$) than the row sown treatment (Table 4.15). Like phalaris, the drought resulted in reduced DM yield in the under-sown treatment and more DM yield ($P<0.05$) with the organic seeding rate in October 2006 (Table 4.17).

### 4.2.5.3 Species Mix 3 – Fescue and Lucerne

There was no effect of seeding type on this pasture mix in May and August 2006 (Tables 4.15 and 4.16). In November 2005 row sown fescue and lucerne yielded more DM than the under-sown treatment (Table 4.14), and in October 2006, the under-sown treatment yielded less than the row sown and broadcast treatments (Table 4.17). There was no effect on DM yield of seeding rate (Tables 4.14 to 4.17).

**Table 19 Dry matter yield (kg DM/ha) of sown species (2005 establishment) harvested in November 2005**

| Treatment/Species Mix | Phalaris/sub clover | Plantain/lucerne | Fescue/lucerne |
|---|---|---|---|
| Row sown | 4470 | 2974 | 5000 |
| Broadcast | 7026 | 3967 | 2972 |
| Under-sown | 3195 | 3439 | 2045 |
| | | | |
| l.s.d. | 2444.4 | 3902.6 | 2528.3 |
| | | | |
| Organic | 6290 | 3768 | 4083 |
| Conventional | 3504 | 3152 | 2595 |
| | | | |
| l.s.d. | 1995.8 | 3186.4 | 2064.3 |

**Table 20 Dry matter yield (kg DM/ha) of sown species (2005 establishment) harvested in May 2006**

| Treatment/Species Mix | Phalaris/sub clover | Plantain/lucerne | Fescue/lucerne |
|---|---|---|---|
| Row sown | 1931 | 1172 | 1606 |
| Broadcast | 1178 | 1501 | 1445 |
| Under-sown | 1233 | 1628 | 1343 |
| | | | |
| l.s.d. | 340.7 | 313.6 | 339.1 |
| | | | |
| Organic | 1570 | 1446 | 1507 |
| Conventional | 1326 | 1422 | 1423 |
| | | | |
| l.s.d. | 278.2 | 256.0 | 276.8 |

**Table 21 Dry matter yield (kg DM/ha) of sown species (2005 establishment) harvested in August 2006**

| Treatment/Species Mix | Phalaris/sub clover | Plantain/lucerne | Fescue/lucerne |
|---|---|---|---|
| Row sown | 2846 | 702 | 1355 |
| Broadcast | 1491 | 606 | 1245 |
| Under-sown | 1145 | 1043 | 619 |
| | | | |
| l.s.d. | 1283.3 | 473.2 | 836.9 |
| | | | |
| Organic | 2039 | 848 | 1396 |
| Conventional | 1616 | 719 | 750 |
| | | | |
| l.s.d. | 1047.8 | 386.4 | 683.4 |

**Table 22 Dry matter yield (kg DM/ha) of sown species (2006 establishment) harvested in October 2006**

| Treatment/Species Mix | Phalaris/sub clover | Plantain/lucerne | Fescue/lucerne |
|---|---|---|---|
| Row sown | 3738 | 2639 | 3143 |
| Broadcast | 3555 | 2675 | 3423 |
| Under-sown | 491 | 263 | 799 |
| l.s.d. | 651.0 | 553.2 | 529.8 |
| Organic | 2942 | 2087 | 2558 |
| Conventional | 2247 | 1631 | 2351 |
| l.s.d. | 531.6 | 451.7 | 432.5 |

## 4.2.6 Oat yields at Rutherglen

Sowing perennial species under an oat crop is an accepted practice amongst many producers because it allows income to be generated whilst the perennial species are establishing. Oats were sown in the under-sown treatment at both sites but were only harvested at Rutherglen because no crop developed at Yarrawonga in either year. An average of 2.1 t/ha and 3.3 t/ha were recorded in 2005 and 2006 respectively (Table 4.18). There were no differences in yield between the species mixes or the perennial sowing rates in either year (Table 4.18).

**Table 23 Oat grain yields (t/ha) at Rutherglen in 2005 and 2006**

| **Treatment** | **2005 establishment year** | **2006 establishment year** |
|---|---|---|
| | **Oat grain yield (t/ha)** | |
| *Species Mix* | | |
| Phalaris and sub clover | 2.14 | 3.44 |
| Plantain and lucerne | 2.13 | 3.23 |
| Fescue and lucerne | 2.10 | 3.37 |
| l.s.d. | 0.47 | 0.46 |
| *Sowing rate* | | |
| Organic | 2.08 | 3.20 |
| Conventional | 2.16 | 3.49 |
| l.s.d. | 0.38 | 0.38 |

## 4.2.7 Emergence, persistence and dry matter production at Yarrawonga

### 4.2.7.1 Effect of weed competition

This site was not cultivated prior to sowing. The site was characterised by very high densities of many annual weed species including onion grass (*Romulea rosea* (L.) Eckl. Var. australis (Ewart) de Vos), annual ryegrass (*Lolium rigidum* Gaud.), capeweed (*Arctotheca calendula* L.), storksbill (*Erodium botrys* (Cav.) Bertol., soursob (*Oxalis pes-caprae* L.), Paterson's Curse (*Echium plantagineum* L.), silver grass (*Vulpia bromoides* (L.) S.F.Gray), stonecrop (*Crassula sieberana* (Schult.) Druce), and wireweed (*Polygonum aviculare* L.). There were also established plants of wallaby grass (*Danthonia* spp.) and windmill grass (*Chloris* spp.). All three perennial mixes were affected by this existing plant community resulting in poor germination and emergence. Yarrawonga was also characterised by much lower rainfall than Rutherglen.

Overall, the establishment was low in this experiment because of weed competition (not just rainfall) and very few plants survived through until the following year.

### 4.2.7.2 Species Mix 1 – Phalaris and Subterranean clover

*Phalaris*
Emergence of phalaris at Yarrawonga was very poor with 5 or less plants/$m^2$ recorded in 2005 and two or less recorded in 2006 (Table 4.19). There were no differences between seeding rates or seeding types in either year. There was no DM production of the sown species and no persistence of phalaris in the following year.

**Table 24 Emergence (plants/$m^2$) of phalaris and subterranean clover sown at Yarrawonga in 2005 and in 2006. There were no survivors in either year, in any treatment.**

| | Phalaris | | Sub clover | |
|---|---|---|---|---|
| **Treatment** | Jul 05 | Jul 06 | Jul 05 | Jul 06 |
| | Plants/$m^2$ | | | |
| **Seeding type** | | | | |
| Row sown | 5 | 2 | 35 | 27 |
| Broadcast | 4 | 1 | 52 | 9 |
| Under-sown | 4 | 1 | 60 | 8 |
| l.s.d. | 4.6 | 2.8 | 33.9 | 11.4 |
| **Seeding rate** | | | | |
| Organic | 5 | 1 | 76 | 20 |
| Conventional | 4 | 1 | 23 | 9 |
| l.s.d. | 3.8 | 2.3 | 27.7 | 9.3 |

### 4.2.7.3 Species Mix 2 – Plantain and Lucerne

Emergence of plantain at Yarrawonga was very poor with less than 5 plants/$m^2$ emerging in both years (Table 4.20). An average of 11 (2005) and 8 (2006) lucerne plants/$m^2$ emerged but there were no differences between sowing rates or sowing types. This would be a useful population had it survived, but there was no persistence of plantain or lucerne in the following year, and hence no DM production of the sown species.

