# Foreword

**Dear grower**

The Eyre Peninsula Farming Systems summary is a valuable information source for growers seeking localised research results for the year in review and ABB is proud to once again be involved in the production of this key publication. I commend the Eyre Peninsula Agricultural Research Foundation (EPARF), Grains Research & Development Corporation (GRDC) and additional sponsors who have contributed to the 2006 publication's development.

The book is packed full of information for farmers, providing practical ideas to help you get the most out of your farm; including trial results, new grain varieties, soil and fertiliser information and disease management strategies.

The EPARF, the supporting body behind this publication, promotes farming excellence and through its valuable work encourages members of the agricultural industry to work together towards ensuring a sustainable future, something that ABB wholeheartedly supports and is committed to working towards.

ABB recognises the crucial role that research and development plays in promoting the need for ingenuity in farming practices and helping the Australian agricultural industry to prosper.

ABB is committed to assisting research and development initiatives through its ongoing support for trial groups, grower improvement groups and research organisations. In our most recent financial year ABB invested more than $2.1 million into research and development activities.

I commend this publication and its contributors for the lead they've taken in providing Eyre Peninsula growers with localised research and development information and results that promote new ideas and innovative ways of farming.

**Michael Iwaniw**
**Managing Director**
**ABB Grain Ltd**

# Foreword

This year GRDC is joined by Meat & Livestock Australia, Australian Wool Innovation, and Land & Water Australia in welcoming you to the 2006 edition of the Eyre Peninsula Farming Systems Summary. Through Grain & Graze, this partnership of research bodies is pleased to associate itself with the tremendous progress being made in developing farming systems appropriate to meeting the demands of producers from across Eyre Peninsula.

As ever, the summary remains an excellent and effective presentation of information relevant to producers in Eyre Peninsula and beyond. It reports on the main activities of innovation carried out on the peninsula in 2006 whether supported through Grain & Graze or the wider program portfolio of GRDC. Once again, the summary includes insights from other similar low rainfall areas working together in the Low Rainfall Collaboration Project.

With Grain & Graze beginning to hit its stride in the Eyre Peninsula, we are seeing a growing appreciation of the wider benefits farming systems research, development and extension can yield. In addition to delivering greater productivity and profit, other benefits can be seen in healthier farms through better resource condition. And having healthier farms often means having healthier lifestyles, families and communities.

The triple bottom line is sometimes taken lightly, but very few farmers deny the importance of, and pride they take from, environmental and social outcomes of good production research.

The face of agriculture is rapidly changing, and 2006 highlighted the uncertainties of climate, the market and the traditional institutional arrangements supporting it. Farming systems research is about building resilience into the operations of farming businesses. Much of this resilience lies in the capacity to be flexible and adaptive, and to make decisions based on risk assessment. It is here that the work of GRDC's farming systems projects, together with Grain & Graze activities, promises to address producer needs.

Of course, building resilience in exceptional years is tough, and indeed 2006 was among the toughest of all exceptional years. Building resilience therefore is also about building resolve — resolve to change; resolve to improve; resolve to be prepared.

The history of Australian agriculture tells us that those who don't or won't change, adapt and improve don't attain the productivity gains needed year after year to remain viable. For this reason, farming systems research will always have a role to play in providing producers with options to reduce costs, overcome constraints and open up new opportunities. On traditional specialist grain farms, this may mean diversifying into, or perhaps going back into, pasture and animal production.

It is here that Grain & Graze intends to support the wider farming systems research and extension efforts in Eyre Peninsula.

In collaborating in national programs such as Grain & Graze, some observations may be made of Eyre Peninsula farmers, researchers and extension specialists. Compared to many other regions across Australia, the relationship between these groups is very special. Putting the farmer first is definitely not a rhetorical aspiration! Indeed, much of what is reported in this summary has been achieved by producers working closely with the research and extension teams.

Eyre Peninsula remains an important part of Australian agricultural production, and GRDC continues to view the region as an important area in which to invest. Through Grain & Graze, other investors are seeing the benefits of investing here too. As with any investment, however, there must be a return to the investor. An initial indicator of whether an investment will yield dividends or not lies in the participation rate in the learning process. Sitting on the fence, watching others and waiting for results can therefore be self defeating in that investors may not sense the worth their investment has to producers.

The key message to be taken from this is that while not everyone may want to become involved in projects at the group level, there is certainly value in demonstrating an interest in research activities by getting involved in other ways. Here, producers should be at the forefront of the extension challenge!

You will see from this summary that there is certainly no shortage of farming systems activities to participate in. So get out there, dive in, get about and do whatever it takes to get the best from the research going on in and around Eyre Peninsula!

May 2007 see you grow and prosper.

**RICHARD PRICE**

National Coordinator

Grain & Graze

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## Eyre Peninsula Farming Systems 2006 Summary

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All article submissions are reviewed by the Editorial Team prior to publication for scientific merit and to improve readability, if necessary, for a farmer audience.

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### Front cover

From left to right — EP Grain & Graze Lotfeeding and Nutrition Field Day, eastern Eyre Peninsula; Emma McInerney and Alison Frischke in EPARF Grain & Graze demo plots; New Haldrup Plot Harvester funded by SARDI and SAGIT.

### Back cover

From top to bottom — MAC 2006 Field Day, Farmers at 2006 EPARF Grain & Graze Field Day; Karcultaby Area School staff and students at 2006 EPARF Grain & Graze Field Day; Farmer utes at Eyre Peninsula Field Day.

### Inside back cover

Photos from various Eyre Peninsula agricultural events in 2006.

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# About this manual

Hi all,

This year the Eyre Peninsula Farming Systems 2006 Summary is supported by ABB Grain Ltd, Grains Research & Development Corporation (GRDC) through the Eyre Peninsula Farming Systems Project, and Meat & Livestock Australia, Australian Wool Innovation, Land & Water Australia and GRDC through the Eyre Peninsula Grain & Graze Project. We would like to thank the sponsors for their contribution to the Eyre Peninsula communities for research, development and extension, and enabling us to extend our results to all farm business on the peninsula and beyond in other low rainfall areas.

Unfortunately, due to the poor 2006 season, some trials were established but not harvested. These are listed in this manual, but with no results to report! However, all was not lost, and the manual once again presents a *book full* of very useful information.

The Eyre Peninsula Farming System project continues to research the two big issues of plant-available water and disease suppression. A new SAGIT-funded project has begun to identify if soil compaction exists on Eyre Peninsula and what we can do to address the issue.

The Eyre Peninsula Grain & Graze Project continues research and extension on grazing cereals, feed base management (filling feed gaps, grazing management) and livestock management (stock nutrition, lambing percentage), and the farm biodiversity study with Eyre Peninsula NRM across the peninsula.

Risk management is a issue that faces all farm businesses and the Eyre Peninsula Farm Profitability Workshops have been developed jointly by Grain & Graze and Eyre Peninsula Farming Systems to allow farmers to give their business a 'health check', and determine what is the best mix of cropping and livestock for their farming system and resources. Be sure to check out the new Risk Management section in this manual.

Dates to remember for this year are the MAC Annual Field Day on 21 August, and the 2007 EPARF Disease Field Day on 20 September.

We hope you enjoy the 2006 Summary of research results and extension from Eyre Peninsula (*and remember to bring your research ideas to the farmer meetings in a few weeks*).

We look forward to working with you again and seeing you at our events, and hope 2007 is a good season!

**AMANDA COOK**
Eyre Peninsula Farming Systems
Project Coordinator

**ALISON FRISCHKE**
Eyre Peninsula Grain & Graze
Project Coordinator

# Contents

# Eyre Peninsula Agricultural Research Foundation (EPARF)

EPARF
EYRE PENINSULA
Agricultural Research Foundation Inc.

## 2006 IN REVIEW

### Rowan Ramsey, Chairman EPARF

EPARF continues to represent the farmers of Eyre Peninsula in many ways, most importantly by negotiating to bring relevant agricultural research and extension to the peninsula. If we are to maintain competitive and viable farming communities it is imperative we continue to invent, adapt and adopt!

During the year, EPARF attended the annual SARDI Executive visit and it was then we saw the value of our restructure of the last few years. SARDI is currently going through some structural reform and, while this will present some challenges to us, we are very well positioned to adapt and prosper in the new environment.

The Minnipa Agricultural Centre (MAC) is extremely well run by Sam Doudle and the enthusiastic, professional and dedicated group working with her. It is a pleasure to work with this team.

One of the highlights of the year was the Foundation Field Day in August. More than 250 people attended to learn from an excellent group of speakers on livestock management and how to integrate crops and livestock more profitably on the farm. It highlighted to the EPARF Board the need to maintain this balance in future work.

One of the key roles of EPARF is to identify new research opportunities and position MAC to participate in them.

During the last 12 months we have been considering how we measure, contribute to and will adapt to climate change. Many of our responses may not be much different to what has gone before, say 'drought tolerant wheat'; see Sam Doudle's climate change article in this manual for more information.

EPARF is playing a leading role in various tillage methods and crop canopy management, and has developed important linkages with Western Australian scientists in this regard. This involves the EP Farming Systems Project and MAC Farm research into row spacing, seeding rates, N timing, etc. which are all aimed at making better use of plant-available water by the crop.

In all of its work, EPARF is linked to other research centres and farm systems projects through its active involvement in the Low Rainfall Collaboration Project, which involves groups across southern Australia.

Another key role of EPARF is to market MAC and the Eyre Peninsula as an attractive place for rural-based business to invest. We have been fortunate to attract such a cooperative group of partners.

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The major funders of MAC are also acknowledged — SARDI, as owners and operators of MAC; GRDC as a major investor in programs; University of Adelaide as a collaborator and investor in programs; and SAGIT which provides strategic staff and support programs.

During the year there were a number of changes to our EPARF Board. Three long-standing and incredibly valuable members stepped down.

Ed Hunt was the first. Ed is missed at EPARF level but we are extremely grateful that he continues to have involvement with our Farming Systems and Grain & Graze projects and farm management. Thanks Ed.

Peter Gibson has been the SARDI Management Representative on the EPARF Board (and its predecessor, the MAC Committee) since 1996. Peter's experience, support, aura of calmness and quirky sense of humour has been invaluable to the EPARF Board and MAC Management.

And finally, Paul Kaden. It is impossible to overstate Paul's contribution. Enthusiastic and energetic, a stronger advocate one could not imagine. Although a loss to the EPARF Board, Paul continues to provide valuable input as Chairman of the Grain & Graze Committee.

But with the loss, comes the opportunity to bring in fresh blood.

Mathew Dunn from Rudall and Brent Cronin from Piednippie join the board as farmer members.

Tim Richardson from Cummins has been appointed from agribusiness, and through his involvement with Lower Eyre Agricultural Development Association (LEADA) provides that important link.

Geoff Thomas who has been working with us during the review took Neil Smith's place and helps give us perspective from the outside world.

As part of the SARDI restructure, Rob Thomas has replaced Peter Gibson as the SARDI Management Representative.

Thank you all for your continued support of agricultural research in our dryland environments. A membership base for EPARF is one of the most important things we have ever done to promote our cause. This committee is listened to because our partners know that over 300 Eyre Peninsula farmers are committed to the cause. Your membership fees are important to us, but your involvement and support are more so.

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# 2006 Eyre Peninsula Seasonal Summary

**Neil Cordon[1], Kieran Wauchope[2] and Linden Masters[2]**

[1]Minnipa Agricultural Centre, [2]Rural Solutions SA Sustainable Agriculture Systems Consultants

### Western Eyre Peninsula

Like most of South Australia, farmers and advisers have had a reminder of how resilient and tough the 'old' cereal plant is. Yes, it was a drought year with most farmers losing money from their cropping program, but it was often heard 'Gee, I don't know how the crop is hanging on, as we've had little rain since July'.

- The last week of April saw 5–20 mm of rainfall, mainly along coastal areas, which enabled some early sowing. Up to 30 mm during May and similar for June saw seeding completed by the end of June. The early sown crops were growing well, while cold frosty weather slowed growth for the later sown crops. July was the last month of significant rainfall, and little rain through to harvest depressed crop growth and grain yields.
- Most districts received below average annual rainfall and, despite significant falls early in the year, the growing season rainfall was well below average. Rainfall (mm) at selected centres (growing season in brackets) was Streaky Bay 264 (150), Penong 212 (110), Nundroo 301 (135), Minnipa 235 (112), Mount Cooper 284 (147) and Elliston 318 (175).
- Insects were an issue again in 2006, partly as a result of seasonal conditions and partly because of our farming systems. Locusts were prevalent in April and October in the Nundroo area, while Polyphrades caused some damage to emerging crops on lighter soils. The predominant insect was aphids, with a range of species attacking medics, cereals, pulses and canola crops. Spraying was carried out with questionable effectiveness due to issues such as poor identification of insects and thresholds, and insecticide timing, rate and type.
- Mice were a localised problem, with baiting conducted from Kyancutta through to Penong.
- The major root disease to show up early was *Rhizoctonia*, and areas of cereal cyst nematode were identified in July.
- Stem rust was identified in self-sown wheat in the Far West during January, and it wasn't long before the disease was located throughout Eyre Peninsula. It was evident in early sown susceptible varieties during the growing season, but weather conditions reduced its effect.
- Summer rains created an ideal environment for summer weeds, which saw widespread chemical control across the district. Pasture growth was excellent early, and powdery mildew was evident in most medic-based pastures. Although pasture production was not bulky, the feed value was extremely good resulting in excellent stock condition.
- Overall the yields on Western Eyre Peninsula were well below average, ranging from 0.2 to 1.0 t/ha. Most farmers had a large range of yields from areas that were not harvested and which then provided some early grazing to areas of early sown crops that may have reached average yields. The more favourable areas were Elliston, Streaky Bay, Nundroo and north of Ceduna. Many paddocks of field peas and canola were not harvested.
- Overall harvest quality was good, with low screenings, high protein and high test weights.

### Eastern Eyre Peninsula

The 2006 season on Eastern Eyre Peninsula started with promise but the lack of significant rainfall after July saw yield potential deteriorate rapidly. Crops yields were totally dependent on plant-available water, and soil type amplified this.

- Early rainfall was patchy, with thunderstorms in the Cowell Hills and Arno Bay, and early sowing achieved above average yields. Unfortunately Tooligie–Murdinga did not receive any substantial rain, with many waiting until July to sow. Heavy soils suffered badly with the districts of Kelly, Kimba and Buckleboo worst affected.
- March, April and May saw falls of 10–15 mm each month, with thunderstorms delivering 20–30 mm in isolated pockets. Cleve averaged 30 mm for June and 67 mm for July. For many areas the growing season rainfall was in the 1–2 decile range, which is considered a drought, but the effect was seen economically rather than damage to the land. The farmers who used minimum-till, stubble retention and were not over-stocked saw only small areas of land suffer from wind erosion damage. Late June and July are our wind prone months, but good cover from the previous year and timeliness of sowing provided excellent cover during this period.

- Crop yield varied greatly, with heavier soils and sodic flats 'haying off' completely, or at the best returning seed. Kelly, Kimba and Buckleboo were the worst hit districts. As a generalisation, wheat and barley averaged around 0.6 t/ha across the region. Excellent grain quality and better yields than expected surprised many farmers. Average and above average yields were harvested from soils with sand over clay.
- Stock feed, although minimal, was of a high quality and several farmers were able to buy in additional breeding stock. Little medic pasture was cut for hay and a limited quantity of cereals were baled. Farmers may use containment feedlots until the break of the season in 2007.
- For many farmers it has been an economic drought, with a poor season in 2004, low grain prices in 2005, and grain prices not meeting the cost of production in 2006. Managing risk is a high priority for 2007. The high cost of production — particularly for diesel fuel, weed sprays, fertiliser and machinery replacement — will continue to be a challenge to cropping enterprises. Farmers may consider increasing sheep numbers as a tool for balancing the high input costs of cropping and minimising risk.

### Lower Eyre Peninsula

Significant rainfall through the first few months created much enthusiasm for the season. Farmers could sow early and crops were healthy until the rainfall went well below a decile 5 from June onwards. Fortunately, grain quality was generally good and commodity prices were well above the 2005 year.

- The first three months of the year provided most of the region with rainfall above decile 8, encouraging good weed germination and provided green feed for stock. Port Lincoln received around 40 mm for each month.
- Most districts ended the year with well below average rainfall, and even after large falls at the beginning of the year the growing season rainfall was a long way short of average. Rainfall (mm) at selected centres (growing season in brackets) was Koppio 374 (207), Wangary 446 (263), Ungarra 266 (140) and Cummins 336 (179). The annual rainfall for these centres was either the lowest or second lowest on record.
- A green bridge, combined with the ideal climatic conditions at the start of the season, created a large stem rust outbreak with the first sighting being at Brimpton Lake.
- High rainfall allowed good clover germination, produced good feed, and more farmers invested in improved pastures, resulting in the good condition of stock.
- Farmers took the opportunity to sow canola and some beans in early May, creating a high yield potential.
- June brought in cold and frosty conditions, slowing plant growth and affecting the germination of later sown crops.
- During July, the rainfall decile dropped to around 3. August had hot, dry and windy (80+ kph) conditions, making moisture stress evident during the vulnerable flowering period.
- Aphids caused damage as well as large numbers of heliothis, making farmers spend extra money when things were already tight.
- The region from Kapinnie to Yeelanna, through to Ungarra and above, was more exposed to drought conditions as September, October and November were all well below decile 1 for the year.
- Spending had stopped by mid–September, with farmers becoming very hesitant about spraying for disease or insect problems.
- Canola yields varied from 100 kg/ha (northern LEP) to 1.3 t/ha (southern LEP), with the average for LEP being 0.5 t/ha. Oil quality was also variable, with levels ranging from 30 to 43%. Beans were of good quality and yielded around 1–1.2 t/ha. Peas yielded poorly, with 0.6–1 t/ha being the standard. Barley had a great level of variation across the region, with reports of yields between 1and 2.3 t/ha and an average at Cummins of around 2 t/ha. Wheat had similar yields and variation across the region, with high protein and few screenings.

# Understanding Trial Results and Statistics

## Jim Egan, SARDI, Port Lincoln

Interpreting and understanding replicated trial results is not always easy. We have tried to report trial results in this book in a standard format to make interpretation easier. Trials are generally replicated (treatments repeated two or more times) so there can be confidence that the results are from the treatments applied, rather than due to some other cause such as underlying soil variation or simply chance.

### The average

The results of replicated trials are often presented as the average (or mean) for each of the replicated treatments. Using statistics, means are compared to see whether any differences are larger than is likely to be caused by natural variability across the trial area (such as changing soil type).

### The LSD test

To judge whether two or more treatments are different or not, a statistical test called the Least Significant Difference (LSD) test is used. If no appreciable difference is found between treatments then the result shows 'NS' (not significant). If the statistical test finds a significant difference, it is written as '$P \leq 0.05$'. This means there is a 5% probability or less that the observed difference between treatment means occurred by chance, or we are at least 95% certain that the different results are due to the treatment effects.

The size of the LSD can then be used to compare the means. For example, in a trial with four treatments, only one treatment may be significantly different to the other three — the size of the LSD is used to see which treatments are different.

*Table 1 Mean grain yields of fertiliser treatments (four replicates per treatment)*

| Treatment | Grain yield (t/ha) |
|---|---|
| **Control** | **1.32 a** |
| **Fertiliser 1** | **1.51 a,b** |
| **Fertiliser 2** | **1.47 a,b** |
| **Fertiliser 3** | **1.70 b** |
| **Significant treatment difference** | **$P \leq 0.05$** |
| **LSD (P=0.05)** | **0.33** |

### Results from a replicated trial

An example of a replicated trial of three fertiliser treatments and a control (no fertiliser), with a statistical interpretation, is shown in Table 1.

Statistical analysis indicates that there is a fertiliser treatment effect on yields. $P \leq 0.05$ indicates that the probability of such differences in grain yield occurring by chance is 5% (1 in 20) or less. In other words, it is highly likely (more than 95% probability) that the observed differences are due to the fertiliser treatments imposed.

The LSD shows that mean grain yields for individual treatments must differ by 0.33 t/ha or more for us to accept that the treatments do have a real effect on yields. These pairwise treatment comparisons are often shown using the letter as in the last column of Table 1. Treatment means with the same letter are not significantly different from each other. The treatments that do differ significantly are those followed by different letters.

In our example, the control and fertiliser treatments 1 and 2 are the same (all followed by 'a'). Despite fertilisers 1 and 2 giving apparently higher yields than control, we can't dismiss the possibility that these small differences are just due to chance variation between plots. And the three fertiliser treatments have to be accepted as giving the same yields (all followed by 'b'). But fertiliser treatment 3 can be accepted as producing a yield response over the control, indicated in the table by the means not sharing the same letter.

### On-farm testing — Prove it on your place!

Doing an on-farm trial is more than just planting a test strip in the back paddock, or picking a few treatments and sowing some plots. Problems such as paddock variability, seasonal variability and changes across a district all serve to confound interpretation of anything but a well-designed trial.

Scientists generally prefer replicated small plots for conclusive results. But for farmers such trials can be time consuming and unsuited to use with farm machinery. Small errors in planning can give results that are difficult to interpret. Research work in the 1930s showed that errors due to soil variability increased as plots got larger but, at the same time, sampling errors increased with smaller plots.

The carefully planned and laid out farmer unreplicated trial or demonstration does have a role in agriculture as it enables a farmer to verify research findings on his particular soil type, rainfall and farming system, and we all know that 'if I see it on my place, then I'm more likely to adopt it'. On-farm trials and demonstrations often serve as a catalyst for new ideas, which then lead to replicated trials to validate these observations.

The bottom line with unreplicated trial work is to have confidence that any differences (positive or negative) are real and repeatable, and due to the treatment rather than some other factor.

To get the best out of your on-farm trials, keep the following points in mind:

- Choose your test site carefully so it is as uniform as possible and representative — yield maps will help, if available.
- Plan and identify what sort of treatments you wish to investigate and their possible effects. Don't go overboard with too many treatments.
- Make treatment areas to be compared as large as possible, at least wider than your header.
- Treat and manage these areas similarly in all respects, except for the treatments being compared.
- If possible, place a control strip on both sides and in the middle of your treatment strips, so that if there is a change in conditions you are likely to spot it by comparing the performance of control strips.
- If you can't find an area that is completely even for everything, then run your strips in a direction so that all treatments are equally exposed to the changes. For example, if there is a slope, run the strips up the slope. This means that all strips will have part of their length on the flat, part on the mid-slope and part at the top of the rise. This is much better than running the strips across the slope, which may mean that your control ends up on the sandy soil at the top of the rise and your treatment on the heavy flat. This would make a direct comparison very tricky.
- Record treatment details and monitor the test strips, otherwise the whole exercise will be a waste of time.
- If possible, organise a weigh trailer come harvest time, as header yield monitors have their limitations.
- Don't forget to evaluate the economics of treatments when interpreting the results.
- Yield mapping provides a new and very useful tool for comparing large-scale treatment areas in a paddock.

The 'Crop Monitoring Guide' published by Rural Solutions SA and available through PIRSA district offices has additional information on conducting on-farm trials.

# Types of work in this publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad-scale nature, care should be taken when interpreting results from demonstrations.

| Type of work | Replication | Size | Work conducted by | How analysed |
|---|---|---|---|---|
| Demo | No | Normally large plots or paddock size | Farmers and agronomists | Not statistical, trend comparisons |
| Research | Yes, usually 4 | Generally small plot | Researchers | Statistics |
| Survey | Yes | Various | Various | Statistics or trend comparisons |
| Extension | N/A | N/A | Agronomists and researchers | Usually summary of research results |
| Information | N/A | N/A | N/A | N/A |

# Some Useful Conversions

### Area

1 ha (hectare) = 10 000 m2 (square 100 m by 100 m)

1 acre = 0.4047 ha (1 chain (22 yards) by 10 chain)

1 ha = 2.471 acres

### Mass

1 t (metric tonne) = 1000 kg

1 imperial tonne = 1016 kg

1 kg = 2.205 lb

1 lb = 0.454 kg

A bushel (bu) is traditionally a unit of volumetric measure defined as 8 gallons.
For grains, one bushel represents a dry mass equivalent of 8 gallons.
Wheat = 60 lb, Barley = 48 lb, Oats = 40 lb

1 bu (wheat) = 60 lb = 27.2 kg

1 bag = 3 bu = 81.6 kg (wheat)

### Volume

1 L (litre) = 0.22 gallons

1 gallon = 4.55 L

1 L = 1000 mL (millilitres)

### Speed

1 km/h = 0.62 miles/h, 10 km/h = 6.2 miles/hr, 15 km/h = 9.3 miles/h

10 km/h = 167 m/minute = 2.78 m/second

### Pressure

10 psi (pounds per sq inch) = 0.69 bar = 69 kPa (kiloPascals)

25 psi = 1.7 bar = 172 kPa

### Yield

1 t/ha = 1000 kg/ha

### Yield approximations

| | | | |
|---|---|---|---|
| Wheat | 1 t = 12 bags | 1 t/ha = 5 bags/acre | 1 bag/acre = 0.2 t/ha |
| Barley | 1 t = 15 bags | 1 t/ha = 6.1 bags/acre | 1 bag/acre = 0.16 t/ha |
| Oats | 1 t = 18 bags | 1 t/ha = 7.3 bags/acre | 1 bag/acre = 0.135 t/ha |

# 2006 trials sown but not harvested or reported

### Soil Rhizobia — Neil Cordon

Soil was collected from EP farms by MAC staff for Nigel Charman (Pasture Research Scientist) to study the effectiveness of soil rhizobia. Due to a redirection of resources, the project was halted and the soils placed in storage for future evaluation. This was to follow up work documented in Eyre Peninsula Farming Systems Summary 2000, page 49.

### Enhancing Lupin Establishment — Neil Cordon

A demonstration using MAC's Fluid Fertiliser cart on Neild's property at Mangalo to evaluate the effectiveness of wetting agents in non-wetting sands to enhance lupin emergence and establishment.

Early visual observation showed no differences, but seasonal conditions limited harvest opportunities.

### *Polyphrades* Weevil Demonstration — Neil Cordon

This demonstration was to evaluate insecticides to control the *Polyphrades* or native weevil. The site was at Brenton Goosay's property, Streaky Bay, in conjunction with the local agricultural bureau.

Recommended control strategies are spraying with deltamethrin at 300 mL/ha ($6.45/ha) when numbers reach 300/m2. In 2005, farmers had good control with alpha-cypermethrin at rates ranging from 100 to 200 mL/ha ($1.60/ha).

In many situations, weevil numbers have built up and become active before patches appear so this demonstration planned to use pre-sowing and post-sowing but pre-emergent applications of alpha-cypermethrin, with the aim of achieving control and relieving early pressure on emerging plants. Due to low weevil numbers, no visual differences were seen and the plots were not harvested.

Preventative insecticides may provide short-term solutions but the repeated use of some chemicals increases the risk of the pest population becoming resistant, making the chemical ineffective. A broad-brush approach also has a negative influence on beneficial insects, which is a detriment to our farming system.

### Iceplant Control — Neil Cordon

This trial was conducted on Craig Trowbridge's property at Penong to evaluate those herbicides tested in 2005 that provided good economic control of iceplant in a medic-based pasture. Due to seasonal conditions and target weeds being too far advanced, there was little control of iceplant so no results can be reported with confidence. This work is planned for 2007.

### Pratylenchus — Sharyn Taylor and Leigh Davis

This trial was located on Michael Zerk's property at Lock and aimed to assess tolerance response of wheat lines within two doubled haploid populations to determine relative contributions of drought and P. neglectus tolerance on yield. This information was to be used to develop molecular markers to drought tolerance in wheat.

### S1 Canola — Trent Potter, Willie Shoobridge and Leigh Davis

Based at MAC, these trials were not harvested due to poor emergence and dry seasonal conditions.

### S4 Vetch — Rade Matic, Willie Shoobridge and Leigh Davis

These trials at MAC were not harvested due to dry conditions and poor crop growth.

### Late Sown Oilseeds — Leigh Davis, Willie Shoobridge and Jim Egan

This trial contained the same oilseed varieties (conventional canola and mustard lines, and TT canola) as the early sown trial to compare varieties at the two times of sowing. The late sown (2 June) trial failed due to poor establishment and subsequent growth in the very dry conditions, and most varieties failed to set seed.

### Subsoil amelioration on a sand over clay — Nigel Wilhelm, Damien Adcock, Terry Blacker, Ian Richter

2006 was the third year of a trial being conducted on Alan and Mark Edward's property at Darke Peak. This site is on water repellent sand and was sown last year under very marginal moisture conditions. There was little follow up rain and establishment was so poor and patchy that there was insufficient crop to harvest at the end of the year.

### Seed dressings for *Rhizoctonia* control in wheat and barley — Jo Crouch and Brian Purdie

These trials were conducted to evaluate potential seed dressing controls for *Rhizoctonia* in cereals and were carried out at four different locations — Cowell on Jack Kaden's property; Warramboo on David Murphy's property; Elliston on Nigel May's property; and Wharminda on Gavin Master's property. These trials were harvested, but no conclusive results were obtained due to the dry conditions.

Section 1

**Section editor:**
**Neil Cordon**
SARDI
Minnipa Agricultural Centre

# Cereals

**The total 2006 production figures for Eyre Peninsula were approximately 520 000 t of wheat, 240 000 t of barley, 8000 t of oats and 2000 t of triticale.**

## CEREAL VARIETY EVALUATION, 2006

### *Oat Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as t/ha and as % of Echidna's yield.*

| Variety | 2006 (t/ha) | | | 7 year average (2000–06) (% Echidna) | | |
|---|---|---|---|---|---|---|
| | Minnipa | Nunjikompita | Greenpatch | Minnipa# | Nunjikompita | Greenpatch |
| **Echidna** | | 0.57 | 1.13 | 100 | 100 | 100 |
| **Euro** | No | 0.65 | 1.54 | 93 | 91 | 96 |
| **Kojonup** | valid | 0.36 | 1.42 | | 83 | 97 |
| **Mitika** | result, | 0.58 | 1.73 | 103 | 97 | 108 |
| **Possum** | droughted | 0.69 | 1.89 | 102 | 97 | 106 |
| **Potoroo** | | 0.65 | 1.25 | 101 | 103 | 103 |
| **Quoll** | | 0.53 | 1.15 | 101 | 99 | 101 |
| **Echidna yield (t/ha)** | | **0.57** | **1.13** | **1.55** | **1.23** | **3.16** |
| **Date sown** | 6 June | 30 May | 13 May | | | |
| **Soil type** | SCL/CLS | SL | L/MC | | | |
| **pH (water)** | 111 | 109 | 262 | | | |
| **Apr–Oct rain (mm)** | 8.6 | 8.8 | 5.6 | | | |
| **Site stress factors** | de,dl,bt | de,dl,r | de, dl, b, w, rlem | | | |

*# 7 year long term from 1999 to 2005 only, as 2006 was droughted*
***Soil type:** S = sand, L = loam, C = clay, Li = light, M = medium, H = heavy, / = separates top soil from subsoil*
***Stress factors:** b = BYDV, bt = boron toxicity, de = pre-flowering moisture stress, dl = post-flowering moisture stress, r = Rhizoctonia, rlem = red mite, w = weeds*
***Data source:** NVT, GRDC and SARDI Crop Evaluation and Oat Breeding Programs (long-term data based on weighted analysis of sites)*
***More information:** Rob Wheeler (08) 8303 9480 or e-mail wheeler.rob@saugov.sa.gov.au*

### *Triticale Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as a % of Tahara's yield.*

| Variety | 2006 | | | | 7 year average (2000-06) | | | |
|---|---|---|---|---|---|---|---|---|
| | Greenpatch | Minnipa | Streaky Bay | Wharminda | Greenpatch | Minnipa | Streaky Bay | Wharminda |
| **Credit** | 88 | | | | 97 | 92 | 89 | 90 |
| **Everest** | 97 | | | | 99 | 101 | 95 | 98 |
| **Kosciuszko** | 120 | 86 | 104 | 119 | 106 | 107 | 106 | 109 |
| **Rufus** | 115 | 97 | 104 | 115 | 102 | 102 | 101 | 103 |
| **Speedee** | 120 | 106 | 123 | 136 | 104 | 104 | 100 | 105 |
| **Tahara** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Tickit** | 106 | 100 | 97 | 103 | 100 | 99 | 101 | 105 |
| **Treat** | 99 | | | | 99 | 97 | 95 | 100 |
| **Tahara yield (t/ha)** | **1.230** | **0.710** | **0.540** | **0.920** | | | | |
| **Sowing date** | 13 May | 5 June | 31 May | 6 June | | | | |
| **Soil type** | L/MC | SCL/CLS | SL/LS | S/SC | | | | |
| **pH (water)** | 5.6 | 8.6 | 8.6 | 8.5 | | | | |
| **Apr-Oct rain (mm)** | 262 | 111 | 132 | 110 | | | | |
| **Site stress factors** | de, dl, byd, w, rlem | de, dl, bt | de, dl, rh | de, dl, rh | | | | |

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## *Wheat Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as t/ha or as % of Frame's yield.*