**Table 25 Emergence (plants/$m^2$) of plantain and lucerne sown at Yarrawonga, in 2005 and 2006. There were no survivors in either year, in any treatment.**

| | **Plantain** | | **Lucerne** | |
|---|---|---|---|---|
| **Treatment** | Jul 05 | Jul 06 | Jul 05 | Jul 06 |
| | Plants/$m^2$ | | | |
| **Seeding type** | | | | |
| Row sown | 3 | 1 | 21 | 8 |
| Broadcast | 2 | 2 | 9 | 7 |
| Under-sown | 2 | 3 | 3 | 8 |
| l.s.d. | 3.5 | 4.3 | 23.1 | 10.3 |
| **Seeding rate** | | | | |
| Organic | 4 | 3 | 14 | 11 |
| Conventional | 1 | 1 | 8 | 4 |
| l.s.d. | 2.8 | 3.5 | 18.9 | 8.4 |

### 4.2.7.4 Species Mix 3 – Fescue and Lucerne

Emergence of fescue averaged 22 plants/$m^2$ in 2005 and 14 plants/$m^2$ in 2006. There were no differences between sowing rates or sowing types in 2005 but in 2006, there was less fescue emerged with the conventional sowing rate (Table 4.21). Emergence of lucerne averaged 8 plants/$m^2$ in 2005 and 7 plants/$m^2$ in 2006. There was no DM production of the sown species and no persistence of fescue or lucerne in the following year.

**Table 26 Emergence (plants/$m^2$) of fescue and lucerne sown at Yarrawonga, in 2005 and 2006. There were no survivors in either year, in any treatment.**

| | Fescue | | Lucerne | |
|---|---|---|---|---|
| **Treatment** | Jul 05 | Jul 06 | Jul 05 | Jul 06 |
| | Plants/$m^2$ | | | |
| **Seeding type** | | | | |
| Row sown | 31 | 23 | 8 | 13 |
| Broadcast | 18 | 8 | 6 | 3 |
| Under-sown | 17 | 10 | 10 | 4 |
| l.s.d. | 23.1 | 15.8 | 7.5 | 7.6 |
| **Seeding rate** | | | | |
| Organic | 31 | 20 | 12 | 8 |
| Conventional | 13 | 7 | 4 | 5 |
| l.s.d. | 18.9 | 12.9 | 6.1 | 6.2 |

## 4.3 Native grass grazing management experiment

The objective of this experiment was to determine the best grazing strategy to optimise production and persistence of red grass (*Bothriochloa macra*). This experiment was used within the project because producers expressed an interest in knowing whether it was possible to improve perennial pastures, including native grass based pastures, through grazing management, rather than traditional re-establishment methods.

The experiment was conducted on a property that was managed without herbicides or synthetic fertilisers, but not certified organic. The treatments imposed were: 1. Continuous grazing at the 'local' average stocking rate of 5 DSE/ha (Dry Sheep Equivalent) to demonstrate the potential detrimental effect of set stocking on native grass management; 2. No grazing; 3. Hard grazing in spring (September to November) at 23 DSE/ha to reduce annual species seed set, reverting to 5 DSE/ha; 4. High spring utilisation at 23 DSE/ha, with sheep exclusion over summer-autumn to promote perennial seed set and recruitment; 5. Continuous grazing at 5DSE/ha with sheep exclusion over summer-autumn to promote perennial seed set and recruitment.

Treatment 2 (no grazing) resulted in the highest total DM yield over the course of the experiment, with a mean DM yield of 3002 kg (Figure 4.16). The next best treatment for total DM yield was treatment 5 where the pasture was grazed continuously but sheep were excluded over summer-autumn to promote seed set (2165 kg). This was followed by treatment 4 (1635 kg), then treatment 1 (1266 kg), then treatment 3 (1259 kg) SED (151.7) (Figure 4.16). There was a significant treatment by time interaction ($P<0.001$) at the beginning of the experiment but by about 200 days, this interaction no longer occurred (Figure 4.16). Treatment 1 (no grazing) and treatment 3 (spring grazing) behave similarly throughout the experiment (Figure 4.16).

The experiment began in July 2003 and continued until June 2006.

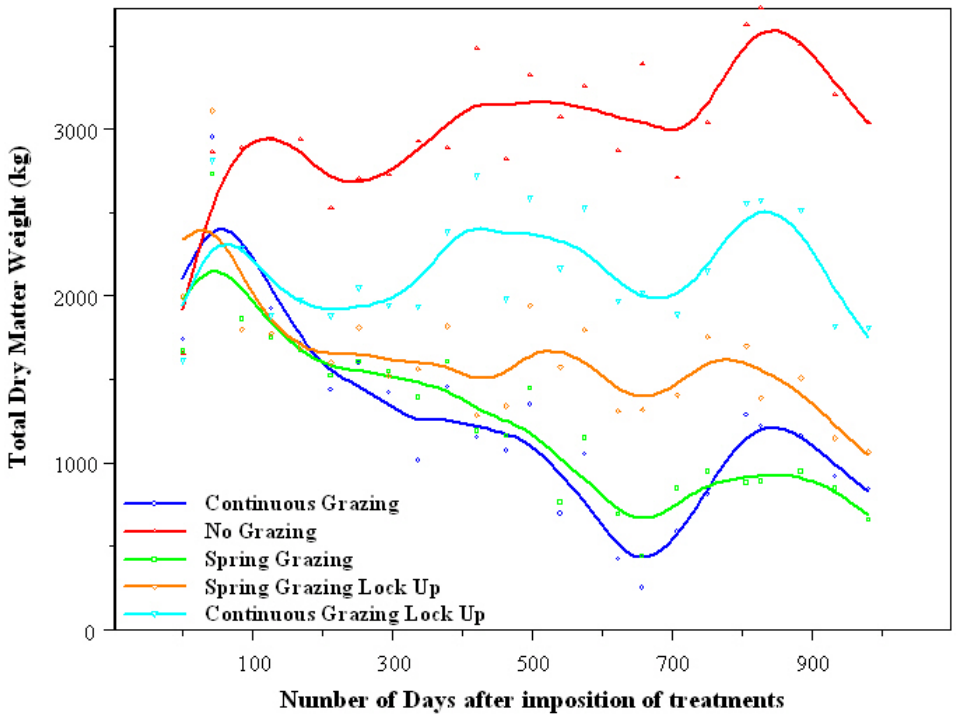


**Figure 4.16: Dry weight (kg) of all species by grazing treatments through time for Tarrawingee**

The red grass DM yield was best promoted by treatment 5 (continuous grazing with sheep exclusion over summer-autumn) with a mean of 951 kg (Figure 4.17). This was followed by treatment 2 (832 kg), treatment 4 (673 kg), treatment 3 (550 kg) and treatment 1 (473 kg) SED (160.9). There was a significant treatment by time interaction ($P<0.05$) that occurred in the first year of the experiment (Figure 4.17). After 400 days, the interaction no longer occurs (Figure 4.17).