| Variety | Upper, Eastern and Western Eyre Peninsula | | | | | | | | | | | | | | Mid and Lower Eyre Peninsula | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 (t/ha) | | | | | | | 7 year average (2000–06) (% Frame) | | | | | | | 2006 (t/ha) | | | 7 year average (2000–06) (% Frame) | | |
| | Kimba | Minnipa | Mitchell-ville | Nunji-kompita | Penong | Streaky Bay | Warram-boo | Kimba# | Minnipa | Mitchell-ville | Nunji-kompita | Penong | Streaky Bay | Warram-boo | Cummins | Rudall | Ungarra | Cummins | Lock–Rudall | Ungarra |
| **AGT Scythe**(b | | | 0.54 | 0.72 | 0.21 | 0.36 | 0.31 | 109 | 108 | 111 | 105 | 107 | 104 | 108 | 2.88 | 0.65 | 1.88 | 105 | 110 | 107 |
| **Annuello**(b | | | 0.47 | 0.65 | 0.17 | 0.21 | 0.12 | 101 | 100 | 98 | 95 | 99 | 94 | 97 | 2.98 | 0.45 | 1.78 | 103 | 101 | 104 |
| **Carinya**(b | | | 0.47 | 0.65 | 0.16 | 0.23 | 0.23 | | 106 | 108 | 101 | 104 | 101 | 106 | 2.83 | 0.50 | 1.87 | 104 | 107 | 106 |
| **Catalina** | | | 0.58 | 0.65 | 0.17 | 0.39 | 0.24 | | 106 | 111 | 103 | 105 | 103 | 106 | 2.90 | 0.77 | 2.01 | | | |
| **Chara**(b | | | | | | | | 89 | 93 | 85 | 90 | 91 | 91 | 91 | 2.56 | 0.41 | 1.44 | 99 | 95 | 98 |
| **Correll**(b | | | 0.55 | 0.73 | 0.21 | 0.38 | 0.28 | | 109 | 116 | 107 | 110 | 106 | 110 | 2.98 | 0.73 | 1.96 | 106 | 111 | 108 |
| **Derrimut**(b | | | 0.54 | 0.59 | 0.16 | 0.23 | 0.27 | | 108 | 111 | 104 | 107 | 103 | 107 | 3.14 | 0.77 | 2.15 | 105 | 109 | 107 |
| **Drysdale**(b | | | 0.48 | 0.67 | 0.24 | 0.44 | 0.24 | 99 | 99 | 101 | 95 | 97 | 98 | 100 | 2.75 | 0.73 | 1.54 | 100 | 100 | 100 |
| **EGA Wentworth**(b | No | No | 0.56 | 0.71 | 0.19 | 0.28 | 0.30 | 103 | 105 | 106 | 99 | 102 | 99 | 104 | 2.73 | 0.63 | 1.98 | 103 | 106 | 105 |
| **Excalibur** | valid | valid | 0.59 | 0.85 | 0.25 | 0.47 | 0.32 | 110 | 108 | 111 | 106 | 110 | 107 | 110 | 3.10 | 0.80 | 1.99 | 105 | 110 | 106 |
| **Frame** | result, | result, | 0.42 | 0.54 | 0.16 | 0.40 | 0.15 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 2.76 | 0.49 | 1.52 | 100 | 100 | 100 |
| **GBA Ruby**(b | droughted | droughted | 0.51 | 0.74 | 0.18 | 0.41 | 0.28 | 109 | 106 | 107 | 102 | 104 | 103 | 107 | 3.01 | 0.75 | 1.85 | 104 | 109 | 105 |
| **Guardian** | | | 0.52 | 0.80 | 0.20 | 0.32 | 0.26 | | 107 | 110 | 104 | 106 | 103 | 107 | 3.17 | 0.66 | 2.16 | | | |
| **H46**(b | | | 0.50 | 0.67 | 0.24 | 0.39 | 0.41 | 110 | 107 | 109 | 101 | 105 | 102 | 108 | 3.25 | 0.91 | 2.29 | 106 | 112 | 108 |
| **Janz** | | | 0.54 | 0.72 | 0.20 | 0.34 | 0.23 | 96 | 99 | 97 | 94 | 96 | 92 | 97 | 2.67 | 0.55 | 2.12 | 99 | 98 | 102 |
| **Krichauff** | | | 0.55 | 0.69 | 0.23 | 0.53 | 0.26 | 105 | 107 | 109 | 102 | 106 | 104 | 106 | | | | 104 | 108 | 104 |
| **Kukri** | | | 0.50 | 0.64 | 0.16 | 0.33 | 0.24 | 96 | 98 | 99 | 93 | 95 | 94 | 96 | 2.74 | 0.63 | 1.90 | 98 | 98 | 99 |
| **Pugsley**(b | | | 0.43 | 0.65 | 0.15 | 0.35 | 0.17 | 113 | 107 | 114 | 106 | 109 | 105 | 108 | 2.80 | 0.56 | 1.74 | 106 | 110 | 108 |
| **Gladius**(b | | | 0.54 | 0.83 | 0.23 | 0.42 | 0.37 | | 113 | 120 | 113 | 115 | 111 | 115 | 3.05 | 0.94 | 2.03 | 107 | 116 | 110 |
| **SW Odiel**(b | | | 0.59 | 0.71 | 0.23 | 0.39 | 0.29 | 99 | 101 | 100 | 95 | 98 | 96 | 100 | 3.02 | 0.69 | 1.62 | 102 | 101 | 100 |
| **Wyalkatchem**(b | | | 0.58 | 0.65 | 0.21 | 0.39 | 0.32 | 115 | 110 | 113 | 105 | 109 | 106 | 110 | 3.00 | 0.77 | 2.08 | 109 | 117 | 110 |
| **Yitpi**(b | | | 0.46 | 0.59 | 0.20 | 0.42 | 0.18 | 109 | 106 | 111 | 105 | 107 | 105 | 106 | 2.90 | 0.57 | 1.84 | 103 | 106 | 104 |
| **Young**(b | | | 0.56 | 0.82 | 0.19 | 0.43 | 0.42 | 108 | 108 | 112 | 104 | 106 | 104 | 109 | 2.92 | 0.91 | 2.05 | 105 | 111 | 107 |
| **Frame yield (t/ha)** | | | **0.42** | **0.54** | **0.16** | **0.40** | **0.15** | **1.33** | **1.55** | **0.92** | **1.23** | **1.18** | **1.39** | **1.45** | **2.76** | **0.49** | **1.52** | **3.82** | **1.78** | **3.14** |
| **Date sown** | 5 June | 6 June | 1 June | 29 May | 2 June | 31 May | 6 June | | | | | | | | 19 May | 5 June | 6 June | | | |
| **Soil type** | LSC/SC | SCL/CLS | LC/SL/SC | SL | CL/SL/SCL | SL/LS | LS/CS | | | | | | | | MC | LS/C | SL/SC | | | |
| **pH (water)** | 105 | 111 | 97 | 109 | 117 | 132 | 101 | | | | | | | | 179 | 94 | 194 | | | |
| **Apr–Oct rain (mm)** | 8.3 | 8.6 | 8.6 | 8.8 | 8.9 | 8.6 | 8.5 | | | | | | | | 8.1 | 8 | 8 | | | |
| **Site stress factors** | de,dl | de,dl,bt | de,dl,e | de,dl,r | de,dl,m | de,dl,r | de,dl | | | | | | | | dl | de,dl | de,dl | | | |

*# 7 year long term from 1999 to 2005 only, as 2006 was droughted*

*(b = Plant Breeders' Rights*

***Soil type:** S = sand, L = loam, C = clay, Li = light, M = medium, H = heavy, F = fine*

***Site stress factors:** bt = boron toxicity, de = pre-flowering moisture stress, dl = post-flowering moisture stress, e = poor establishment, m = mice damage, r = Rhizoctonia*

***Data source:** SAFCEP, REML analysis. Long-term data based on weighted analysis of sites, Biometrics SA.*

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## *Barley Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as t/ha or as % of Schooner's yield.*

| Variety | Upper Eyre Peninsula | | | | | | | | | | Lower Eyre Peninsula | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 (t/ha) | | | | | 7 year average (2000–06) (% Schooner) | | | | | 2006 (t/ha) | | 2000–06 (% Schooner) | |
| | Darke Peak | Elliston | Minnipa | Streaky Bay | Wharminda | Elliston | Mangalo* | Minnipa# | Streaky Bay | Wharminda | Cummins | Wanilla | Cummins | Wanilla |
| **Barque**$^{(\text{D}}$ | | 1.56 | | 0.61 | 0.97 | 111 | 115 | 108 | 110 | 102 | | | 105 | 107 |
| **Baudin**$^{(\text{D}}$ | | 1.17 | | 0.61 | 1.05 | 100 | 106 | 105 | 104 | 97 | 2.89 | 2.45 | 103 | 104 |
| **Buloke**$^{(\text{D}}$ | | 1.40 | | 0.63 | 1.03 | 107 | | 109 | 104 | 102 | 3.14 | 2.99 | 108 | 111 |
| **Capstan**$^{(\text{D}}$ | | | | | | 109 | 117 | 116 | 111 | 100 | 3.11 | 2.17 | 108 | 107 |
| **Flagship™** | | 1.48 | | 0.57 | 1.13 | 104 | | 110 | 105 | 99 | 2.94 | 2.64 | 103 | 104 |
| **Fleet™** | No | 1.81 | No | 0.73 | 0.86 | 115 | | 115 | 114 | 105 | 3.33 | 3.15 | 111 | 111 |
| **Gairdner**$^{(\text{D}}$ | valid | 1.30 | valid | 0.54 | 0.80 | 105 | 111 | 103 | 104 | 90 | 2.59 | 2.29 | 99 | 101 |
| **Hindmarsh**$^{(\text{D}}$ | result | 1.76 | result | 0.91 | 1.26 | | | | | | 3.78 | 2.23 | | |
| **Keel** | droughted | 1.73 | droughted | 0.92 | 1.26 | 111 | 114 | 115 | 109 | 105 | 3.35 | 3.17 | 107 | 107 |
| **Maritime**$^{(\text{D}}$ | | 1.44 | | 0.61 | 1.07 | 105 | | 108 | 106 | 102 | 2.95 | 2.74 | 108 | 111 |
| **Schooner** | | 1.24 | | 0.58 | 1.12 | 100 | 100 | 100 | 100 | 100 | 2.97 | 2.25 | 100 | 100 |
| **Sloop**$^{(\text{D}}$ | | 1.27 | | 0.56 | 0.97 | 100 | 104 | 99 | 99 | 94 | 2.97 | 2.55 | 98 | 101 |
| **Sloop SA**$^{(\text{D}}$ | | 1.36 | | 0.63 | 1.14 | 100 | 106 | 103 | 101 | 95 | 3.10 | 2.47 | 100 | 100 |
| **Sloop VIC**$^{(\text{D}}$ | | | | | | 98 | 102 | 95 | 98 | 93 | | | 98 | 98 |
| **Torrens** | | | | | | 95 | 84 | 86 | 91 | 84 | 2.67 | 2.38 | 93 | 93 |
| **Vlamingh**$^{(\text{D}}$ | | 0.91 | | 0.40 | 0.83 | 95 | | | 94 | 87 | 2.77 | 2.51 | 99 | 102 |
| **Yarra**$^{(\text{D}}$ | | 1.61 | | 0.63 | 0.94 | 112 | | 116 | 108 | 101 | 3.18 | 2.38 | 109 | 109 |
| **Schooner yield (t/ha)** | | **1.24** | | **0.58** | **1.12** | **2.04** | **1.43** | **1.83** | **1.76** | **1.80** | **2.97** | **2.25** | **3.93** | **3.42** |
| **Date sown** | 5 June | 3 June | 5 June | 31 May | 6 June | | | | | | 7 June | 19 May | | |
| **Soil type** | LS/CLS | SL/S | SCL/CLS | LS | S/SC | | | | | | MC | NWS/MC | | |
| **pH (water)** | 118 | 175 | 111 | 113 | 110 | | | | | | 179 | 172 | | |
| **Apr–Oct rain (mm)** | 7.8 | 8.3 | 8.6 | 8.7 | 8.5 | | | | | | 8.1 | 6.2 | | |
| **Site stress factors** | de,dl | de,dl,r,w | bt,de,dl | de,dl,r | de,dl,r | | | | | | dl | de,dl,r | | |

*# 7 year long term from 1999 to 2005 only, as 2006 was droughted*
**Mangalo long-term data based on 1999–2004, site relocated in 2005*
$^{(\text{D}}$ *= Plant Breeders' Rights*
***Soil type:*** *S = sand, L = loam, C = clay, Li = light, M = medium, H = heavy, F = fine, / = separates top soil from subsoil*
***Site stress factors:*** *bt = boron toxicity,de = moisture stress pre-flowering, dl = moisture stress post-flowering, r = Rhizoctonia, w = weeds*
***Data source:*** *SARDI, GRDC & NVT. Long-term data based on weighted analysis of sites.*
***More information:*** *Rob Wheeler (08) 8303 9480 or e-mail wheeler.rob@saugov.sa.gov.au*

# District Cereal Trials and Demos

**Neil Cordon**
SARDI Minnipa Agricultural Centre

Demo Research

## Key messages

- **The new hard quality variety called Correll should be considered.**
- **The APW variety Wyalkatchem has shown its adaptability by yielding well over a range of seasons and soil types.**
- **Guardian (APW) showed good consistent-yielding ability, which warrants further evaluation in 2007.**
- **Evaluate other trial yield data from 2006 and agronomic characteristics when selecting a new variety for a farming system.**

## Why do the trials?

These trials are identified as a priority by the local Ag Bureaus, or farmer groups, to compare current cereal varieties with those not commonly grown in the district. It also enables cultivars to be compared in an environment different to the SARDI NVT cereal evaluation sites on Eyre Peninsula.

## FRANKLIN HARBOUR WHEAT DEMO

## How was it done?

- Treatments — 11 wheat varieties were sown in demonstration strips with three check plots
- Measurements — grain yield and quality
- Sowing date —24 May
- Sowing rate — 60 kg/ha
- Fertiliser — 18:20:0 @ 70 kg/ha.

## What happened?

Well below average growing season rainfall produced tough conditions for grain production but yields were up to 91% of the potential, indicating that production almost matched plant-available water supply.

The newly named hard quality wheat Correll had the best yield and gross income (Table 1).

The un-named variety RAC1263 and Gladius (formerly RAC1262) also performed well and need further evaluation.

## MOUNT COOPER CEREAL DEMO

## How was it done?

- Treatments — nine wheat and six barley varieties were sown in demonstration strips with three check plots
- Measurements — grain yield and quality
- Sowing date — 22 May
- Sowing rate — wheat (80 kg/ha), barley (75 kg/ha)
- Fertiliser — 18:20:0 @ 80 kg/ha.

*Table 1* ***Yield, grain quality and gross income of wheat at Franklin Harbour Ag Bureau site 2006.***

| Variety | Grade | Protein (%) | Screenings (%) | Test weight (kg/hL) | Yield (t/ha) | *Gross income ($/ha) |
|---|---|---|---|---|---|---|
| Correll | AH | 12.4 | 2.6 | 76.6 | 1.66 | 370 |
| RAC1263 | APW | 12.3 | 1.1 | 80.2 | 1.64 | 364 |
| Gladius | APW | 11.9 | 1.5 | 79.6 | 1.54 | 339 |
| Wyalkatchem | APW | 12.5 | 0.9 | 81.8 | 1.45 | 323 |
| Scythe | APW | 11.4 | 2.0 | 80.0 | 1.47 | 321 |
| Young | AH | 12.6 | 2.5 | 81.4 | 1.41 | 316 |
| Pugsley | APW | 13.5 | 2.0 | 79.6 | 1.40 | 310 |
| Guardian | APW | 13.3 | 2.4 | 79.6 | 1.37 | 302 |
| Yitpi | AH | 14.0 | 2.4 | 78.0 | 1.29 | 300 |
| Lang | APW | 13.8 | 3.6 | 80.2 | 1.34 | 293 |
| Frame | APW | 14.3 | 1.1 | 80.4 | 1.10 | 246 |

**Gross income is yield x price (with quality adjustments) delivered to Port Lincoln as at 15 November 2006.*

**Try this yourself now**

**Location**
Witera: Craig and Nick Kelsh
Mount Cooper Ag Bureau

**Rainfall**
Av. annual: 350 mm
Av. GSR: 270 mm
2006 total: 266 mm
2006 GSR: 151 mm

**Yield**
Potential: 1.5 t/ha (wheat), 1.9 t/ha (barley)

**Paddock history**
2005: pasture
2004: wheat
2003: pasture

**Soil type**
Reddish brown loam.

**Location**
Cowell: Chris Schumann
Franklin Harbour Ag Bureau

**Rainfall**
Av annual: 378 mm
Av GSR: 277 mm
2006 total: 322 mm
2006 GSR: 172 mm

**Yield**
Potential: 1.8 t/ha (wheat)

**Paddock history**
2005: pasture
2004: wheat
2003: pasture

**Soil type**
Reddish brown sandy loam.

**Location**
Elliston : Nigel May
Elliston and district farmers

**Rainfall**
Av annual: 410 mm
Av GSR: 340 mm
2006 total: 318 mm
2006 GSR: 175 mm

**Yield**
Potential: 1.97 t/ha (wheat)

**Paddock history**
2005: grassy pasture
2004: barley
2003: grassy pasture

**Soil type**
Grey calcareous sand

**Plot size**
10 m x 1.5 m x 3 replications

**Disease**
*Rhizoctonia.*

## What happened?

The plots were sown into damp soil with good growing conditions through to mid-August, but prolonged dry conditions limited grain production.

Varieties yielded up to 85% of the potential. The stand-out wheat variety was Guardian, and the best barley variety was Keel (Table 2).

High grain protein for the malt-classified barley varieties meant downgrading to feed one, while high screenings saw Gardiner Plus classified as feed three.

*Table 2 Yield, grain quality and gross income of cereals at Mount Cooper Ag Bureau site 2006.*

| Variety | Grade | Protein (%) | Screenings (%) | Test weight (kg/hL) | Yield (t/ha) | *Gross income ($/ha) |
|---|---|---|---|---|---|---|
| Guardian | APW | 11.5 | 2.3 | 85.4 | 1.28 | 282 |
| Wyalkatchem | APW | 10.7 | 0.8 | 82.6 | 1.11 | 245 |
| Correll | AH | 11.6 | 2.2 | 80.8 | 1.07 | 242 |
| Gladius | APW | 12.5 | 1.5 | 80.0 | 1.07 | 240 |
| Yitpi | AH | 12.6 | 0.3 | 80.8 | 1.00 | 237 |
| Scythe | APW | 11.1 | 2.7 | 83.4 | 1.03 | 225 |
| Frame | APW | 14.0 | 1.0 | 80.8 | 0.97 | 220 |
| Young | AH | 11.6 | 2.0 | 85.8 | 0.97 | 218 |
| Pugsley | APW | 13.3 | 0.7 | 81.6 | 0.85 | 193 |
| Keel | F1 | 13.6 | 9.3 | 71.0 | 1.47 | 307 |
| Fleet | F1 | 15.3 | 4.2 | 71.8 | 1.4 | 293 |
| Maritime | F1 | 16.3 | 0.5 | 72.8 | 0.98 | 205 |
| Sloop SA | F1 | 15.1 | 4.0 | 74.8 | 0.93 | 194 |
| Gardiner Plus | F3 | 14.9 | 25.5 | 72.4 | 1.06 | 191 |
| WI3416 | F1 | 15.5 | 4.6 | 72.4 | 0.77 | 161 |

*Gross income is yield x price (with quality adjustments) delivered to Port Lincoln as at 15 November 2006.*

## ELLISTON WHEAT TRIAL

## How was it done?

- Treatments — 10 wheat varieties were sown in replicated plots.
- Measurements — grain yield and quality.
- Sowing date — 3 June.
- Sowing rate — 60 kg/ha.
- Fertiliser — 23:16:0 @ 100 kg/ha.

## What happened?

Early crop growth was good, but *Rhizoctonia* and dry hot weather at grain filling limited yields to 68% of potential.

Correll was clearly the top yielder at this site and was significantly better than the next group of varieties — Guardian, Wyalkatchem, Young and RAC1263 (Table 3).

Grain quality measurements were not included due to excessive cracking of grain by the header.

*Table 3 Yield, grain quality and gross income of wheat at Elliston site 2006.*

| Variety | Grade | Yield (t/ha) | *Gross income ($/ha) |
|---|---|---|---|
| Correll | AH | 1.33 a | 283 |
| RAC1263 | APW | 1.18 b | 245 |
| Guardian | APW | 1.18 b | 245 |
| Wyalkatchem | APW | 1.12 b | 233 |
| Young | AH | 1.09 bc | 232 |
| Yitpi | AH | 0.98 d | 213 |
| Gladius | APW | 1.01 cd | 210 |
| Scythe | APW | 0.99 cd | 206 |
| Pugsley | APW | 0.96 d | 200 |
| Frame | APW | 0.93 d | 193 |
| LSD (P=0.05) | | 0.11 | |

*Gross income is yield x price delivered to Port Lincoln as at 15 November 2006.
Treatments followed by the same letter are not statistically different*

## What does this mean?

This work suggests that farmers should consider Correll as a replacement for any existing hard quality wheat varieties.

Wyalkatchem is still showing its good yielding ability over a range of soil types and seasons but the new APW quality variety Guardian also performed well at these sites in 2006.