Red grass is a warm season native perennial grass with an active growing season in January and February; this warm season growth is very useful in that it dries out the soil and prevents drainage in the winter months that can contribute to salinity.

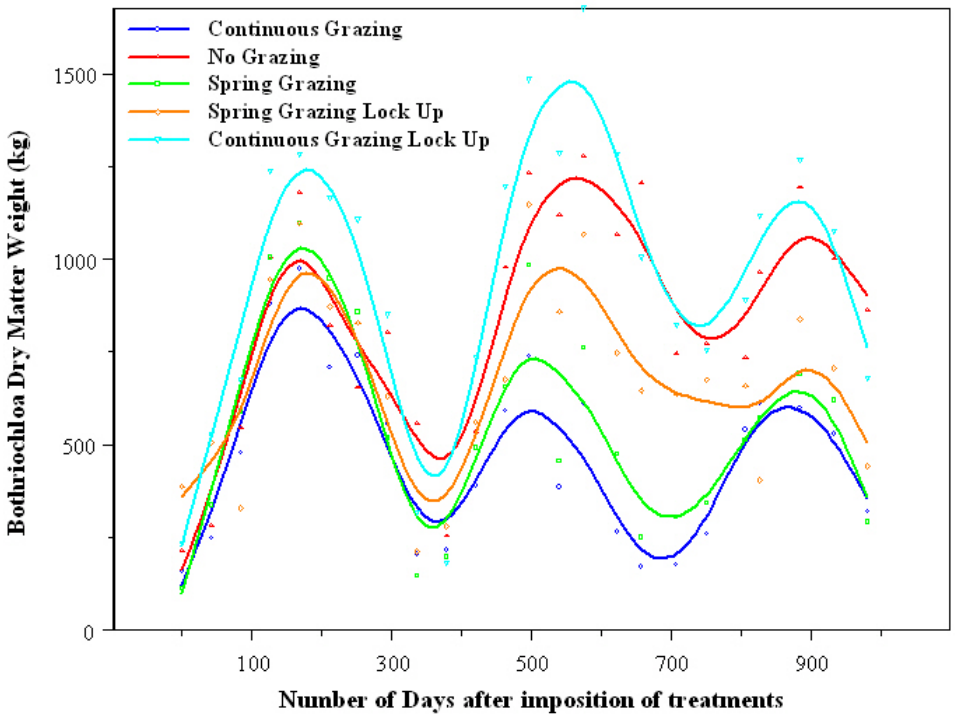


**Figure 4.17: Dry weight (kg) of red grass (Bothriochloa macra) by grazing treatments through time for Tarrawingee**

## 4.4 Perennial Pasture Workshop and Study Tour

Sixty producers attended the event (see Figure 4.18) and significant follow-up media in the Stock and Land newspaper added value to the delivery of information to producers. Thirty-six producers completed an evaluation of the workshop and study tour, with eight producers being fully certified organic, sixteen producers indicating that they were not certified organic, and twelve producers not completing the section, hereafter referred to as 'neutral' producers.

**Figure 4.18: Promoting perennial pastures workshop and study tour**

General evaluation of the workshop/study tour showed that producers were generally satisfied with the program and content. A sample of quotes received included: "Extremely informative and encouraging"; "Excellent well-organised day"; "Events like these are so interesting – I really appreciate them".

Producers were asked at the beginning of the day to rate their knowledge in each of the subject areas, and again at the end of the day. There was a general trend that showed that most producers indicated their knowledge had increased as a result of the presentations (Table 4.22).

**Table 27 Level of knowledge amongst participants before and after the workshop**

| Subject area | None | | Low | | Satisfactory | | Excellent | |
|---|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | Before | After |
| Importance of perennials | 1 | 0 | 7 | 1 | 20 | 15 | 6 | 16 |
| Establishment methods | 4 | 0 | 13 | 4 | 14 | 21 | 2 | 5 |
| Grazing management | 2 | 0 | 10 | 5 | 18 | 20 | 2 | 6 |
| Pasture cropping | 10 | 0 | 14 | 6 | 7 | 22 | 0 | 3 |
| Organic perennials | 9 | 0 | 12 | 4 | 9 | 22 | 2 | 4 |
| Native grasses | 6 | 0 | 13 | 3 | 12 | 24 | 1 | 3 |

In the evaluation conducted at the end of the day producers were asked to indicate what the major barriers were to the introduction of perennial pastures on their farms. A range of potential barriers was provided and producers could select more than one option. Results are presented for the three groups outlined above. Certified organic producers indicated that the major barriers to pasture establishment included moisture, weeds and soil fertility, with cost of establishment not registering (Figure 4.19). In contrast, the 'not certified' producers indicated that cost was a major barrier, along with weeds and having the appropriate machinery (Figure 4.19). The neutral producers did not indicate that soil fertility was an issue, but did consider weeds, cost and machinery as major barriers (Figure 4.19).

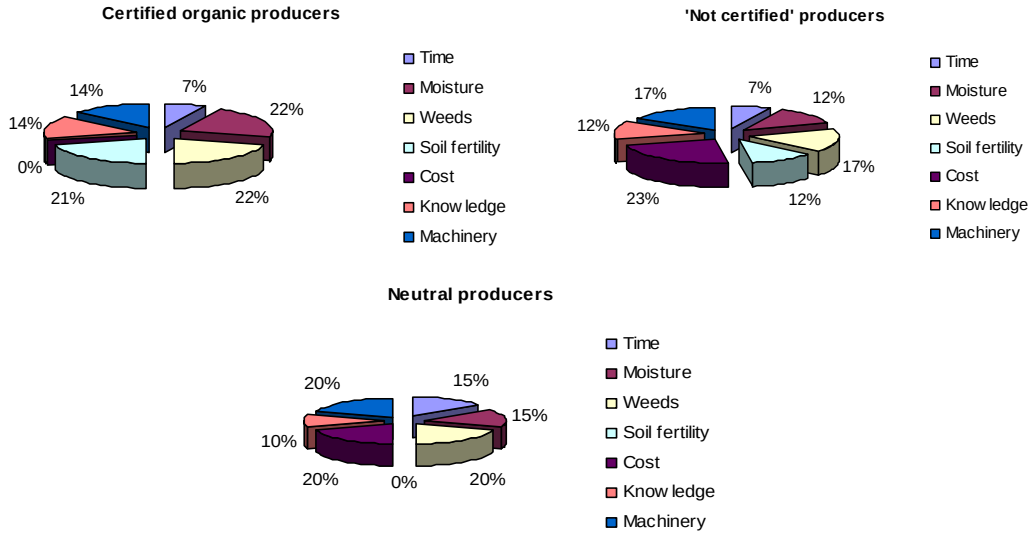


**Figure 4.19: Major barriers to perennial pasture establishment indicated by different producer groups at the workshop**

Producers were asked in what year they last tried to establish a perennial pasture and what species they had chosen. The majority of producers indicated that they had attempted to establish a perennial pasture in 2005 (Figure 4.20). There was generally more re-establishment activity from the not certified producers than either the organic or neutral producers (Figure 4.20).