Guardian appears to have characteristics such as stem rust resistance, moderate resistance to yellow leaf spot, longer coleoptile and good tolerance to pre-harvest quality disorders, which warrants consideration in a farming system.

The un-named variety RAC1263 and the new variety Gladius need further evaluation in 2007.

## Acknowledgements

Thanks to the farmer cooperators Craig Kelsh, Nigel May and Chris Schumann for their time and land. Ben Ward, SARDI, Minnipa, Donna Longmire, Elders, Cleve, and the Port Lincoln SARDI team for assisting in the trial management and harvesting. Longreach Plant Breeders, AGT Plant Breeders and Plant Tech supplied seed.

# Gladius (RAC1262) — A Drought-Tolerant Wheat Variety

Searching for answers

**Steve Jefferies**[1]**, Haydn Kuchel**[1] **and Willie Shoobridge**[2]
[1]AGT, [2]SARDI Minnipa Agricultural Centre

Research

## Key messages

- **First variety release Gladius from AGT and SARDI collaborative project on fast tracking the development of drought tolerant wheat varieties for South Australian growers.**
- **Gladius yields well in poor and good seasons.**
- **Commercial quantities of seed will be made available for the 2007 crop.**

## Why do the trial?

South Australian wheat growers in low rainfall areas rely on capturing as high as possible returns in the good years to buffer against poor or negative financial returns in the drought years. Gladius was developed with the aim of providing South Australian growers with a tool to help minimise losses in drought years while capturing maximum benefits in the good years.

The challenge for the wheat breeder however is to develop a variety that rarely completely fails in the drought years while performing solidly in the good years. Gladius is such a variety.

Gladius is the latest variety release from Australian Grain Technologies (AGT), the plant breeding joint venture involving GRDC, University of Adelaide, SARDI, Sydney University and Graincorp. This program has been ongoing and reported in the annual EPFS Summary since 2002.

## How was it done?

Gladius is derived from a cross involving Excalibur, RAC875, Kukri and a Trident derivative. Excalibur became recognised for its excellent tolerance to drought stress during the series of severe droughts encountered in the state in the mid- to late 1980s. It has since been a valuable risk management tool particularly for Upper Eyre Peninsula growers despite its rust susceptibility and relatively poor quality. RAC875 was a breeder's line, which also had exceptional performance under drought stress but was never released as it had a serious quality defect and was very susceptible to leaf rust. The aim of the Gladius cross was to combine the drought-tolerant attributes of Excalibur and RAC875 with the rust resistance and quality of Kukri and the Trident derivate.

## What happened?

The positive outcome of Gladius is it appears to have recovered the drought tolerance of Excalibur and RAC875, some of the disease resistance and quality characteristics of Kukri and Trident, but has also produced excellent yield performance in good years such as 2005.

Over five years of trials, Gladius has demonstrated excellent yields under drought stress on Upper Eyre Peninsula, often 20–30% above benchmark varieties Frame and Yitpi, and 10–15% above other well-performing varieties Wyalkatchem and Westonia. While Gladius has performed well in the drought years (very similar to Excalibur), it has maintained competitive yields in good years such as 2005 (Table 1).

In comparison to Excalibur, Gladius has produced very similar yields under drought stress but in other regions has performed much better, particularly where grain yields exceed 2.0 t/ha. Gladius was the highest yielding commercial variety behind Pugsley in the 2005 NVT program.

Preliminary results from the drought-affected 2006 National Variety Trials (NVT) show Gladius as the overall highest yielding commercial variety across all South Australian trials. Gladius was ranked second behind Pugsley in the higher yielding year of 2005.

In addition to its high grain yield and broad adaptation, Gladius has excellent resistance to stem rust and to both the dominant WA strain of stripe rust and the former Yr17 attacking strain of stripe rust. Gladius' response to the new Yr17 attacking mutation of the WA strain (first identified in 2006 in NSW and Vic.) will not be known until tested in the field in spring 2007, but it may be found to carry backup resistance to this strain. Gladius has excellent resistance to the Krichauff and Janz attacking strain of leaf rust but is rated moderately susceptible to the 'VPM' strain that attacks Pugsley.

Gladius has adequate levels of yellow leaf spot resistance similar to that of Krichauff, has good levels of tolerance to blackpoint, is moderately tolerant

***Table 1 Results of Upper Eyre Peninsula Drought Tolerant Wheat Variety Trials 2002 to 2006 (yield expressed as percent of Yitpi).***

| Name | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| Excalibur | 100 | 117 | 119 | 99 | 136 |
| Frame | 92 | 88 | 87 | 101 | 95 |
| Gladius | 115 | 121 | 117 | 100 | 133 |
| Janz | 92 | 88 | 98 | 92 | 112 |
| Krichauff | 99 | 101 | 113 | 97 | 126 |
| Pugsley | | 87 | 99 | 106 | 105 |
| Westonia | | 104 | 107 | 90 | 118 |
| Wyalkatchem | | 109 | 115 | 95 | 115 |
| Yitpi | 100 | 100 | 100 | 100 | 100 |
| Mean yield | 1.17 | 0.89 | 0.71 | 2.68 | 0.44 |
| Number of sites | 1 | 4 | 8 | 6 | 6 |

to boron toxicity, and produces very similar grain size, screenings losses, and test weight to Yitpi. Gladius is rated moderately susceptible to moderately resistant to root lesion nematode. It is susceptible to CCN and is susceptible to very susceptible to septoria leaf blotch. Gladius has received a preliminary APW classification, and a final classification decision will be made in early March 2007.

## What does this mean?

Approximately 300 t of seed are expected to be available to South Australian growers for sowing in 2007 through local seed distributors.

A proportion of the financial support for the breeding of Gladius was provided by SAFF's South Australian Grain Industry Trust and more recently by the SA Premier's Drought Relief Fund (PDRF). The additional resources from SAGIT and PDRF have enabled AGT and SARDI to fast track the variety's development. The cross resulting in Gladius was first made in 2000, with commercial quantities of seed now available to growers seven years later. Up until recently, the time taken to go from cross to commercial release had taken 10–12 years.

Gladius should provide growers with a valuable tool for managing the climatic vagaries of the South Australian cropping environment.


## Acknowledgements

We thank Gil Hollamby and Neil Howes for their valuable contributions towards the variety's development, and Minnipa-based SARDI staff, particularly Michael Bennet and Leigh Davis for technical assistance.


# Early Maturing Barley as a Management Option in Low Rainfall Farming Systems

Research



## Stewart Coventry and Jason Eglinton

School of Agriculture, Food & Wine, Waite Campus, University of Adelaide


## Key messages

- **Early maturing varieties offer alternative management options in low rainfall farming systems.**
- **Early maturing malting barley has been developed.**
- **Early maturing varieties have a yield advantage in <3 t/ha environments.**

## Why do the trial?

Early season farm management decisions are typically based on the expectation of an 'average' season. These strategies are based on maximising profit in the good seasons, while relying on later decision making to try to minimise losses in drought years. Recently there has been a growing awareness of risk management in the context of variable seasons. It may now be timely to challenge this traditional philosophy and consider whether there is a place for very early maturing cereal varieties, which escape drought stress, but are not capable of high yields in very good seasons.

In the low rainfall environments of southern Australia with GSR<250 mm, yield potential is <3 t/ha with appropriate management, and in the absence of other constraints. In environments where the growing season is short or in the case of a late break to the season, an early maturing barley that yields reliably and maintains good physical grain quality may offer a useful risk management tool. Breeding for a 'bankable' yield in low potential environments typically means selecting for inherently low yield potential, possibly no more than 3 t/ha no matter how much moisture is available, but could be expected to provide income in most years.

Utilising early maturity to avoid drought stress is not new, with farmers aggressively adopting earlier maturing varieties, such as SloopSA and Keel (now the state's dominant malting and feed barley varieties), and Wyalkatchem wheat. The current paper examines the merit of taking this trend further, analysing the performance of 'super early' barley to potentially ensure a harvest even under toughest Spring conditions.

A very short growing season variety could also be late sown where seeding is delayed to allow pre-sowing weed control, or under main season sowing the very early harvest could be used as part of a weed management strategy. This could provide a tool to reduce drought risk by producing a reliable 'base' income from lower potential paddocks or zones where soil conditions limit potential. The potential of early maturing breeding lines are discussed, with data presented on the most advanced line WI4025. The commercial application of 'super early' varieties is considered more likely following the successful improvement in frost tolerance by the University of Adelaide Barley Program.

## How was it done?

The adjusted means of feed and malting varieties important in southern Australia were examined for 19 sites across South Australia for the years 2004–06 from University of Adelaide Barley Program Stage 3 trials. From this data set a range of environments with different site mean yields were obtained. Feed varieties selected for analysis were Barque, Keel and Fleet, whilst the malting quality varieties were Schooner and Flagship. These were compared to the 'super early' WI4025, an export malting quality line developed for low rainfall – short season – late sowing environments. The aim of this analysis is to demonstrate a yield advantage and/or reliable yield of very early maturity in low yielding environments. For each individual variety, the yield of the variety within a site (environment) was regressed against the mean yield of the all genotypes at that site (mean site yield), and regression lines were generated as indicated in Figure 1. Additionally, the yield performance of WI4025 as a percentage of each comparator variety across all sites in individual years from 2004 to 2006 is presented in Table 1. The correlation between yield and maturity score (1 = early, 9 = late) using Stage 3 yield data from the low yielding site of Clinton in 2006 is shown in Figure 2.

## What happened?

There is a significant effect of year on the mean yield of all environments, with 2004 and 2006 being drought years and in general having below average site mean yields, while 2005 was a favourable season and most site mean yields were above average. This is reflected in Table 1, with WI4025 having higher yield than the other comparators in the unfavourable years of 2004 and 2006 where the overall site mean yield was <2 t/ha, and lower yield in the favourable year of 2005 where the overall site mean yield was >3 t/ha. The relationship between yield potential and the performance of WI4025 is further dissected in Figure 1. The slope of the line for WI4025 is significantly different than the other varieties (i.e. p=0.015 vs Schooner), showing higher yields in low yielding environments and lower yields in higher yielding environments.

The point where WI4025 has higher yields than the other varieties is dependent if feed or malting quality varieties are compared, and the crossover points are circled in Figure 1. Between the WI4025 and the feed varieties, the crossover is at 2 t/ha indicating that WI4025 is a better option than the feed varieties in environments with yield <2 t/ha. Between WI4025 and the malting quality varieties, the crossover occurs higher at 3 t/ha, indicating WI4025 is a better option in environments with yield <3 t/ha. Much of the yield advantage in low yielding environments is driven by the early maturity, and even within very low yielding environments (Figure 2) the correlation between yield and maturity can be strong. Lines earlier than Schooner in these environments are generally higher yielding.

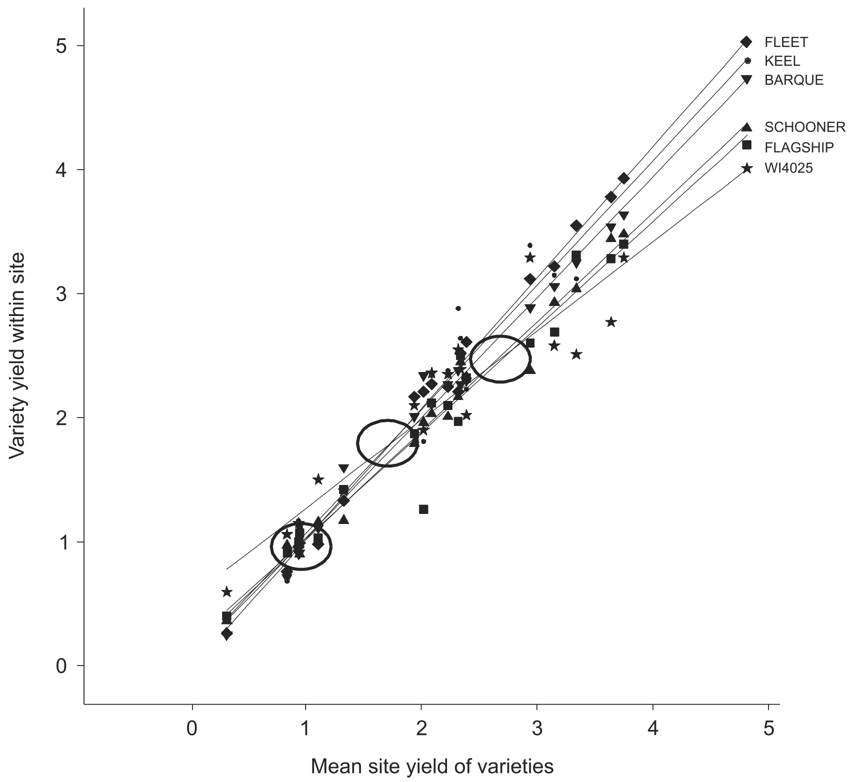


***Figure 1*** ***Regression of site mean yield against the yield within each site for WI4025 plus five feed and malting varieties. Crossover points are circled.***

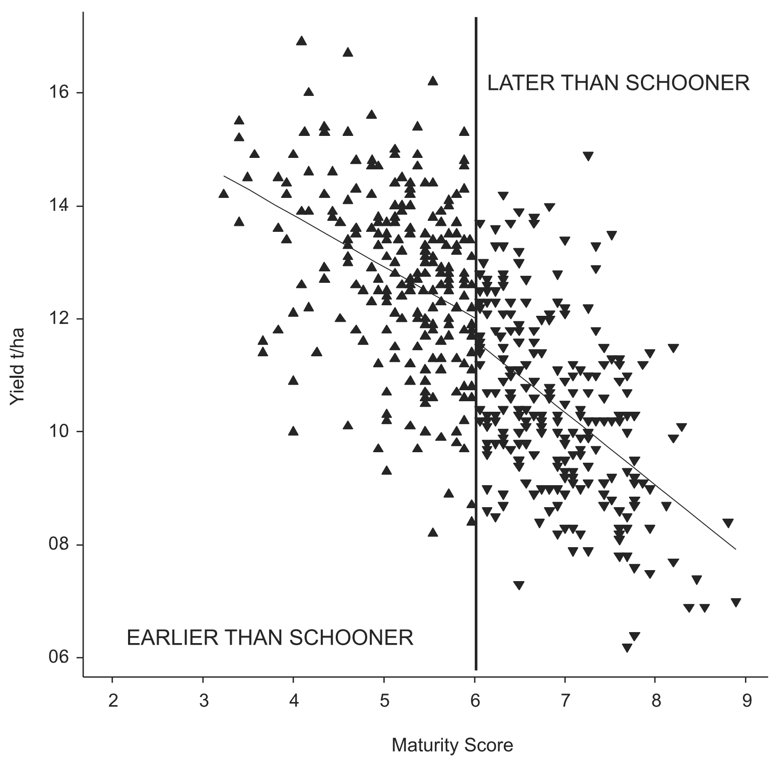


***Figure 2*** ***Correlation between yield and maturity (visual score) at Clinton 2006 (<2 t/ha environment; -0.7, p<0.001). Maturity earlier and later than Schooner is indicated, with correlations -0.38 (p<0.001) and -0.48 (p<0.001), respectively. Data are from Stage 2 advanced yield trials.***

## What does this mean?

In environments where drought stress occurs with high frequency, early maturing varieties are an important management option and offer choice in the farming system. Early maturing varieties also offer an option for weed management and late sowing. A risk-minimisation approach to breeding for reliable performance in 'bad conditions' runs counter to the current approach of breeding for high yield potential in good conditions, with the aim of growing enough in the good seasons to 'sit out' the bad ones. On the another hand, it complements the 'maximisation' approach by providing a more stable financial base and freeing up resources that can be used to capitalise on the good years and the yield potential of better soil types.

Considering the yield potential in the low rainfall environments of <250 mm is 3.2 t/ha, WI4025 is an advancement in breeding for a 'less risky' export quality variety for the low rainfall environments. In environments of Upper Eyre Peninsula where yield is rarely above 3 t/ha, having such a variety to capitalise on early moisture and provide a 'bankable' base yield even in extremely tough growing conditions is important. This would provide an important option with drought risk planning. This option may also be more advantageous than growing feed, especially with the poor market forces for delivering feed on Eyre Peninsula. The disadvantages of early maturing varieties are the increased risk of reproductive frost damage, but with recent advances in frost tolerance in barley this should be reduced in the future. Currently there are a number of early maturing lines with putative frost tolerance in the pipeline. Early maturing barley with the package of agronomic traits including frost tolerance, disease resistances, and malting quality, will provide farmers with more choice in their farming systems, and are currently under development in the University of Adelaide Barley Program.

***Table 1** Yield of WI4025 expressed as a percentage of the yield of five feed and malting varieties across all sites within the years 2004–05. Data are from University of Adelaide Barley Program Stage 3 advanced yield trials.*

| | Year | | |
|---|---|---|---|
| | **2004** | **2005** | **2006** |
| **%Barque** | 112 | 87 | 107 |
| **%Keel** | 100 | 84 | 102 |
| **%Fleet** | 105 | 83 | 107 |
| **%Schooner** | 122 | 95 | 117 |
| **%Flagship** | 116 | 99 | 112 |
| **Mean yield (t/ha)** | 1.89 | 3.17 | 1.27 |


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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

THE UNIVERSITY OF ADELAIDE AUSTRALIA

GRDC Grains Research & Development Corporation

# National Variety Trials (NVT) Web Site


## Jim Egan

SARDI Port Lincoln


Information

There is now a Growers Guide which can be downloaded from a link on the Home page of the NVT website (http://www.nvtonline.com.au) to help growers access the database. This gives instructions on several computer system settings that they need to have set right in order to be able to download reports, etc.

It then has step-by-step instructions to work through the four report types that can be generated from the NVT database.

The **Trial Report** enables users to locate nearby trials of relevance to them, and provides detailed information on these trials, including paddock history, trial management details, rainfall, yield results and receival standard test results. There are several ways to locate where trials are, all described in the guide. At present this includes only the 2005 trial results.

The **Variety Report** allows the user to view all of the information available on a chosen variety.

The **Compare Varieties Report** allows a comparison of measurable characteristics between different varieties of the same crop. For example, a user may compare rust resistances of a selection of wheat varieties.

The **Predicted Yield Report** contains state-by-state biometric analysis of variety performance over a number of years, by rainfall or geographic zones, incorporating results from previous trials. For South Australia, this provides the 1997–2003 combined trial results, so is not as recent as the long-term yield data in our reports in *Grain Business* or the *EP Farming Systems 2006*.

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# How Seeds Germinate


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Extension

Cereal seeds have a range of mechanisms to ensure survival to subsequent generations in less than ideal environments. Before domestication, ripe seeds (or spikelets — segments of the spike containing seeds) simply fell to the ground to await a substantial rain event to commence the next cycle. Thus, 'dry sowing' is not new although some of the mechanisms (e.g. dormancy) that assisted primitive cereals to survive have been discarded during domestication and breeding.

However, survival is one thing, getting the best return in terms of plant establishment and yield is another. Germination is the critical first step in crop establishment and it is important to get right.

## Germination

The key to turning dry, quiescent seeds into a young seedling is rehydration of the living tissues within the seed and therefore access to water. Wheat seeds placed in a moist environment suitable for germination show a triphasic pattern of water uptake (Figure 1).

**Phase I**

Water movement into the grain (imbibition) occurs along a substantial water potential gradient created by the dry seed being considerably lower in potential than the moist environment or soil and leads to a swelling of the seed.

Water enters the seed primarily at the point of attachment at the germ end of the grain where the seed was originally connected to the rachis and the water and nutrient-conducting tissues of the plant. Dissection of imbibing grains, followed by tissue moisture determination or magnetic resonance imaging (MRI) of intact grains, clearly shows that whilst water moves rapidly into the seed coat, entry into the germ and subsequently the endosperm occurs via the micropyle situated within the attachment zone.

Water uptake into the embryo, or germ, proceeds very rapidly (depending on the level of soil moisture) to the point where normal cellular processes such as metabolism, cell division, etc. can commence. As a rough guide, the seeds need to reach moisture contents of around 35% dry weight before germination can occur. Too much water can impede germination by restricting the diffusion of oxygen to the seed.

It should be noted that all seeds, whether viable or non-viable, dormant or non-dormant, go through phase I

**Phase II**

During phase II, which extends until the first visible signs of germination, the major metabolic events required to prepare the seed for germination occur in viable and non-dormant seeds. These changes are conserved if the seeds are dried, and the seeds can remain dry for considerable periods without significant reduction in viability or germination potential. When such seeds are rewetted, they again rapidly imbibe and often show accelerated germination and the phase II is now markedly shorter.

**Phase III**

Phase III is associated with germination and subsequent growth, and as part of this growth there is new metabolic activity including the start of mobilisation of the stored food reserves in the endosperm. Germination starts with the rupture of the seed coat over the germ and the protrusion of the shoot and radicle. As this process advances, the seedling becomes increasingly vulnerable to damage through drying and there is a reducing capacity to regenerate following rewetting. Up until the establishment of green coleoptiles and leaves, the seedling is totally dependent on the stored reserves in the endosperm. During the early stages of germination, the embryo produces the plant hormone gibberellic acid that is transported to the aleurone surrounding the endosperm, where it triggers synthesis of the enzymes required to initiate the breakdown of starch and protein stored in the starchy endosperm. The activity of these enzymes leads to the production of the sugars and amino acids required by the growing seedling.

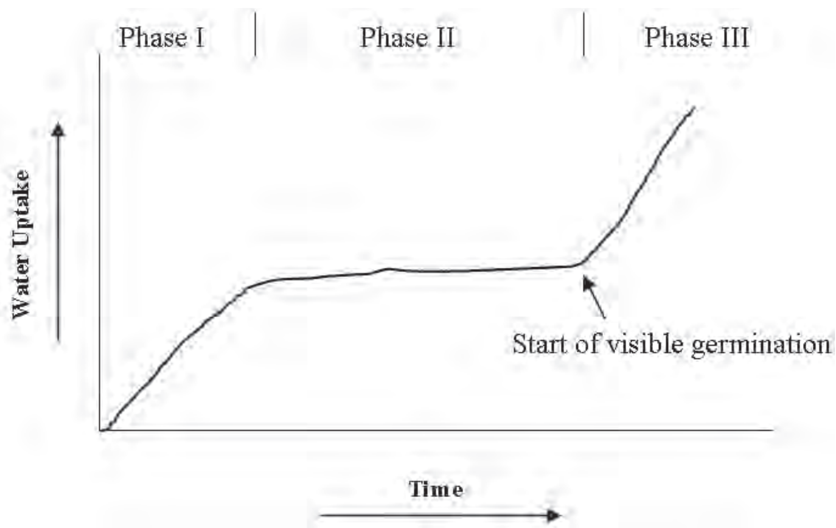



***Figure 1** General pattern of water uptake (increase in grain fresh weight) by wheat seeds when placed in a moist environment.*

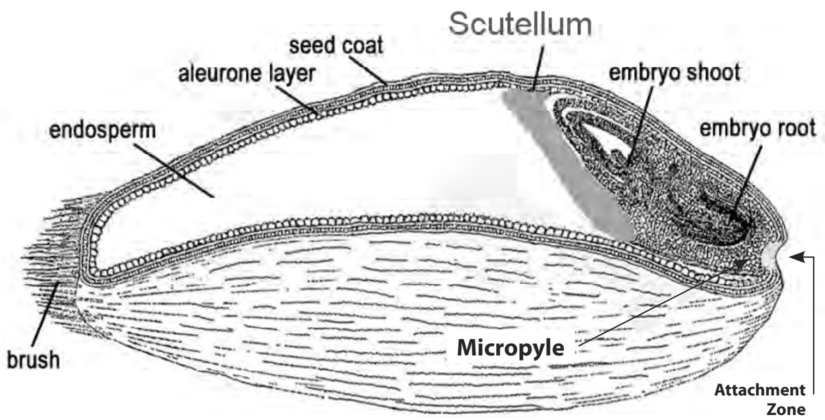



*Figure 2 Longitudinal section of a wheat grain showing the different component tissues.*

## Impact of drying and rewetting on seed and seedling survival

**Phase I** (water uptake and swelling of the seed) — seeds can be dried and rehydrated several times without apparent damage or loss of viability.

**Phase II** (metabolism and cell division ready for germination) — seeds can be dried and rehydrated without apparent damage. In fact, the changes that have already occurred as part of Phase II appear to be conserved and germination following rewetting can be more rapid.

**Phase III** (rupture of seed coat and emergence of roots and a shoot) — if seedlings are dried under laboratory conditions, they rapidly lose their ability to regenerate on rewetting. However, in the soil and with the cooler conditions typical of seeding time, seedlings may, depending on soil type, air temperature and humidity, retain sufficient moisture to survive but not grow very much until further rain.

## Factors that affect germination, growth and seedling establishment

- Temperature — for after-ripened seeds that retain no residual dormancy (the normal situation in Australian conditions), the rate of germination increases as temperature increases at least up to 35°C.
- Soil moisture — as mentioned above, increasing soil moisture to the point of good contact with the seed surface increases germination rate, but excess water in the soil can impede oxygen diffusion to the seed and retard germination.
- Seed history — given that early seedling growth is dependent on the stored food reserves in the seed itself, it follows that good seedling establishment will be more likely for seeds produced on plants with adequate nutrition, that are well filled with the normal range of protein content, that are sound, and that have been stored under optimal conditions since harvest.
- Seed-borne micro-organisms — may be present on the surface or in the crease of seeds, particularly if the seed has ripened under warm, humid conditions, and can rapidly colonise the seed surface and reduce or inhibit germination.
- Pre-harvest sprouting — may have limited effect on germination percentage if tested at harvest but results in a decline in germination percentage, germination vigour and seed viability during storage.
- Cracked or damaged grains — the seed coat acts as a protective barrier and any damage can result in direct access of moisture and micro-organisms into the stored starch and protein reserves in the endosperm. This can lead to rapid growth of microbes, spoilage of the grains and inhibition of germination. In an experiment under controlled laboratory conditions, the seed coat of seeds were cut with a scalpel and germination compared to sound grains. Whilst the sound grains remained microbe-free, some of the damaged grains were over-run with microbes and failed to germinate.

THE UNIVERSITY OF ADELAIDE AUSTRALIA

# Germination Observations When Dry Sowing

**Cherie Reilly**
Research Coordinator, Birchip Cropping Group

Research

**Try this yourself now**

## Key message

- **Dry sowing a percentage of your farm (with good grass control) is a safe sowing option.**

## Why was it done?

For the critical months of May and June (and even into July), little or no rain fell in 2006. Many questions were asked during this time — 'Is my seed still viable after sitting in the ground for two months?', 'Has my crop died?', 'Should I be re-sowing?'.

A lot of these questions have probably now been answered. We know that seed sown dry or almost dry will quite happily wait until rain, and that it does not matter how long it takes until the rain comes. Other paddocks where the seed had germinated with small shoots also sat there for two months still emerged and will have the same potential with rain.

## What happened?

So what is happening in the germination process to allow the seed to withstand months of no rain?

The first stage of germination is initial water absorption and grain swelling. This process is reasonably slow and can, under drying conditions, be reversed with little or no subsequent loss in quality.

When the water content of the grain approaches 30%, the germination process begins. This stage is noticed when the swollen germ splits. It is during this stage that follow up rain is required otherwise germination will slow or stop.

The appearance of the first root is followed almost immediately by the coleoptile (shoot) and signals the grain has shot. Once the plant has emerged from the soil it is surprising how resilient it is unless it is in the presence of soil-applied herbicides such as Trifluralin, or poorly structured heavy soils, which can inhibit emergence.

*Table 1 Scenario 1 — The first root formed; small coleoptile with little vigour in heavy soil.*

| Irrigation applied 19 June | Monitored 10 days later | Comments |
|---|---|---|
| 10 mL | 30% grain shrivelled<br>50% coleoptile little vigour<br>20% coleoptile present | No potential<br>Poor but still viable<br>Potential |
| 20 mL | 30% grain shrivelled<br>70% coleoptile present | No potential<br>Potential |

*Table 2 Scenario 2 — Coleoptile developed (not yet emerged).*

| Irrigation applied 19 June | Monitored 10 days later | Comments |
|---|---|---|
| 10 mL | 50% emerged<br>50% coleoptile visible | Good<br>Potential |
| 20 mL | 75% emerged<br>25% coleoptile visible | Good<br>Potential |

*Table 3 Scenario 3 — Plant emerged (1–2 leaf) very dry, blue.*

| Irrigation applied 19 June | Monitored 10 days later | Comments |
|---|---|---|
| 10 mL | 1 tiller | Good |
| 20 mL | 1–2 tillers | Good |
| 30 mL | 2 tillers | Good |

Given the situation at the end of June and the questions being asked, BCG conducted an experiment to determine how germinating crops would respond to 10, 20 or 30 mL of irrigation. The trial was conducted across three paddocks. Irrigation was applied on 19 June and monitored over a three-week period.

In general, crops that had emerged prior to irrigation, but were looking dry and blue, responded well to irrigation and showed renewed vigour. Seed that had germinated but only possessed small shoots and roots still benefited from the irrigation. However, a very small percentage of seed that was shrivelled and had no vigour prior to irrigation did not respond — irrigation came too late.

## What does this mean?

If you are planning on sowing, in order to get the best yield potential, dry sowing a percentage of your farm remains the best alternative if we fail to get an opening break. Dry sowing is safe and it was only on very heavy, poorly structured soil that we saw a small percentage of irreversible germination damage.

# Grain Growth and Development in Cereals

**Glenn McDonald**
School of Agriculture, Food and Wine, Waite Campus, University of Adelaide

Extension

## The structure of the cereal seed

The seed of cereal crops contains three main parts — the embryo (or germ), the endosperm and the seed coat. The embryo contains the first two to three seedling leaves, surrounded by the coleoptile, and the first seedling roots. The endosperm is the main part of the seed and it largely consists of dead cells filled with starch, which is embedded in protein. This is the food source for the germinating seed until the first seedling leaves start to photosynthesise. The outer part of the wheat endosperm consists of a row of living cells called the aleurone layer. This produces many of the enzymes that break down the starch and protein in the endosperm during germination as well as containing many of the mineral nutrients, such as phosphorus. The outer part of the seed consists of a number of layers of cells that are fused to form the seed coat.

## Growth of the seed

The starchy endosperm comprises more than 80% of the final weight of the mature cereal seed and so the weight of individual grains and the grain protein concentration is determined largely by the deposition of starch during grain filling. All the resources for the growth of the seed — the carbon (in the form of sugars), nitrogen (as amino acids) and minerals — are imported from the rest of the plant during the growth of the seed. As the leaves and stems die, the complex molecules contained in them are broken down to sugars and amino acids. Much of this is transported to the seed where it is converted into starch and protein within the endosperm. Essentially the seed is preparing itself for survival until conditions for germination are favourable in the following growing season. The greater the reserves of starch, protein and minerals in the seed, the more vigorous the seedling will be.

There are two main phases of grain development: (i) grain enlargement, which involves a period of cell division followed by cell enlargement, and (ii) grain filling when the cells formed during grain enlargement are filled with starch and protein (Figure 1). After grain filling has stopped, the grain dehydrates until it reaches harvest ripeness. The length of the phases is sensitive to seasonal conditions. Stress will tend to reduce the length of each phase leading to smaller grains, although under mild stress the grain can compensate by growing at a faster rate.

***1. The grain enlargement phase***

Very soon after pollination, the rudimentary structures of the seed are established. The developing seed enters a period of cell division during which time the number of cells in the endosperm increases rapidly. These cells increase in size as water moves into the developing grain. The number of cells that are formed sets the upper limit of grain size. Stress during the first 10–15 days of this stage that is severe enough to reduce cell division will limit the number of cells formed and can reduce final grain size. The grain at this stage is described as watery ripe because an almost clear watery sap is apparent when the seed is squeezed. There is no starch in the grain at this stage and the growth of the grain is slow (Figure 1).

Grain enlargement lasts for about 15–20 days and, once it is completed, there is no further increase in cell numbers within the endosperm. Further growth of the grain depends on the deposition of starch and protein during grain filling

***2. Grain filling***

This is the phase of development when the grain weight increases most rapidly because of the deposition of starch and protein from sugars and amino acids that are imported into the developing grain. The grain filling period starts 10–15 days after anthesis and continues until the grain reaches physiological maturity 20–30 days later.

The moisture content of the grain is high and, as the amount of starch in the grain increases, the consistency and texture of the grain changes, giving rise to a number of distinctive stages of development, which are:

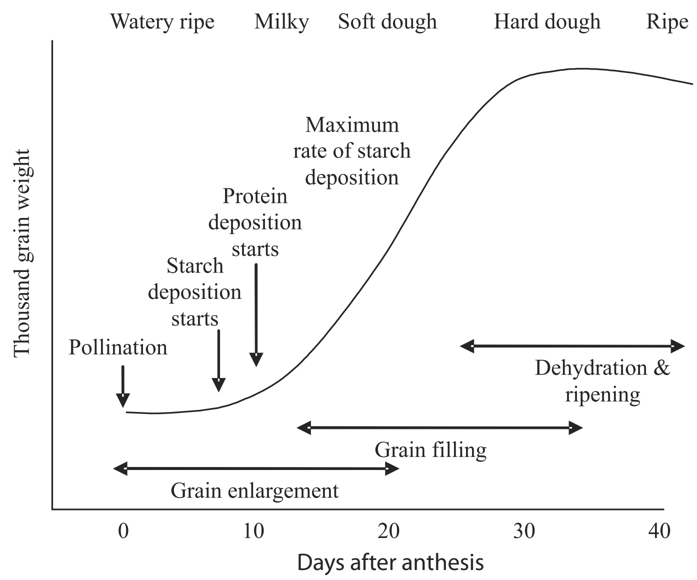



***Figure 1*** ***Developmental stages of a wheat grain in relation to the changes in grain weight. The actual timing of the developmental events and length of the different growth stages will be influenced by weather conditions and genotype.***

**Milk stage.** This is the early stage of grain filling. Starch deposition in the endosperm has just commenced and the endosperm, which is quite soft at this stage, appears as a milky fluid when the grain is squeezed between the fingers. The embryo is nearly fully formed and is clearly visible. The grain has reached its maximum length, but is still only a small fraction of its final weight. Nutrients from the leaves and stems are being remobilised to the grain in increasing amounts. The developing seed is still green at this stage.

**Soft dough stage.** The endosperm is becoming harder as the amount of starch in the grain increases and the moisture content starts to decline. The embryo is fully formed and the green colour of the seed starts to fade.

**Hard dough stage.** At this stage the grain has reached is maximum dry weight and has reached physiological maturity (but not harvest ripeness). The moisture content of the grain is quite high (e.g. 30%) but falls rapidly to 10–12% at harvest ripeness. The grain becomes increasingly difficult to squeeze between the fingers, and loses its green colour. This phase coincides with a decline in greenness from the ears and death of the upper leaves.

***3. Dehydration and maturity***

This is the ripening stage. After the grain is fully mature its dry weight does not change, but its moisture content falls. At the end of this phase the grain becomes hard and it is at harvest ripeness.

## What determines final grain size?

There are a number of factors that determine grain size — the variety grown, location of the grain on the plant, the number of grains set on the plant, and weather conditions during grain growth. Some of these are described below.

***Position***

Where a grain is located will affect how it grows and its final grain weight.

- Grain formed on the main stem and first tiller will generally be larger than grain in the later-formed tillers.
- Grain located in the central spikelets of an ear will generally be larger than grain in spikelets at the top and the bottom of the ear.
- Grain in the bottom two florets of the spikelet will generally be larger than those in the third and fourth florets.

***Grain number and grain weight***

The number of grains produced by a plant is determined shortly after flowering and is the culmination of growth up to this point. This sets the potential yield of the plant. In general, crops that set a large number of grains (i.e. have a high yield potential) will produce smaller average grain size, for two main reasons:

- the additional grains come from the later tillers and the positions in the spikelets that produce smaller grains
- there is greater competition among the developing grains for the C, N and minerals necessary for grain growth.