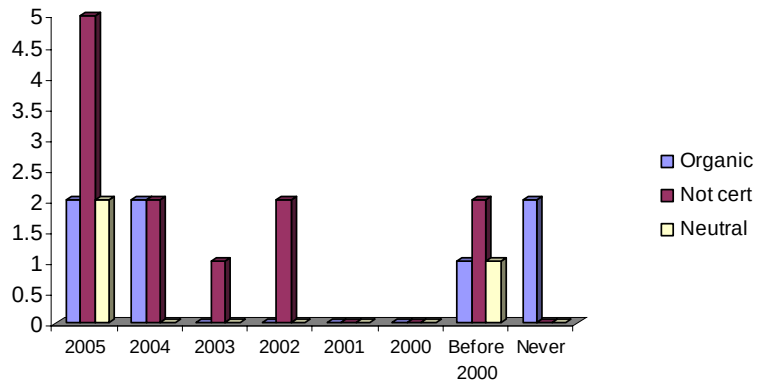


**Figure 4.20: What year did you last attempt to establish a perennial pasture?**

Lucerne was the most popular perennial species to be established by all groups with 34% of organic producers, 32% of not certified producers and 20% of neutral producers indicating that they had sown lucerne recently (Figure 4.21). The not certified group of producers indicated a wider range of perennial species, including native grasses, than either the organic or neutral producers (Figure 4.21).

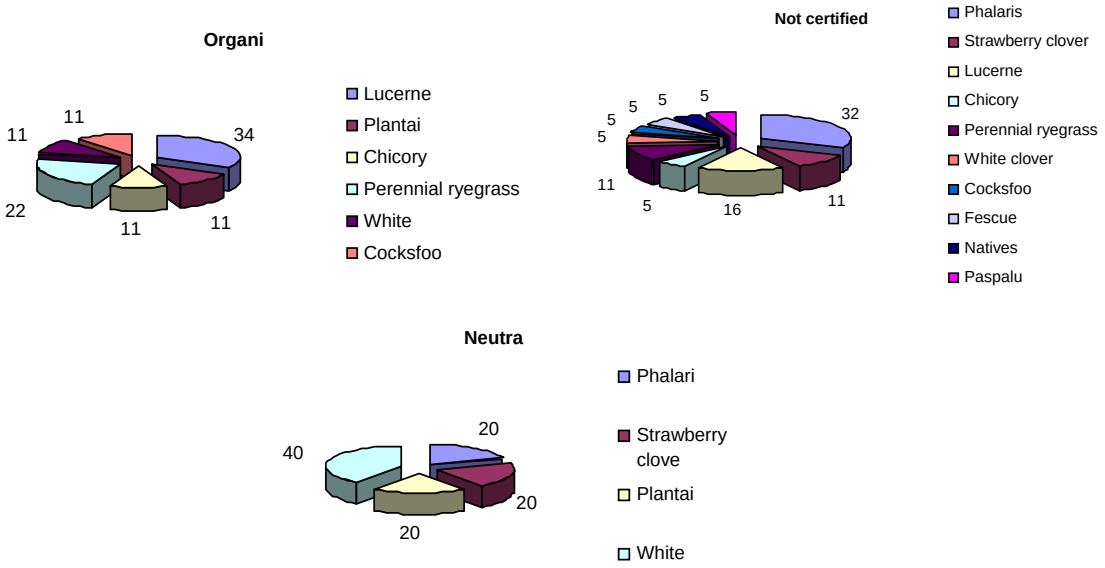


**Figure 4.21: Perennial species selected for establishment by producers**

The subject of increasing perennial species content in pastures through grazing management was mentioned by three producers, all certified organic. These producers indicated that the perennial component would increase through appropriate grazing management, and one producer also mentioned that this was a long term strategy.

In the evaluation conducted at the end of the tour there was a high awareness of the presence of native grasses amongst producers with 100% of organic producers, 94% of not certified producers, and 50% of the neutral producers indicating that they had observed native grasses on their properties. There were comments about native grass identification, cost and availability of seed, and comparative productivity with introduced species.

The evaluation also asked what DPI and research and development could provide for producers in the area of perennial pastures.

*Organic producers wanted:*

- more information on sourcing seed
- native grass identification
- perennial species performance in specific areas
- continued research projects, such as the current perennial project, and the establishment of long term experiments on soil inputs.

*'Not certified' producers wanted:*

- training for producers in grazing management
- perennial species performance in specific areas
- availability of native grass seed
- information on sowing techniques
- performance of native grasses on steep country
- producer grants that are available
- economic analyses for different pasture/stock systems
- native grass identification
- palatability of native grasses.

*Neutral producers wanted:*

- productivity comparison between native and introduced pastures
- information on establishment options.

## 4.5 PhD study results

### 4.5.1 Wireweed Survival Study

Twenty-three plants from a total of 100 survived to flower and produce seed in the 2005 season (Table 4.23). The average height (longest branch length) grew from 2.6 cm to over 50 cm during the season (Table 4.23). Wireweed plants grew from one stem to multiple branches with mature plants having an average of 11 branches in May 2005 (Table 4.23). The number of branches per plant increased as the number of plants in the total population declined (Figure 4.22).

**Table 28 Decline in wireweed population from August 2004 until May 2005**

| Date | Number | Av. Height (cm) | Branches | Plants flowering | Population decline (%) |
|---|---|---|---|---|---|
| 27/08/2004 | 100 | 2.6 | 1 | 0 | |
| 18/11/2004 | 43 | 8.0 | 1 | 0 | 57 |
| 16/12/2004 | 34 | 11.6 | 1 | 1 | 21 |
| 21/1/2005 | 29 | 16.0 | 3 | 2 | 15 |
| 25/2/2005 | 26 | 36.5 | 7 | 18 | 10 |
| 26/5/2005 | 23 | 52.3 | 11 | 23 | 12 |

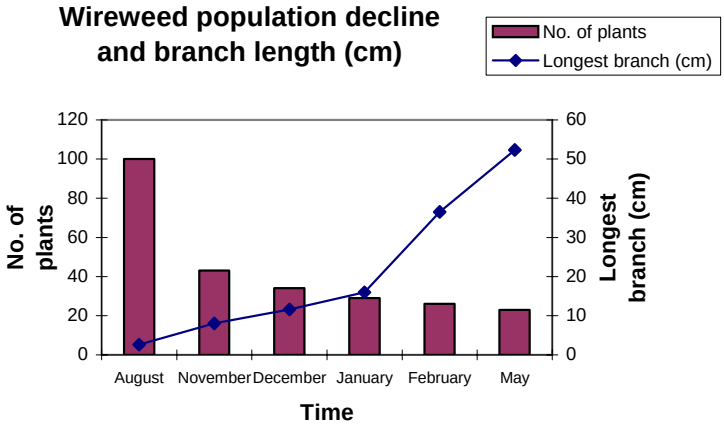


**Figure 4.22: Wireweed population decline and longest branch length (cm)**

## 4.5.2 Effect of fertility regimes on wireweed germination

Seed germination was not affected by P or N addition (Figure 4.23). The average number of seeds germinated after 4 days, irrespective of treatment, was 5.0, at 7 days, 5.2, and at 11 days, 5.3. Irrespective of the time of assessment, nil P resulted in 5.2 germinated seeds, 5 P was 5.7, 10 P was 5.2, 20 P was 4.9 and 50 P was 4.8. Similarly for N, nil N resulted in 5.3 germinated seeds, 10 N was 5.6, 20 N was 4.6, 50 N was 5.7 and 100 N was 4.6. The interaction between P and N showed that at the highest rate of N, seed germination was significantly better with 5 kg P than with all other rates of P (Figure 4.23).

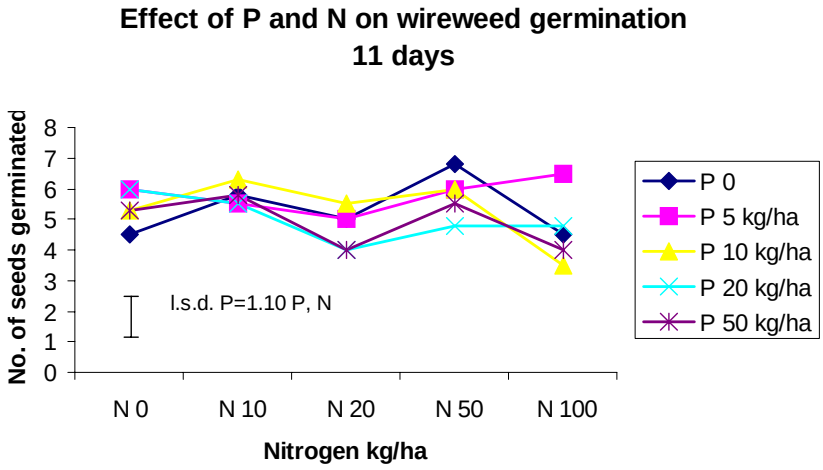


**Figure 4.23: Number of seeds germinated after 11 days**

## 4.5.3 Competition effects between lucerne and wireweed in glasshouse studies

Lucerne is more affected by wireweed at low densities of lucerne and at high densities of wireweed (Figure 4.24a). As lucerne density increases, its proportion of total dry weight decreases at the highest wireweed density (6 plants/pot) (Figure 4.24a). As wireweed density increases, its proportion of total dry weight only decreases at the higher lucerne densities (3 plants/pot) (Figure 4.24b).

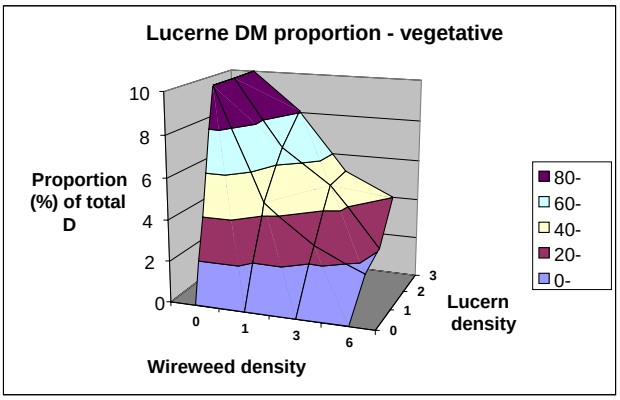


**Figure 4.24a: Lucerne DM production at vegetative phase**

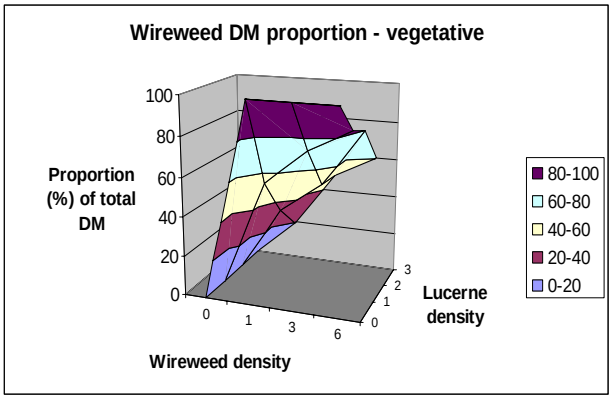


**Figure 4.24b: Wireweed DM production at vegetative phase**

This preliminary result shows that if wireweed is allowed to develop into high seed-bank populations, it can seriously compromise the ability of lucerne seedlings to establish. Similarly for wheat, wireweed has the ability to compete effectively for light (through branching) and resources (moisture and nutrients) even though wheat plants have a different growth habit to wireweed.

# 5. Discussion of Results

## 5.1 Survey

### Aim

*To determine the amount and status of perennial pastures (exotic and native) on certified organic dryland farms in Victoria, New South Wales and South Australia.*

Our survey showed that much of the recent (last 5 years) perennial pasture sowing on organic farms has consisted of lucerne with SA respondents listing it as the most common perennial species and also the most recently sown species. In NSW three quarters of the area on organic farms was under pasture and the majority (73%) was under perennial pasture, with phalaris and paspalum being the most common perennial species. However like SA, lucerne was the most common recently sown perennial species. In Victoria, 72% of the average organic farm was under pasture but only 43% was under perennial species with phalaris and lucerne being the most common species. Lucerne and perennial ryegrass were the most commonly sown perennial species in Victoria. In conventional dryland systems perennial pastures are most widely established in NSW and Victoria and, except for lucerne, are of lesser importance in SA (Campbell *et al* 1987).