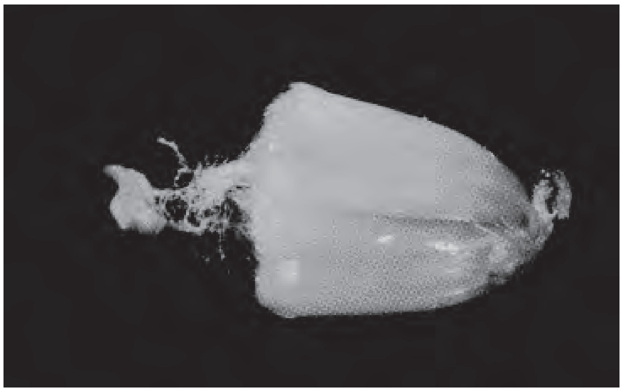
Conversely, if grain set is reduced at flowering for some reason, but the conditions for grain filling are adequate, the average grain size can be high.

***Heat stress***

Grain filling and especially starch deposition is very sensitive to high temperatures. Grain size is greatest under mild grain filling temperatures (15–20°C) because the length of the grain filling period is extended. This favours starch deposition in the grain. Once average post-anthesis temperatures rise above 25–30°C, significant reductions in grain weight occur, even under well-watered conditions, because the duration of grain filling is reduced and starch deposition is reduced. Under European conditions for example, 1000-grain weights of 40–45 g are common compared to 30–35 g, or lower, in South Australia. European crops also achieve this even after setting considerably more grains per plant. This difference largely reflects the lower temperatures and milder grain filling conditions in Europe. Temperatures >30°C can curtail starch synthesis in the developing grain, but have little effect on protein deposition. Consequently, grain protein concentration (which is essentially the ratio of protein to starch) will increase and 1000-grain weight will be low.

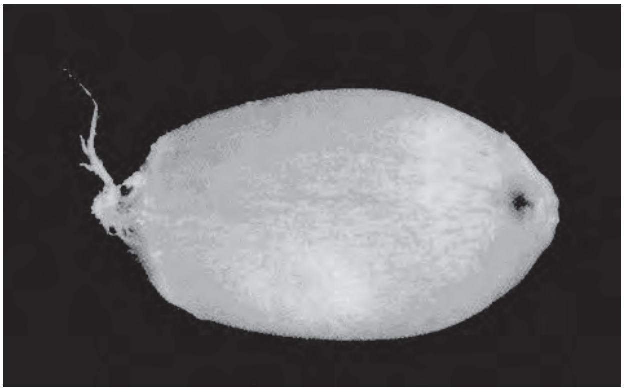
***Water stress***

If water stress develops gradually, wheat plants have a great capacity to maintain grain growth in part by drawing on reserves of sugars from other parts of the plant, and particularly the stems. The metabolic activities related to grain filling within the grain (as opposed to the effects on leaves) also appear not to be greatly affected by drought stress as the water content of the grain is relatively insensitive to drought. In other words, although the rest of the plant may suffer from drought, the grain itself may not be severely stressed. Consequently, grain size may not be greatly reduced by reduced water availability after anthesis. The smaller grain size observed under very dry conditions may be the combined effects of high temperature (both from high air temperatures and an increase in ear temperatures from reduced evaporative cooling) and water stress, rather than drought stress alone. Severe drought stress will tend to reduce the length of the grain filling period and cause a reduction in grain weight. Water stress can increase the rate of loss of green leaf area. This may increase the supply of N (as amino acids) to the developing grain and increase grain protein deposition.

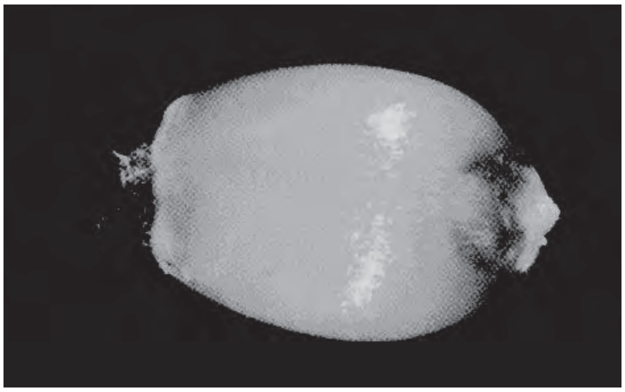


**Watery ripe stage.** Pollination is completed and grain growth has started. Rapid cell division is occurring and the grain is increasing in length.

**Early milk stage.** The grain has reached its full length, and maximum cell numbers in the endosperm has been reached. The grain is green.



**Milk stage.** The grain is half grown and the embryo is visible. The grain has entered the main period of starch deposition. Grain is green.



**Soft dough.** The grain has reached its maximum fresh weight. The moisture content is high and the green colour begins to fade.

**Hard dough.** The grain has reached its maximum dry weight and the moisture content is declining. The grain has lost most of its green colour and has reached physiological maturity.

**Harvest ripe.** The grain has reached a moisture content of 10–12%

***Source: Grain development in wheat (Adapted from Kirby and Appleyard (1981) Cereal Development Guide.***

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# Types of work in this publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad-scale nature, care should be taken when interpreting results from demonstrations.

| Type of work | Replication | Size | Work conducted by | How analysed |
|---|---|---|---|---|
| Demo | No | Normally large plots or paddock size | Farmers and agronomists | Not statistical, trend comparisons |
| Research | Yes, usually 4 | Generally small plot | Researchers | Statistics |
| Survey | Yes | Various | Various | Statistics or trend comparisons |
| Extension | N/A | N/A | Agronomists and researchers | Usually summary of research results |
| Information | N/A | N/A | N/A | N/A |

Section 2

Section editor:
**Amanda Cook**
SARDI
Minnipa Agricultural Centre

# Break Crops

**The total 2006 production figures for Eyre Peninsula were approximately 30 000 t of canola, 5000 t of beans, 7000 t of peas and 12 000 t of lupins.**

## BREAK CROP VARIETY EVALUATION, 2006

***SA Field Pea Variety Trial Yield Performance at Eyre Peninsula Sites***

*2006 (t/ha) and long-term (2000–06, yields expressed as a % of Kaspa's yield).*

| Variety | 2006 | | | 2000–06 | | |
|---|---|---|---|---|---|---|
| | Minnipa | Rudall | Yeelanna | Minnipa | Rudall | Yeelanna |
| Bundi | 0.84 | | 1.55 | 98 | 97* | 96 |
| Excell | | | | 87 | 90 | 90 |
| Kaspa | 0.54 | No | 1.37 | 100 | 100 | 100 |
| Moonlight | 0.61 | valid | 1.62 | 89 | 92* | 95 |
| Mukta | | result, | | 92 | 89 | 97 |
| Parafield | 0.61 | droughted | 1.64 | 95 | 97 | 96 |
| Sturt | 0.78 | | 1.90 | 99 | 101 | 97 |
| SW Celine | | | 1.81 | | | 96* |
| Yarrum | 0.50 | | 1.47 | 92 | 94* | 97 |
| Kaspa yield (t/ha) | 0.54 | | 1.37 | 1.31 | 1.88 | 3.06 |
| Date sown | 16 May | 2 June | 8 June | | | |
| Soil type | SCL/CL | S/SC | LC/SC | | | |
| pH (water) | 8.7 | 7.6 | 175 | | | |
| Apr–Oct rain (mm) | 111 | 111 | 7.9 | | | |
| Site stress factors | de,dl,ht | de,dl | de,dl,ht | | | |

**Varieties have only had limited evaluation at these sites, treat with caution.*
***Soil type:*** *S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = divides topsoil from subsoil*
***Site stress factors:*** *dl = post-flowering moisture stress, de = pre-flowering moisture stress*
ht = high temperatures during flowering and/or pod fill
***Data source:*** *SARDI–PBA–GRDC and NVT (long-term data based on weighted analysis of sites)*
***More information:*** *Larn McMurray (08) 8842 6265 or e-mail mcmurray.larn@saugov.sa.gov.au*

## SA Chickpea Variety Trial Yield Performance at Eyre Peninsula Sites

*2006 (t/ha) and long term (2000–06, yields expressed as a % of Howzat's desi chickpeas or Genesis 090's kabuli chickpeas yield).*

| Variety or Line | 2006 | | 2000–06 | |
|---|---|---|---|---|
| | Cocka-leechie | Rudall | Cocka-leechie | Rudall** |
| *Desi trials* | | | | |
| Genesis 508 | 0.76 | No | 88 | 85 |
| Genesis 509 | 0.75 | valid | 95 | 96 |
| Genesis 090# | 0.98 | result, | 97 | 96 |
| Howzat | 1.29 | droughted | 100 | 100 |
| Sonali | 0.89 | | 99 | |
| Howzat yield (t/ha) | 1.29 | | 1.75 | 0.99 |
| *Kabuli trials* | | | | |
| Almaz | 0.38 | | 87 | |
| Genesis 090 | 0.44 | | 100 | |
| Nafice | 0.25 | | 82 | |
| Genesis 090 yield (t/ha) | 0.44 | | 1.69 | |
| Date sown | 8 June | 2 June | | |
| Soil type | CL/MC | S/CS | | |
| pH (water) | 7.9 | 7.6 | | |
| Apr–Oct rain (mm) | 172 | 111 | | |
| Site stress factors | de,dl,id | de,dl | | |

*# Kabuli lines ** Rudall site includes data from Lock pre-2005*
**Varieties have only had limited evaluation at these sites, treat with caution.*
***Soil type:** S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = divides topsoil from subsoil*
***Site stress factors:** dl = post-flowering moisture stress, de = pre-flowering moisture stress, id = insect damage (native budworm)*
***Data source:** SARDI–PBA–GRDC and NVT (long-term data based on weighted analysis of sites)*
***More information:** Larn McMurray (08) 8842 6265 or e-mail mcmurray.larn@saugov.sa.gov.au*

## SA Lentil Variety Trial Yield Performance at Eyre Peninsula Sites

*2006 (t/ha) and long term (2000–06, yields expressed as a % of Nugget's yield).*

| Variety or Line | 2006 | | 2000–06 | |
|---|---|---|---|---|
| | Rudall | Yeelanna | Cocka-leechie | Yeelanna |
| Aldinga | | 0.59 | 96 | 96 |
| Boomer | No | 1.03 | | |
| Digger | valid | | 96 | 97 |
| Matilda | result, | | 96 | 95 |
| Nipper | droughted | 0.79 | 100 | 100 |
| Northfield | | 0.85 | 93 | 93 |
| Nugget | | 0.97 | 100 | 100 |
| Nugget yield (t/ha) | | 0.97 | 2.10 | 2.25 |
| Date sown | 2 June | 7 June | | |
| Soil type | S/SC | LC/SC | | |
| pH (water) | 7.6 | 7.9 | | |
| Apr–Oct rain (mm) | 111 | 175 | | |
| Site stress factors | de,dl | de,dl,ht | | |

***Soil type:** S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, / = divides topsoil from subsoil*
***Site stress factors:** dl = post-flowering moisture stress, de = pre-flowering moisture stress, ht = high temperatures during flowering and/or pod fill*
***Data source:** SARDI–PBA–GRDC and NVT (long-term data based on weighted analysis of sites)*
***More information:** Larn McMurray (08) 8842 6265 or e-mail mcmurray.larn@saugov.sa.gov.au*

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

National Variety Trials

### *Bean Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as a % of Farah's yield.*

| Variety | 2006 | | | 7 year average (2000–06) | | |
|---|---|---|---|---|---|---|
| | Cockaleechie | Rudall | Minnipa | Cockaleechie | Lock–Rudall * | Minnipa |
| **Cairo** | 115 | Not harvested, droughted | 113 | 96 | 98 | 100 |
| **Farah** | 100 | | 100 | 100 | 100 | 100 |
| **Fiesta VF** | 104 | | 127 | 100 | 101 | 99 |
| **Fiord** | 118 | | 102 | 98 | 94 | 90 |
| **Manafest** | 93 | | 68 | 90 | 91 | 87 |
| **Nura** | 104 | | 102 | 104 | 103 | 101 |
| **Farah yield (t/ha)** | **1.40** | | **0.25** | **3.42** | **1.76** | **0.92** |
| **Date sown** | 13 May | 2 June | 8 May | | | |
| **Soil type** | CL/MC | S/CS | SCL/CL | | | |
| **pH (water)** | 7.9 | 7.6 | 8.7 | | | |
| **Apr–Oct rain (mm)** | 172 | 111 | 111 | | | |
| **Site stress factors** | de, dl | de, dl | de, dl | | | |

***Soil type:*** *S = sand, C = clay, L = loam, F = fine, M = medium, Li = light, H = heavy, / = divides topsoil from subsoil.*
***Site stress factors:*** *de = pre-flowering moisture stress, dl = post-flowering moisture stress.*
** Lock–Rudall long-term yield is a composite of Lock (1999–04) and Rudall (2005) results.*
***Data source:*** *SARDI–GRDC and NVT (long-term data based on weighted analysis of sites).*
***More information:*** *Jim Egan (08) 8688 3424 or e-mail egan.jim@saugov.sa.gov.au*

### *Lupin Variety Yield Performance at Eyre Peninsula Sites*

*2006 and long-term (2000–06) yields expressed as a % of Mandelup's yield.*

| Variety | 2006 | | | 7 year average (2000–06) | | |
|---|---|---|---|---|---|---|
| | Tooligie | Ungarra | Wanilla | Tooligie | Ungarra | Wanilla * |
| **Coromup** | No valid results, droughted | 103 | 88 | n.a. | n.a. | n.a. |
| **Jindalee** | | 70 | 85 | 94 | 96 | 97 |
| **Mandelup** | | 100 | 100 | 100 | 100 | 100 |
| **Merrit** | | 83 | 74 | 91 | 94 | 95 |
| **Moonah** | | 86 | 86 | 91 | 94 | 95 |
| **Wonga** | | 92 | 88 | 91 | 94 | 94 |
| **Mandelup yield (t/ha)** | | **1.04** | **1.82** | **1.38** | **2.31** | **2.85** |
| **Date sown** | 2 June | 17 May | 13 May | | | |
| **Soil type** | NWS/S | S/SC | SL/MC | | | |
| **pH (water)** | 7.8 | 7.0 | 6.9 | | | |
| **Apr–Oct rain (mm)** | 121 | 151 | 172 | | | |
| **Site stress factors** | de, dl, w, sh | de, dl, ap, w, e | de, dl, w, e | | | |

***Soil type:*** *S = sand, C = clay, L = loam, M = medium, Li = light, NWS = non-wetting sand, / = divides topsoil from subsoil.*
***Site stress factors:*** *de = pre-flowering moisture stress, dl = post-flowering moisture stress, e = poor emergence, w = weeds, sh = shattering, ap = aphids*
** Wanilla long-term yield is a composite of Kapinnie (2000–02) and Wanilla (2003–06) results.*
***Data source:*** *SARDI–GRDC and NVT (long-term data based on weighted analysis of sites).*
***More information:*** *Jim Egan (08) 8688 3424 or e-mail egan.jim@saugov.sa.gov.au*

## *Canola Variety Yield Performance at Eyre Peninsula Sites*

*Canola yield performance 2006 (t/ha) and long-term (2000–06, as a % of Ag-Spectrum and ATR-Beacon).*

| Variety | 2006 (t/ha) | | 2000–06 | |
|---|---|---|---|---|
| | Yeelanna | Mt Hope | Yeelanna | Mt Hope |
| AG-Spectrum | 0.64 | 0.88 | 100 | 100 |
| AV-Sapphire | 0.55 | 0.82 | 96 | 97 |
| Warrior CL | 0.82 | 0.84 | 88 | 90 |
| Pioneer 44C11 | 0.72 | 1.21 | 105 | 106 |
| Pioneer 46C04 | 0.68 | 0.96 | 98 | 100 |
| Pioneer 46C76 | 0.63 | 0.74 | 91 | 94 |
| Pioneer 46Y78 | 0.72 | 0.89 | 101 | 103 |
| Pioneer 45Y77 | 0.89 | 0.83 | 99 | 99 |
| AG-Drover | 0.52 | 0.91 | 96 | 102 |
| Hyola 50 | 0.85 | 1.44 | | |
| Hyola 75 | 0.68 | 1.32 | 107 | 110 |
| Monola NMC130 | 0.42 | 0.75 | | |
| AV-Ruby | 0.33 | 0.80 | 95 | 96 |
| AV-Jade | 0.60 | 1.12 | 97 | 98 |
| Skipton | 0.58 | 0.87 | 97 | 98 |
| RocketCL | 0.63 | 0.56 | 83 | 86 |
| RT125 | 0.75 | 1.53 | | |
| CARGILL-102 | 0.21 | 0.48 | | |
| CARGILL-103 | 0.39 | 0.42 | | |
| Ag-Spectrum yield | | | **1.82** | **1.97** |
| ATR-Beacon | 0.58 | 1.09 | 100 | 100 |
| Surpass 501 TT | 0.56 | 1.15 | 93 | 89 |
| ATR-Summitt | 0.36 | 1.21 | 97 | 100 |
| BravoTT | 0.69 | 1.28 | 108 | 105 |
| ThunderTT | 0.66 | 1.13 | 102 | 99 |
| TornadoTT | 0.65 | 1.27 | 105 | 100 |
| ATR-Marlin | 0.67 | 1.22 | | |
| Flinders TTC | 0.43 | 1.05 | | |
| ATR-Barra | 0.52 | 1.08 | 99 | 98 |
| ATR-Signal | 0.59 | 1.14 | | |
| ATR-Beacon yield | | | **1.27** | **1.58** |
| Date sown | 14 May | 15 May | | |
| Soil type | LS/HC/MC | LS/MC | | |
| Apr–Oct rain (mm) | 167 | 181 | | |
| pH | 7.1 | 5.8 | | |
| Stress factors | dl | dl | | |
| Polygenic variety | 23, 8 | 42, 10 | | |
| Sylvestris variety | 52, 32 | 41, 5 | | |

***Soil type:*** *S = sand, C = clay, L = loam, H = heavy, M = medium, Li = light, F = fine, K = coarse, lime = limestone, / = divides topsoil from subsoil*
***Site stress factors:*** *de = moisture stress pre-flowering, dl = moisture stress post-flowering, w = weeds, lo = lodging, sh = shattering, pe = poor establishment, s = sulphur deficiency, ap = aphids, hd = herbicide damage, bl = blackleg, wind = wind loss, ls = late sown, sn = snails, f = frost*
***Blackleg data:*** *Polygenic variety: ATR-Beacon, Sylvestris variety: Surpass 501TT*
*First figure is average stem internal infection. Second figure is the percentage of plants that were severely infected (e.g. >75% internal infection)*

SAGIT

National Variety Trials

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GRDC Grains Research & Development Corporation

# Field Pea Performance and Future Potential in Low Rainfall Regions

**Larn McMurray[1], Matt Dare[1], Tony Leonforte[3], Willie Shoobridge[2] and Mark Bennie[1]**

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Research

## Key messages

- **Early sowing of field peas was essential to achieve a break-even gross margin in 2006.**
- **Despite lower yielding in 2006 due to the short and dry season, Kaspa remains a good option for low rainfall environments provided that early sowing can be achieved.**
- **Native budworm caused significant damage to field pea crops in low rainfall areas in 2006; early monitoring and timely chemical control are imperative, particularly in years with early season hot temperature events.**
- **Dry seasonal conditions provided an ideal year for the pea breeding node of the National Pulse Breeding Program (Pulse Breeding Australia) to identify breeding lines for potential release with earlier flowering than Kaspa, and higher and greater yield stability than all current varieties.**

## Why do the trial?

This work aims to expand the field pea industry in low rainfall areas of southern Australia through the development of cultivars that will increase and stabilise production in the more marginal soil and climate cropping environments.