The popularity of lucerne on organic farms is not surprising as there has been an increasing level of interest in the use of lucerne in dryland farming systems over the past fifteen years with the area sown steadily increasing since the mid 1980s (Dear *et al* 2003). Lucerne has many advantages including a deep root system to manage drought conditions and water use, forage for livestock and the ability to fix nitrogen for crop production.

Almost all producers surveyed indicated an awareness of native grass species on farms and most had observed native species on their own farms. Most organic producers indicated that native species were managed in the same way as exotic, with the exception of NSW where slightly more producers indicated differing management of native species. Native grass management was focused on either no grazing or limited grazing with periods of 'lock-up' for recovery or seed production. It is likely that native perennial pastures will play an increasingly important role in dryland grazing systems as they have demonstrated that they are better adapted to the variable climate experienced in much of south eastern Australia and they can directly contribute to sustainability outcomes such as reducing salinity. Whilst there was some evidence in the survey of the different requirements that native perennials have in terms of management, organic producers will need to become more skilled at specific grazing management to ensure that these species persist for the long term.

Data on producers' perceptions of the status (composition and quantity) of their pastures was also collected as part of the survey. The data are subjective but they provide some indication of pasture status. Approximately half (51%) of the producers surveyed rated their perennial pastures as good or of medium status. A further third (30%) rated their pastures as being poor or fair and 19% rated their pastures as either very good or excellent. Field validation of pasture status including species and density is required.

### Aim

*To understand the barriers to perennial pasture establishment and/or improvement on organic farms.*

The majority of farmers indicated that the greatest barrier to establishing a perennial pasture was the lack of available moisture at the appropriate time. If the Bureau of Meteorology's rainfall variability index is used in the critical period from February through to May, high or very high rainfall variability zones are present in the areas where the majority of survey farms are located (BOM 2006). This means that the chance of obtaining reliable rainfall for perennial pasture establishment is low, which confirms the farmers' answers. Although farmers raised rainfall and weed control as separate issues, the adequacy of rainfall is closely linked to the degree of competition for the rain that falls.

The second major barrier to perennial pasture establishment was the management of weeds. Whilst there was some indication that other methods of preparatory weed management were being used (heavy grazing, cutting hay), our survey showed a concentration on the use of cultivation. Whilst excessive cultivation is known to result in soil structure decline, successful perennial pasture establishment, irrespective of the sowing method, is highly dependent on achieving a weed-free seed-bed (Watson *et al* 2002, Stanley *et al* 2002, Campbell *et al* 1987). Therefore an acceptable trade-off between the short-term cost of cultivation against the long-term benefits needs to be found. Perennial pasture establishment (full renovation) return on investment can be from three to five years or even longer, depending on the enterprise. Whilst the initial cost (monetary and cultivation of soils) and the length of time before returns are recovered may seem daunting for many producers, the long term benefits to be gained in improved soil management and more productive and persistent pastures are worth the investment. Costs can be managed by adopting a paddock/year program.

These barriers are not that different from those found in conventional farming systems but the relative importance may differ in an organic system. In a similar survey conducted amongst conventional producers in 1998 (Daunt) barriers indicated by producers included finances (costs), climate, management of stock, farm set up, and age. In the conventional survey, cost of establishment was the main barrier preventing producers from developing their perennial pasture systems.

The barriers encountered by organic producers are unlikely to change in the short term with costs of re-establishment generally rising. Perennial pasture establishment could also become more complicated and expensive if the derogation that currently allows the use of conventional pasture seed in an organic system is no longer accepted. If predictions of a warming, drying climate also eventuate, perennial establishment may become even more risky as the number of ideal seasons for establishment might reduce. This means that more emphasis on grazing management to restore and enhance existing perennial pastures is required.

Whilst successful perennial pasture establishment has been achieved using a direct drilling technique in conventional farming systems, this success has been predicated on the use of herbicides to manage the competitive effects of existing plant species. In organic farming where the competitive effects of weeds cannot be managed using herbicides there is likely to be a high risk of establishment failure if direct drilling techniques are used. This risk was assessed experimentally at Yarrawonga.

Other important barriers to perennial pasture establishment included cost, having sufficient time to conduct sowing operations, having the right equipment and managing pests. These reasons are no different from those found in conventional farming systems.

## Aim

*To understand current, and discover new methods, of perennial pasture establishment that may have wider applicability in organic systems.*

The data showed that the majority of perennial pastures were established in organic systems using a cultivated seed-bed, after conducting a soil test to determine nutrient status. Seed (legumes were inoculated) was broadcast on to the cultivated surface and fertiliser used at sowing. After sowing, no further weed management was conducted. Many minor variations on this recipe were recorded but there were no exceptionally different establishment techniques. It is likely that successful establishment within an organic context will rely on sound seedbed preparation, agronomy (choice of perennial species, sowing rates, fertiliser), monitoring for growth stage and development and grazing management for persistence.

### Aim

*To understand current perennial pasture management on organic farms.*

The data showed that organic producers had a sound understanding of grazing management practice and the need for rest periods with perennial pastures. This was clearly shown in their decision to move stock out of a paddock, with pasture height and pasture growth stage rating significantly higher than other factors. The result for time spent on the pasture by livestock was less clear. This result may reflect the adoption of holistic grazing principles amongst organic producers, where pasture is grazed by livestock for short periods (days only) with lengthy recovery times in order to mimic what may occur in a natural system.

## 5.2 Experimental program

The experimental program was conducted over two challenging seasons and interpretation of results needs to be understood within that context. The two experimental years can also be viewed as allowing establishment methods to be compared under 'risky' conditions so recommendations arising from the work may be seen as reasonably safe.

The research demonstrated that successful establishment of perennial pastures in organic systems relies on the management of competition. Where competition from other plants was managed effectively at Rutherglen, establishment and survival was good, despite late sowing and less than ideal rainfall. Where direct drilling was used at Yarrawonga, and competition was not managed, establishment was very poor with no survival of sown species. Cultivated seed-beds provide a weed-free window of opportunity for perennial pasture species to establish, in contrast to direct drilling, where sown seeds have to compete with existing plant populations (if herbicides are not used). In our experiments, direct drilling was not successful for perennial establishment and could not be recommended in an organic farming system. In some years and in some circumstances, direct drilling may be achieved but the risks of establishment failure in an organic system are high, although least so for lucerne.

Whilst cultivation of soil can be damaging and costly, organic producers can be judicious and strategic in their cultivation in order to achieve the appropriate seed-bed for perennial establishment. The costs of re-establishment can be relatively high with 'return on investment' not being achieved for 3-5 years depending on the enterprise. However, the longer term benefits of improved soil management achieved from the presence of a perennial species, and increased pasture productivity with effective grazing management, provide support for the decision to re-establish perennials in degraded annual systems.

Both Rutherglen and Yarrawonga had large seed-bank populations of annual weed species, some of which germinated and competed with the emerging perennial species, however, this was less of a concern than the difference between cultivation and direct drill. Attention to annual seed-bank reduction in the seasons prior to perennial establishment will help to reduce the influence of annual plant competition.