Numerous evaluation trials of break crop species in low rainfall areas have consistently indicated that field peas are the best adapted break crop option currently available for these environments. Due to these results and the continuing need for a break crop in continuous cropping rotations in low rainfall environments, the breeding node of the National Pulse Breeding Program (Pulse Breeding Australia) has focused on increasing adaptation to the medium to low rainfall areas of Australia. Minnipa is a key site in South Australia focusing on developing field pea varieties for low rainfall, short season environments. Currently, key selection criteria at these sites include resistance to blackspot, shattering, lodging, boron and salinity, and appropriate flowering and maturity time. The breeding program has also been expanded to include a germplasm enhancement node focusing on identifying and incorporating genes with tolerance to frost, transient drought, and heat at flowering and/or podding.

## How was it done?

A replicated Stage 3 pea breeding trial containing 10 commercial entries and 68 advanced breeding lines, and a replicated Stage 2 breeding trial containing six commercial checks and 181 preliminary breeders lines, were sown into reasonable moisture levels on 15 and 16 May at Minnipa.

The trials were sown after knockdown sprays had been applied with 70 kg/ha of 18:20:0. Weed levels were low and the only selective herbicides applied were Amicide 625 @ 0.1 L/ha plus Brodal @ 0.12 L/ha on 27 July, and Select plus Hasten at 0.25 L/ha and 1%, respectively, on 4 August. The trials were harvested on 10 November after being desiccated on 6 November with 1.3 L/ha of Gramoxone. Insect sprays were applied as required from flowering onwards.

Scores for establishment, early vigour, flowering, maturity, lodging, shattering and selection potential were recorded during the year, and grain yields were measured at harvest.

## What happened?

An early break to the season allowed field peas to be sown at an optimum time for this environment. Establishment and early growth was exceptional, with no disease, pest or weed interference. The early field pea lines started flowering in mid-August some 5–6 weeks earlier than the same lines in 2005 due to the early sowing date. Moderate moisture stress pre-flowering was followed by severe moisture stress post-flowering, with no

**Try this yourself now**

**Location**
MAC Paddock-North 11

**Rainfall**
Av. annual: 326 mm
Av. GSR: 241 mm
Actual annual: 236 mm
Actual GSR: 111 mm

**Yield**
Potential: 0.46 t/ha
Actual: 0.54 t/ha (Kaspa)

**Paddock history**
2004: Euro oats
2000: pasture
1999: wheat and oats

**Soil**
Sandy clay loam (pH 9.0) over clay loam (pH 9.0)

**Diseases**
Nil

**Plot size**
1.5 m x 5 m

**Other factors**
Pre-flowering moisture stress (moderate), post-flowering moisture stress (severe), high temperatures during flowering and podfill.

rain after mid-July. However, most lines were able to set some pods due to good levels of plant biomass and ideal conditions during early flowering. High temperatures during late flowering and pod fill combined with moisture stress further reduced grain yield potential and penalised late flowering lines. The severe dry conditions meant the field peas matured quickly and were harvested from 10 October. The site mean yield was 0.54 t/ha (46% of long-term average), with the highest yielding commercial line being Bundi at 0.84 t/ha (71% of long-term average). This was a very good result given the dry conditions and that the growing season rainfall was only 46% of the long-term average. Furthermore, the French–Schultz yield potential for field peas at Minnipa in 2006 was only 0.46 t/ha. This result highlights the importance of early sowing field peas in low rainfall environments.

## Pea variety choice and performance in low rainfall environments

Early and mid-flowering varieties were favoured for grain yield in 2006 (Table 1). Late flowering lines generally flowered under higher levels of moisture stress and had a much shorter flowering period (Table 1) which reduced their ability to set pods. The early flowering white pea type Bundi was the highest yielding variety in 2006 and 2004, but it continues to show instability in yield in these environments. It was substantially lower yielding than Kaspa and Parafield in 2005. It does provide an early flowering alternative to Kaspa for low rainfall environments provided that markets can be found for its white seed.

Parafield and Kaspa yielded similarly at Minnipa in 2006. Kaspa has outyielded Parafield over the long term (Table 1), but it has been less reliable in lower rainfall seasons and more productive in good years (Table 2). As Kaspa has resistance to lodging, downy mildew and shattering, it remains a good option for these environments provided that early sowing can be achieved. The white pea type Sturt was the second highest yielding variety in 2006, after being the highest yielding variety in 2005, and shows greater yield stability than all other varieties across years in low rainfall environments. Sturt provides an alternative stable option for these areas, particularly where frost may be a concern. Farmers should be aware that Sturt can be more sensitive to metribuzin and that marketing of white peas from this region may require segregation of grain. Sturt is a conventional plant type and its disease responses are similar to Parafield.

***Table 1*** ***2006 Minnipa selected pea trial yields (t/ha), flowering date (number of days flowered in brackets) and long-term predicted yield (2000–06) as a % of Kaspa with number of comparisons in brackets.***

| Variety or Line | 2006 yield | Flowering date | Long-term yield |
|---|---|---|---|
| **Bundi** | 0.84 | 15 August (18) | 98 (5) |
| **Dunwa** | 0.76 | 21 August (14) | 88 (6) |
| **Kaspa** | 0.54 | 25 August (10) | 100 (9) |
| **Moonlight** | 0.61 | 21 August (16) | 89 (5) |
| **Parafield** | 0.61 | 21 August (14) | 95 (7) |
| **Sturt** | 0.78 | 18 August (17) | 99 (7) |
| **Yarrum** | 0.5 | 23 August (9) | 92 (3) |
| **LSD (P=0.05)** | 0.13 | | Kaspa (t/ha) = 1.31 |

## Future pea varieties for low rainfall areas

Over 30 advanced breeding lines from the Stage 3 trial were higher yielding than Kaspa at Minnipa in 2006. A large number of these were higher yielding across all five South Australian sites (Table 3), in stark contrast to 2005 where only seven lines were higher yielding at Minnipa and none of these higher than Kaspa at other sites. Of particular importance to the breeding program are lines that flower earlier than Kaspa with greater yield stability over a number of seasons. A number of lines that performed well at Minnipa in 2005 with mild finishing conditions were disappointing in 2006 (i.e. OZP0609, Table 3). However, OZP0602, OZP606, 97-031-6-3 and 01-230-14 have shown earlier flowering and greater yield potential than Kaspa across seasons and, while lower yielding than Bundi in 2006, were substantially higher yielding than this variety in 2005. Further widespread evaluation of these lines will continue.

In the Stage 2 early breeding trial, over 70% of the lines evaluated at Minnipa were higher yielding than Kaspa and over 50% higher yielding than Parafield. A number of these lines have earlier maturity, increased disease resistance and better tolerance to salt and/or boron. Of particular note was the line 02-230-33, a sister line to OZP0601 in the Stage 3 trial. This line looked outstanding during the growing season at a number of sites in 2006 and was nearly 30% higher yielding than any other line at Minnipa and 96% higher than Kaspa. Across all four South Australian breeding trials in 2006, this line was 42% higher yielding than Kaspa and is early flowering with good resistance to shattering, downy mildew and lodging. Further evaluation of this line and others will occur in 2007.

***Table 2*** ***Parafield (P) and Kaspa (K) pea trial yields compared to rainfall and sowing date at Minnipa, 1999–2006.***

| | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | | 2004 | | 2005 | | 2006 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | K | P | K | P | K | P | K | P | K | P | K | P | K | P | K |
| Yield (t/ha) | 0.90 | 0.81 | 2.20 | 2.24 | 2.46 | 2.56 | 1.51 | 1.52 | 1.40 | 1.40 | 0.87 | 0.79 | 0.92 | 0.86 | 0.61 | 0.54 |
| GSR (mm) | 210 | | 299 | | 267 | | 219 | | 204 | | 223 | | 264 | | 111 | |
| AR (mm) | 268 | | 389 | | 354 | | 277 | | 263 | | 288 | | 334 | | 236 | |
| Date sown | 31 May | | 2 June | | 29 May | | 27 May | | 8 June | | 1 June | | 24 June | | 15 May | |

*Table 3 Grain yield (% of Kaspa), flowering time and other improved traits of selected lines from Stage 3 PBA pea breeding trials at Minnipa and across South Australia in 2005 and 2006.*

| Line or Variety | 2006 | | 2005 | | Flowering time | Other improved traits over Kaspa |
|---|---|---|---|---|---|---|
| | MAC | All SA | MAC | All SA | | |
| OZP0601 | 148 | 126 | 95 | 94 | Early | Improved salt tolerance, resistant to downy mildew |
| 00-226-5 | 141 | 116 | 72 | 76 | Early | |
| 97-031-6-3 | 130 | 117 | – | 101 | Mid | Moderately resistant to downy mildew |
| 01-230-14 | 130 | 113 | 106 | 95 | Mid-Early | Resistant to downy mildew |
| OZP0602 | 125 | 119 | 90 | 101 | Early | Resistant to downy mildew |
| 01-260-6 | 124 | 113 | 81 | 82 | Early | Resistant to downy mildew |
| 99-104*2 | 123 | 124 | 76 | 95 | Early | Improved tolerance to boron, resistant to downy mildew |
| OZP0606 | 122 | 115 | 102 | 101 | Mid | Resistant to downy mildew |
| 96-286*1-16 | 117 | 117 | 98 | 93 | Early | Improved black spot and bacterial blight resistance |
| 99-098*3 | 108 | 116 | 82 | 87 | Mid-Late | Improved salt tolerance |
| OZP0609 | 68 | 91 | 108 | 99 | Mid | |
| Parafield | 113 | 107 | 100 | 82 | Mid | |
| Bundi | 157 | 127 | 84 | 91 | Early | |
| Kaspa (t/ha) | **0.54** | **0.8** | **1.52** | **2.36** | **Late** | |

## General low rainfall pea performance in 2006

A number of commercial pea crops in low rainfall regions in 2006 suffered significant yield losses due to native budworm damage late in the season. Estimates of yield losses were over 50% in severe cases. While a number of these crops were sprayed, often the spray was too late or a follow-up spray was not applied when needed. In low rainfall environments where hot temperature events occur regularly and early, larvae often enter the pods at an earlier growth stage than normal. This can complicate obtaining effective control and requires earlier and more regular sweep netting than in other areas. Also due to the earlier stage of this control, a follow-up spray is often required in these environments particularly if the podding period has been extended by rain or cooler weather after the first hot event.

Early sowing time was essential to maximising pea yields across all of South Australia in 2006, particularly where Kaspa was the variety of choice. In almost all instances, black spot had no significant effect on yield. This was mainly due to the dry conditions not favouring disease progression but also due to the early opening break allowing stubble breakdown and spore release before sowing began. Early sowing continues to be the key to maximising yield in low rainfall environments, but if dry sowing or sowing directly after the opening break is to occur a low black spot risk strategy must be employed. This includes using a seed dressing, avoiding sowing close to or downwind of last year's stubble, sowing in paddocks that have not grown peas for at least four years, and avoiding herbicide injury to seedlings. Stubble disease loadings will be low in 2007, reducing but not eliminating this risk.

## What does this mean?

Despite the poor season and dry conditions, field pea trials at Minnipa produced grain yields enabling break even or slightly better gross margins in 2006 (Rural Solutions SA, Farm Gross Margin Guide, 2006). Early sowing of field peas in low rainfall environments is essential to produce grain yield in dry years and continues to be the best risk management strategy when growing this crop. Strategies for minimising blackspot risk must also be implemented.

Kaspa, Parafield, Sturt and Bundi are currently all well suited to low rainfall environments although Sturt and Bundi are white seed types and specific markets for their grain would need to be sought if grown. Kaspa is better suited to the more favourable seasons in these environments due to its later flowering characteristic, and Bundi is more suited to the shorter drier seasons. Sturt and Parafield are generally more consistent in yield but are more susceptible to downy mildew, lodging, shattering and, in the case of Sturt, metribuzin. Kaspa has agronomic advantages (e.g. pod shattering resistance) over Sturt and Parafield, and therefore is still a good choice for low rainfall environments provided that it is sown early.

Advanced breeding lines for low rainfall environments with considerably higher yields than Kaspa in dry years and similar or better yields in good years have been identified and will undergo widespread evaluation in 2007 prior to a decision on their release. These lines incorporate many of Kaspa's characteristics along with earlier flowering time, and salt and/or boron tolerance.

## Acknowledgements

This work was funded by GRDC and SARDI and is part of the Australian Field Pea Improvement Program (AFPIP) that has collaborators from DPI Victoria, DPI NSW, DAWA and University of Sydney, Narrabri. Thankyou to Leigh Davis for his assistance with the management of the trial work at MAC.

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# Faba Beans for a Low Rainfall Break Crop

**Jim Egan**[1]**, Willie Shoobridge**[2]**, Leigh Davis**[2]
[1]SARDI Port Lincoln, [2]SARDI Minnipa Agricultural Centre

Research

**Try this yourself now**

**Location:**
MAC Paddock North 10

**Rainfall**
Av. annual: 326 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 0.46 t/ha (pulse crop)
Actual: site mean 0.25 t/ha, Fiesta 0.31 t/ha

**Paddock history**
2005: Euro oats
2004: pasture (spray topped)
2003: Yitpi wheat

**Soil type**
Sandy clay loam pH 9.0 over clay loam pH 9.0

**Plot size**
1.5 m x 10 m x 3 replications (S3) or 1–2 replications (S2)

**Yield-limiting factors**
No effective rainfall from mid-July through remainder of growing season.

## Key messages

- **Despite an early May sowing, the second driest April–October rainfall on record resulted in faba bean yields of around 0.3 t/ha in MAC trials in 2006.**
- **Fiesta was the top yielding variety in the 2006 trials, but over the past seven years Farah and Nura have averaged 2% higher yields. The seven-year average for Fiesta at Minnipa is around 0.9 t/ha, but yields have ranged from 0.3 to 1.9 t/ha.**
- **Several breeding lines have been identified with significantly improved yields over these varieties at Minnipa and other low rainfall environments. These are being progressed through reselection, seed multiplication, and wider evaluation.**

## Why do the trial?

While faba beans are well established as a pulse crop option in the medium to high rainfall grain-growing districts, their use in lower rainfall regions is restricted by a lack of suitable varieties. This research program aims to develop better adapted bean varieties for these districts by conducting early generation selection and evaluation of faba bean breeding lines in a low rainfall environment. It is a component of the SAGIT-funded project to develop a range of break crop options better suited to the low rainfall Upper Eyre Peninsula region and other similar environments, and complements the selection and evaluation being undertaken in field peas, canola and mustard. This work is reported in other articles in this EPFS 2006 Summary.

## How was it done?

Faba bean lines for field testing at MAC were provided from the National Faba Bean Improvement Program led by Dr Jeff Paull at the University of Adelaide Waite Campus. Early generation lines, entering yield testing in the field for the first time, were included in the Stage 2 (S2) trial with only one or two replicates per line due to limited seed availability. This trial contained 46 lines, including 24 that had been built up from single plant selections taken at Minnipa in 2004, on the basis of height, vigour, standing ability, maturity time and high level of podding. Fiesta, Farah and Nura check plots were repeated throughout the trial to allow statistical analysis with limited replication of test lines.

More advanced lines that had shown promise in previous field testing were included in a fully replicated Stage 3 (S3) trial with 32 entries. This trial contained all entries that are in the South Australian National Variety Trial (NVT) series, including six commercial varieties, so that the results can be used to supplement the NVT variety database now available to growers on its website. Five lines from single plant selections made at Minnipa in 2003 were also promoted to the S3 trial, following good results in the 2005 S2 trial. The S2 and S3 trials also have a high number of entries in common with other faba bean breeding trials conducted by Jeff Paull's team, SARDI and interstate collaborators across southern Australia, so that line performance data can be pooled across a number of sites for analysis to identify lines worthy of progression for advanced testing.

Both Faba bean trials were sown at MAC on 8 May, at a standard rate of 24 seeds/m$^2$, with 18:20:0 fertiliser @ 70 kg/ha, following a herbicide application of 1.5 L/ha Roundup, with 75 mL/ha Striker and 250 mL/ha Li700. Four insecticide sprays were required from two days post-sowing (10 May) to mid-September to protect against insect attack (red-legged earthmite, aphids and native budworm). The trials were harvested on 20 October.

Scores for general appearance in late winter and date of first flowering were recorded. Height to bottom pods was measured shortly prior to harvest, along with scores for lodging and 'necking' (upper part of plant stem bent over) and comments on shattering. Grain yields were recorded at harvest, and grain samples retained for seed size measurement.

## What happened?

Good rain in March and a follow-up in April allowed the earliest sowing of pulse trials at MAC in many years. The faba bean trials were first sown, on 8 May, giving them an excellent start for the season. The good growing conditions were only short-lived however, with the last effective rainfall event for the season around mid-July. As a result, the growing season rainfall deteriorated from around decile 3 at mid-July to end up as the second lowest on record, behind 1959.