Seeding type provided mixed results for different perennial species and years, and more data collection would be required to provide a definitive answer. Sowing in rows generally provided the best establishment and DM yield. Where moisture was limiting, there was some evidence to suggest that broadcasting seed resulted in better establishment and persistence. When water is limiting, our results showed clearly that under-sowing perennial species is not recommended because the cereal crop, in this case oats, captures moisture to the detriment of the pasture species. We did not find any difference in the yield of the oat cover crop with different pasture mixes or seeding rates. If under-sowing is practised, the sowing rate of the cereal needs to be significantly reduced, half or one third of the recommended sowing rate, so that the pasture species have an improved chance of establishment. In previous work conducted in this field, under-sowing has been shown to seriously affect the establishment of the pasture species, such that the more dry matter production of the cover crop, the more the pasture species is suppressed (Scott and Brownlee 1974).

Our project showed that lucerne was a popular choice for perennial establishment because of its resilience and productivity in our climate. Whilst most producers and agronomists would agree that lucerne is a crucial perennial pasture plant, it is also very competitive and may result in bare ground and eventually soil erosion. A more sustainable approach that would fulfil organic requirements is to incorporate lucerne in mixtures with other perennial species, such as phalaris, chicory or perennial ryegrass, or sow lucerne at elevated sowing rates into an existing pasture. Whilst there has been much work done about lucerne in mixtures within conventional systems there is insufficient information on how mixtures of these species perform in organic systems. Some effort is required to review current information and present this to organic producers so that an understanding of the production and persistence challenges of perennial mixes can be obtained.

An organic seeding rate provided higher numbers of emerged plants than the conventional rate in most instances and provided better DM yield in the first year. However, this did not translate into better persistence of the sown species in the following years at Rutherglen, with the exception of lucerne in the plantain/lucerne mix at Yarrawonga. Given the cost of perennial pasture seed and the results obtained from these experiments, a conventional seeding rate ought to be sufficient when combined with a prepared seed-bed during the establishment period.

Native perennial grass species have been studied for many decades (Breakwell, 1915) but are beginning to re-emerge as having potential within dryland farming systems. Their productivity and persistence is directly related to their adaptation and the specific grazing management imposed. There is a strong perception amongst many producers and scientists that native grasses are not as productive or palatable as many introduced species. A continued effort to more closely study these species and how they can be incorporated into existing organic farming systems is warranted.

The project's involvement with the STIPA Native Grass Association provided an example of improving productivity using an existing native grass pasture system. The concept of 'pasture cropping' (Seis 2006) has been trialled in central NSW for some years and basically involves growing an annual cereal crop in the dormant phase of the native grass pasture. The system relies on the native grasses only being active during the summer months when the cereal crop has been harvested. This system relies on herbicides to effectively establish the cereal crop but there is no need to re-establish the perennial pasture. This system can work under current rainfall patterns in this area but its adaptation to other areas is not known. Where grazing management was used to promote a perennial species, in this case the native red grass (*Bothriochloa macra*), the Tarrawingee experiment showed that continuous grazing with a low stocking rate (5 DSE/ha) and an exclusion period in summer and autumn to allow seed set, was the best treatment to promote the red grass. The results obtained are for one site and more research is required to validate this result. Given that red grass is a warm season native perennial with its main growth period in January and February, there is a possibility that the system of pasture cropping trialled in central NSW could be adapted to north east Victoria. This would mean that producers could sow their cereal crops into dormant red grass pastures without the need for costly re-establishment. More effort to investigate this type of system should be a high priority.

The advantage of using grazing management to restore the perennial component is that it generally costs less than complete re-establishment and this would be particularly attractive to producers. The disadvantage of this strategy is that it is a long term process (at least three years before an improvement may be observed) and short term losses in feed availability may be experienced where pastures are locked up for seed set. It will depend on the producer's circumstances as to whether this strategy is achievable on their farm.

## 5.3 Workshop and study tour

The workshop and study tour attracted 60 producers and provided them with a range of information and interaction with respect to perennial pastures. The event was limited by its short duration and the time available to visit successfully managed perennial pasture sites. Ideally, the study tour would have been a three day event where multiple perennial pasture situations could have been visited and studied, with corresponding interactions with producers. This is difficult to achieve as many producers are committed to working on their farms on a daily basis and have limited time and resources to attend longer events.

The workshop/study tour revealed the different level of knowledge amongst producers with respect to the subject area. This is a reflection of the maturity of the industry and information delivery must cover a wide spectrum of experience. The producer audience consisted of experienced certified organic producers, and producers that were sympathetic to the organic system, and conventional producers. Within each of these categories, there were different levels of knowledge with regard to the importance and practical experience of perennials. There are advantages and disadvantages to this situation. For those producers with less knowledge, the event is an opportunity to learn new information and to take this back to their own farms for adoption. For those more experienced, the event may be too basic with limited opportunity to learn new information. It is difficult to gauge producers' level of interest until after the event, and in an ideal project world, these events would be built upon with successive training opportunities.

The involvement of producer groups in communication activities enhanced the information delivery. New perspectives on the management of perennial systems, especially native grass systems, were positively received by the audience. The producer groups that were involved at the beginning of the project are still committed at the end of the project and one group has embarked on their own perennial pasture management experiment, funded through the National Landcare Program.

## 5.4 PhD studies

The PhD study is investigating the biology and ecology of wireweed (*Polygonum aviculare* L.) (see Figures 5.1 and 5.2). There are different views about the purpose of weeds within the organic farming sector, ranging from 'weeds are weeds and should be controlled' to 'weeds are just part of the wider plant community and occupy an ecological niche'. Irrespective of these divergent views, establishing and maintaining productive perennial pastures is a core activity of primary producers and plant species which affect this process can increase risk and lower pasture productivity and quality.

**Figure 5.1a: Wireweed (*Polygonum aviculare* L.) seeds; 5.1b: Wireweed early vegetative growth**

**Figure 5.2: Project leader holding a mature wireweed plant, showing multiple branching**

The preliminary results obtained so far indicate that wireweed can become an issue in dryland farming systems, by interfering with establishing crops and pastures. It is a resilient species, germinating after crops and pastures are generally sown and persisting through the summer to produce large quantities of seed. It has an advantage in that sheep will graze it if there is no other pasture available, and it grows during the hot summer months when other species such as phalaris are dormant. However, if populations of wireweed are greater than about 5-7 plants/$m^2$, it is likely that crop and pasture plants will be adversely affected (lower DM production or grain yield) by it. The PhD study will continue to investigate its effects in crops and pastures, with appropriate management options for organic farming systems being developed in 2008.

# 6. Implications

The project has demonstrated that the major barriers to perennial pasture establishment are the management of competition, as reflected in the interaction between available moisture and weed control. Cost of re-establishment was an issue with organic producers but didn't rate as highly as the competition issue.

The main implications of the survey and the experimental program are:

- Establishment of perennial pastures in an organic system is challenging because of competition so the rate of perennial establishment will remain low until weeds can be effectively managed.

- For successful establishment, cultivation is required so there is a trade-off between the short term damage that cultivation does to soil and the longer term benefits of improved soil management under a perennial system.

- Given that re-establishment is challenging and costly, enhancing pastures through the encouragement of existing native perennial species ought to be examined more closely. Whilst this is a long term process, the cash costs and risks are low which may prove attractive to producers.

- If organic producers want to use direct drilling to establish perennial species, in order to preserve soil structure, then lucerne at an elevated seeding rate is the best option. Sowing the lucerne with P fertiliser in the same furrow should provide it with a competitive advantage over weeds.

The main implications of the workshop and the PhD study are:

- Information provision for the maturing organic industry will remain challenging from both geographical and philosophical perspectives because there is a wide range of information needs.

- Small targeted projects fill a need locally and regionally but the development of an 'Organic Knowledge Hub' where information can be concentrated in the one location is needed for greater access.

- Wireweed (*Polygonum aviculare* L.) is a weed affecting dry land crop and pasture systems. The preliminary investigations have shown that wireweed is susceptible to competition from lucerne and wheat so further study will aim to provide practical options for organic producers to reduce the impact of this species.

# 7. Recommendations

- It is essential to control competition for good establishment. This means preparing a seedbed as no other effective means are available to organic farmers.

- If for any reason a farmer would prefer not to cultivate, then direct drilling is an option. In this case lucerne is the safest species to sow when competition has not been controlled, but even then it would be wise to increase the sowing rate.

- With lucerne, avoid soils with pH < 5.3 ($CaCl_2$), inoculate the seed (and lime pellet if pH is between 5.3 and 5.5 ($CaCl_2$)), and band a certified P-fertiliser with the seed.

- If organic producers are re-establishing perennial pastures, under-sowing should be avoided, especially where moisture is likely to be limiting. If it must be practiced, then reduce the sowing rate of the cover crop (use half or one third of recommended sowing rate of cereal) and choose a less competitive crop than oats.

- Increasing the seeding rate may provide more DM yield in the first year but generally has no effect on plant density in following years. Producers should consider carefully whether they need to boost seeding rates (exception being direct drilling), as pasture seed is a costly input.

- There is potential to manage native grasses for increased productivity and improved sustainability, thereby reducing the costs and risks associated with re-seeding with introduced species. However, there is a need to provide further information on the identification and management of native grass species so that these can be fully utilised.

- Organic producers, and those considering conversion, need to take further advantage of the existing extension material and training packages available for weed management (CRC Weed publications), perennial pasture establishment (Agnotes™ and Primefacts™) and grazing management (e.g. Prograze™).

- More evaluation into perennial pasture performance under a range of soil, climatic and grazing regimes is required for producers to make better decisions on species selection for their enterprise and location.

- Collation and interpretation of existing pasture performance data into an ‘organic-friendly’ format for use on the ‘Organic Knowledge Hub’ would benefit existing and new entrants to organic farming.

# 8. References


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# 9. Appendices

## I. Perennial Pasture Survey Questions

| Survey section | Question | Alternative answers |
|---|---|---|
| 1. Property size, conversion history and demographic information | What is the size of your farm? | (acres or hectares) |
| | When did you start farming organically (prior to certification)? | Year |
| | When did you first apply for organic certification? | Year |
| | When did you achieve conversion certification? | Year |
| | When did you achieve full organic/biodynamic certification? | Year |
| | Can you tell me your age? | Less than 20 years; 20 - 29 years; 30 - 39 years; 40 - 49 years; 50 - 59 years; 60 - 69 years; 70 years or over |
| 2. Perennial pasture information | What area of your farm is under pasture this year (2005)? | (acres or hectares) |
| | What proportion of the area under pasture is perennial pasture? | (acres or hectares) |
| | Can you describe the pastures on your farm? | Species |
| 3. Pasture establishment information | Have you tried to sow/establish a perennial pasture on your farm since you have farmed organically? | Yes/No |
| | Think about the most recent time you sowed a perennial pasture. What year was this? | Year |
| | Did you take a soil test before sowing the perennial pasture you just described? | Yes/No |
| | What perennial species or species mix did you sow? | |
| | Why did you select these species? | |
| | How did you sow it? - Soil preparation | Cultivated/Direct drilled |
| | How did you sow it? - Sowing method | Row sown/Broadcast/Under-sown |
| | How did you sow it? - Fertiliser | Yes/No |
| | How did you sow it? - Inoculate legumes | Yes/No |
| | How did you manage competition from other plants/weeds in the establishment process? | Before sowing and after sowing |
| | What do you think would be the major difficulties that you would | |

| | | |
|---|---|---|
| | face when sowing a perennial pasture? | |
| 4. Native grass pasture information | Are you aware that there are native perennial grass species on most farms? | Yes/No |
| | Have you observed native grass species on your farm? | Yes/No |
| | Do you manage native grass pastures differently or the same as introduced pastures? | Differently/Same as introduced species |
| | How do you manage native grass pastures on your farm? | |
| 5. General perennial pasture management | With regard to grazing management, how important are the following factors in your decision to move stock out of a paddock? | Leaf/growth stage of the pasture species? Height of the pasture? Time on the pasture? Paddock has run out of feed? Stock is ready to be sold? Other? |
| | Do you lock up (exclude from grazing) perennial pastures to allow them to set seed? | Yes/No |
| | Is there any other reason that you might lock up (exclude from grazing) perennial pastures? | |

## II. Organic Farming: Perennial Pasture Establishment, DPI Agnote AG 1263

**Organic Farming: Perennial Pasture Establishment**

## III. Organic Farming: Perennial Pasture Management, DPI Agnote AG 1278

**Organic Farming: Perennial Pasture Management**

## IV. Other project publications


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# Establishing Perennial Pastures

## *The foundation for sustainable organic farming systems*

RIRDC Publication No. 08/134

This publication assists in understanding the requirements to establish and manage introduced perennial pastures, and to increase the perennial grass component of native pastures, in dryland organic farming systems.

The research is important because experienced organic producers and new entrants to organic production need to know the best methods to establish and manage a perennial system for both productivity and long term persistence.

Dryland farming systems require perennial species in order to be environmentally and economically sustainable. Perennial pasture species have the potential to address the water imbalance in current agricultural systems, reduce nitrate leaching that contributes to soil acidification and, once established, are competitive and can reduce annual weed species invasion thereby assisting in chemical-free weed management.

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Phalaris (*Phalaris aquatica*)

Dryland farming systems require perennial species in order to be environmentally and economically sustainable.

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