Faba bean yields were very low under these conditions, with mean yields of only 0.25 t/ha in the S3 trial and 0.21 t/ha in S2. These low yields were accompanied by a relatively high degree of random variability ('noise') in the trials, resulting in a higher than normal level of uncertainty about variety and line performance. Fiesta was the top yielding variety in S3, about 25% higher than Farah and Nura (Table 1). Over the past seven years of testing at Minnipa, however, Farah and Nura have averaged 2% higher yields than Fiesta. Nura's shorter height and later flowering generally put it at a disadvantage in lower rainfall, shorter growing season environments. The graph of variety yields at Minnipa from 2000 to 2006 (Figure 1) shows that Nura has outyielded Fiesta, Farah and Fiord in years when yields were above 1.0 t/ha, but has been inferior to these in recent years which have produced yields below the 1.0 t/ha mark.

The top-yielding line in the S3 trial was **AF03001**, at 0.34 t/ha (10% above Fiesta). Several lines that have yielded well at Minnipa in recent years were not as prominent in 2006, but their overall performance warrants further testing. These include:

- **683*834/16** — average of 18% higher yielding than Fiesta over past four years. Slightly taller than Fiesta and Farah and has a similar flowering time. Has been screened for ascochyta resistance and to eliminate green seeds, and seed multiplication has commenced.
- **1270*278/10** — average of 12% above Fiesta at Minnipa over past three years. Has also performed well in Western Australian breeding trials and was promoted to NVT in 2006. Reasonable chocolate spot resistance (between Fiesta and Nura) and has been reselected for ascochyta resistance. Early stages of seed multiplication.
- **482*1038/30** — average of 12% better than Fiesta over past four years, and included in NVT trials for past two years. Subject to consideration of overall yield performance; will need to be reselected to remove small percentage of green seeds before multiplication.

The top-yielding entry in the S2 trial was a single plant selection line from Minnipa in 2004, and five of these single plant selections were in the top 10 entries in this trial.

***Table 1 Yield of faba bean varieties and top lines in MAC breeding trials in 2006 and previous years (number in parentheses for long-term yield is the number of years tested at MAC).***

| Variety or Line | 2006 yield (t/ha) | 2006 % Fiesta | Long-term % Fiesta | Comments |
|---|---|---|---|---|
| ***S3 Trial*** | | | | |
| Fiesta | 0.31 | 100 | 100 (7) | |
| Farah | 0.25 | 79 | 102 (7) | |
| Nura | 0.25 | 81 | 102 (7) | |
| AF03001 | 0.34 | 110 | – | Top at MAC 2006, 3rd in 2005 S2 at MAC. |
| AF02010 | 0.32 | 103 | – | 2nd at MAC 2006 |
| 683*834/16 | 0.29 | 93 | 118 (4) | Promising line in low rainfall environments |
| 1270*278/10 | 0.32 | 101 | 112 (3) | Promoted to NVT in 2006 |
| 482*1038/30 | 0.26 | 82 | 112 (4) | In 2005 and 2006 NVT trials |
| ***S2 Trial*** | | | | |
| Fiesta | 0.20 | 100 | | |
| 0016/1-26-2-Min | 0.40 | 195 | | Top in trial — selection made at MAC in 2004 |
| IX101/1-63 | 0.38 | 186 | | |

## What does this mean?

The best of the faba beans only achieved around 70% of the theoretical potential (French–Schultz model) yield in the extremely challenging 2006 season. The very uneven distribution of what little rainfall did come in the 2006 season, with no effective rainfall from mid-July through to crop maturity, was a major factor in the low water use efficiency observed. But the fact that any grain at all was produced in spite of the dry spring demonstrates the importance of stored soil moisture to crop growth. While Fiesta's seven-year average yield at Minnipa (2000–06) is 0.9 t/ha, Figure 1 shows how bean trial yields have varied between years from lows of 0.3 t/ha for Fiesta in 2003 (sown 8 June) and 2006 (sown 8 May), to a high of 1.9 t/ha in 2001 (sown 4 June). These results challenge the validity of a 20 May cut-off date for sowing beans — only one such opportunity has occurred at MAC in the past seven years, resulting in 0.3 t/ha yield, while good yields (1 t/ha or more) have been achieved with sowings into June.

Nura and Farah have the highest long-term yield averages of current varieties at MAC, at 2% better than Fiesta (Table 1). Nura was released by the National Faba Bean Improvement Program in 2005, and seed is available from AWB Seeds. Its main advantages are improved chocolate spot and rust resistance over Farah, but similar to it in other disease and seed quality characteristics. Disease management is easier with Nura, with only ascochyta and/or rust sprays needed in high-risk situations, although these risks are generally low on Upper Eyre Peninsula. Nura's shorter height and lower pods can cause higher harvest losses in some low rainfall situations. This is likely to be more critical for commercial harvesting than in small plot trials.

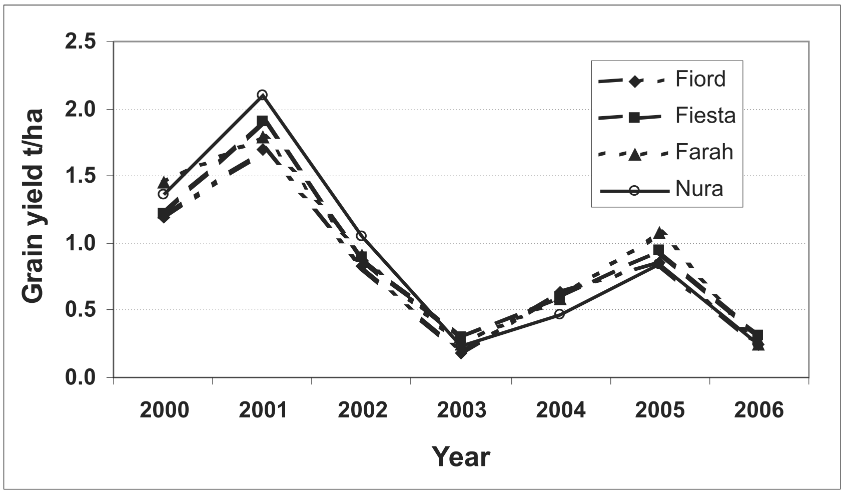


*Figure 1 Yield of faba bean varieties at MAC, 2000–06.*

Performance of breeding lines in the 2006 MAC trials will be reviewed, along with results from all other locations, to determine whether they should be progressed or deleted from the program in 2007. Agronomic, disease and seed quality characteristics will be included in the final determination.


## Acknowledgements

This work is funded by SAGIT and SARDI, but is only made possible with the support of the GRDC-funded National Faba Bean Improvement Program, through Dr Jeff Paull and his team at the Waite (University of Adelaide).


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# Low Rainfall Canola and Mustard


**Trent Potter[1], Willie Shoobridge[2] and Leigh Davis[2]**

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Research

**Almost ready**

**Location**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 246 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 0.8 t/ha (canola)
Actual: (Conv.) Ag Outback 0.1 t/ha, (TT) ATR Stubby 0.13 t/ha

**Paddock history**
2005: pasture (spray topped)
2004: Wallaroo oats
2003: Krichauff wheat

**Soil type**
Loam

**Plot size**
10 m x 2 m x 2 replications

**Yield-limiting factors**
Poor germination, aphids, drought.

## Key messages

- **Canola and mustard yields were low in 2006.**
- **Only early maturing lines produced reasonable yields.**

## Why do the trial?

The aim of all Brassica trials was to further develop lines that are better adapted to low rainfall conditions to increase the break crop options available for farmers. The low rainfall zone has few break crop options and canola has been seen as having value in years when an early break occurs. Problems have included low yields and poor oil content with late breaks and dry finishes. Work has been done over the past five years in developing early maturing canola and mustard lines that have higher grain yield and oil contents. This work follows up on previous reports in the past EPFS Summaries.

## How was it done?

Trial details — a range of early maturing canola lines and varieties were tested at Minnipa and Lock. The trial at Minnipa was sown on 11 May. All agronomic treatments were as normal farm practice.

Measurements — grain yield was measured by machine harvest at Minnipa. Grain quality was measured on grain samples from Lock. Grain yields at Lock were too low to report.

## What happened?

Canola yields in 2006 were very low with the poor finish to the season. With these low yields the sites were also very variable, resulting in more unreliable yield estimates than usual. Long-term results for Minnipa are included where entries have been in trials for at least two years. Highest long-term yields were for the varieties Hyola 50, 44C11 and Tarcoola among the conventional varieties. For the TT varieties, only BravoTT had a higher long-term yield than ATR-Stubby. However, Tanami produced high grain yields in 2006 and may be worth growing. Further testing is needed for many of the varieties that will be commercially marketed in 2007 or 2008.

A range of new varieties has been released for low rainfall areas in 2007. While little information is available due to the drought conditions in 2006, several of these show promise.

## Conventional varieties

**AG-Muster.** New release (coded AGC323). Early maturing. High to very high yielding. Tested in NVT trials in 2005. Moderate oil and protein content, similar to AG-Outback. Blackleg rating 6. Bred by Ag-Seed Research. Marketed by Crop Care Seed Technologies.

**Hyola 50.** New release (coded CBI4403). Mid-maturing hybrid. High yielding. Tested in NVT in 2005 and 2006. High oil and moderate protein content. Blackleg rating 9. Bred by Canola Breeders International. Marketed by Pacific Seeds.

**Tarcoola.** New release (coded BLN2026*SL902). Early maturing variety for low rainfall areas. Tested in NVT in 2005 and 2006. High oil and moderate protein content in 2005 trials. Blackleg rating 6. Bred by NSW DPI and SARDI. Marketed by Nuseed Pty Ltd.

## Triazine tolerant (TT) varieties

TT varieties have lower yield and oil content than conventional varieties when sown in comparative trials with non-TT varieties. However, they can give good yields in weedy paddocks, when sprayed with atrazine and/or simazine herbicides. Yield comments are made in comparison to other TT varieties.

**ATR-Banjo.** New release for New South Wales (coded AGT346). Released in South Australia and Victoria in 2006. Early to mid-maturing. Tested in NVT in 2005 and 2006. Moderate oil and high protein content. Blackleg rating 7. Developed by Ag-Seed Research and DPI-Victoria. Marketed by Crop Care Seed Technologies.

**ATR-Signal.** New release (coded NMT-052). Early to mid-maturity, 2–4 days earlier than ATR-Beacon. First year of testing in NVT in 2006. Nutrihealth indicates good vigour and yield potential, and moderate oil and protein content. Blackleg rating 8 (provisional). Developed by Nutrihealth Ltd. Marketed by Nuseed Pty Ltd.

***Table 1** Grain yield at Minnipa in 2006 and long term (2000–06) as a % of AG-Outback or ATR-Stubby, and grain quality at Lock in 2006.*

| Variety | Minnipa | | Lock | | |
|---|---|---|---|---|---|
| | 2006 (t/ha) | 2000–06 (%) | Oil content (%) | Protein (%) | Glucosinolates (%) |
| AG-Outback | 0.10 | 100 | 34.9 | 45.8 | 5 |
| AG-Spectrum | 0.02 | 95 | 33.2 | 44.7 | 8 |
| Warrior CL | 0.03 | 77 | 34.6 | 45.3 | 9 |
| Pioneer 44C11 | 0.01 | 108 | 32.5 | 43.7 | 12 |
| Pioneer 44C73 | 0.10 | 89 | 34.5 | 44.6 | 11 |
| Rivette | 0.08 | 102 | 33.0 | 46.7 | 8 |
| Pioneer 44Y06 | 0.10 | 97 | 36.9 | 45.1 | 5 |
| Pioneer 45Y77 | 0.03 | 99 | 34.5 | 47.2 | 10 |
| AG-Comet | 0.15 | 93 | 35.5 | 43.2 | 15 |
| AG-Muster | 0.07 | 100 | 32.7 | 46.4 | 6 |
| Tarcoola | 0.17 | 102 | 37.4 | 47.2 | 5 |
| Hyola 50 | 0.08 | 124 | 35.3 | 45.2 | 6 |
| AV-Opal | 0.10 | 92 | 36.1 | 47.4 | 6 |
| AV-Jade | 0.07 | 92 | 35.3 | 46.6 | 6 |
| Ag-Outback yield (t/ha) | 0.10 | 0.75 | | | |
| ATR-Beacon | 0.05 | 92 | 39.0 | 43.8 | 12 |
| ATR-Stubby | 0.13 | 100 | 37.4 | 41.8 | 18 |
| Surpass 501 TT | 0.16 | 88 | 38.9 | 42.7 | 8 |
| ATR-Banjo | 0.08 | 92 | 38.6 | 43.6 | 14 |
| BravoTT | 0.12 | 102 | 39.1 | 44.4 | 16 |
| TornadoTT | 0.09 | 99 | 40.2 | 43.9 | 4 |
| Rottnest TTC | 0.12 | | 39.1 | 42.8 | 14 |
| CBWA Boomer | 0.14 | 91 | 38.5 | 44.1 | 6 |
| CBWA Trigold | 0.21 | 98 | 41.2 | 41.7 | 9 |
| ATR-Cobbler | 0.22 | | 39.4 | 44.2 | 20 |
| ATR-Signal | 0.16 | | 38.5 | 43.1 | 17 |
| Tanami | 0.25 | | 37.2 | 41.5 | 15 |
| ATR-Stubby yield (t/ha) | 0.13 | 0.65 | | | |

**CB™ Tanami.** New release (coded CBTT-061). Early maturing. Targeted for low rainfall areas. First year of testing in NVT in 2006. Canola Breeders WA indicates high yielding, vigorous early growth, tolerant of drought stress and moderate oil and protein content. Blackleg rating 6.5 (provisional). Bred by CBWA, and marketed by Graintrust in Eastern Australia. An End Point Royalty (EPR) applies.

## Additional varieties

Several other varieties were tested in NVT trials in 2006. Seed production was often limited by drought and frost. However, there are indications that some of these may be marketed in very small quantities in specific areas. You will need to check any NVT data to get an idea as to the adaptation of these varieties.

In addition, it is likely that the first juncea canola variety will also be marketed in very small quantities in 2007. This will be a conventional variety with no herbicide tolerance but may fit into low rainfall areas. Juncea canola has not been evaluated in NVT trials. At present the juncea canola variety Dune will only be marketed in New South Wales and Victoria under a closed loop marketing option but greater quantities of seed may allow this variety and possibly two others to be sold on Eyre Peninsula in 2008.

# What does this mean?

Although grain yields were lower than in previous years, the data adds to the long-term results and confirms which varieties have promise in low rainfall areas. In addition, over the past four years, single plant selections have been taken from canola and mustard lines at Minnipa and Lameroo. These selections have been tested in S1 trials in previous years and the better lines have been promoted into S2 trials that allow wider scale testing throughout Australia. Results from S2 trials at Minnipa in 2006 showed that many of these selections are producing higher grain yields than commercial controls and have promise for future years. Results from S2 trials at Minnipa are presented in Tables 2 and 3.

We have now developed some canola lines that are much better suited to low rainfall areas. Early maturing conventional varieties such as Tarcoola are well suited to these conditions and can be considered to be an option when we get relatively early seasonal breaks. TT varieties such as ATR-Stubby, Tanami and several others also are good options when broad leaf weeds mean that the herbicide-tolerant canola is needed. Less developed lines are also showing that further improvements are going to be achieved, making canola a safer and more reliable option in low rainfall districts.

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***Table 2 Grain yield (t/ha) at Minnipa in 2006 TT S2 canola trial.***

| Entry | Yield (t/ha) | % site mean |
|---|---|---|
| SARDI613TT | 0.25 | 203 |
| SARDI609TT | 0.21 | 170 |
| BLN3837TT | 0.18 | 150 |
| SARDI614TT | 0.18 | 148 |
| SARDI617TT | 0.18 | 144 |
| SARDI612TT | 0.18 | 143 |
| ATR-STUBBY | 0.18 | 142 |
| SARDI615TT | 0.15 | 124 |
| SARDI616TT | 0.15 | 123 |
| BLN3838TT | 0.14 | 110 |
| ATR507 | 0.13 | 109 |
| BLN3835TT | 0.12 | 100 |
| BLN3836TT | 0.12 | 100 |
| SARDI610TT | 0.12 | 95 |
| BLN3841TT | 0.11 | 92 |
| TORNADOTT | 0.11 | 92 |
| BLN3839TT | 0.11 | 89 |
| BLN3840TT | 0.11 | 87 |
| BLN3356TT-04M3 | 0.10 | 85 |
| ATR510 | 0.09 | 74 |
| SARDI611TT | 0.09 | 69 |
| ATR512 | 0.08 | 67 |
| BLN3842TT | 0.08 | 64 |
| BRAVOTT | 0.08 | 61 |
| ATR514 | 0.07 | 59 |
| ATR-BANJO | 0.06 | 45 |
| ATR511 | 0.05 | 39 |
| ATR513 | 0.02 | 19 |
| Site mean | 0.12 | |
| LSD (P=0.05) | 0.04 | |

***Table 3 Grain yield (t/ha) at Minnipa in 2006 S2 conventional canola trial.***

| Entry | Yield (t/ha) | % site mean |
|---|---|---|
| RT008-04M3 | 0.35 | 274 |
| SARDI604 | 0.23 | 176 |
| SARDI601 | 0.23 | 176 |
| TARCOOLA | 0.21 | 167 |
| SARDI603 | 0.21 | 167 |
| SARDI602 | 0.17 | 136 |
| BLN3872 | 0.17 | 132 |
| SARDI607 | 0.17 | 129 |
| CC05018 | 0.15 | 121 |
| BLN3224-04W1 | 0.14 | 111 |
| SARDI606 | 0.14 | 106 |
| AV-OPAL | 0.13 | 103 |
| BLN3868 | 0.13 | 102 |
| BLN3346-04M8 | 0.12 | 97 |
| BLN3870 | 0.12 | 96 |
| CC05004 | 0.12 | 94 |
| SARDI605 | 0.10 | 76 |
| CC05002 | 0.08 | 65 |
| BLN3874 | 0.08 | 59 |
| CC05016 | 0.08 | 59 |
| BLN3873 | 0.07 | 55 |
| CC05001 | 0.07 | 54 |
| BLN3869 | 0.07 | 54 |
| AV-JADE | 0.07 | 51 |
| SARDI608 | 0.07 | 51 |
| CC05006 | 0.06 | 48 |
| BLN3875 | 0.06 | 46 |
| CC05015 | 0.06 | 44 |
| BLN3871 | 0.04 | 30 |
| Site mean | 0.13 | |
| LSD (P=0.05) | 0.04 | |

# Is Mustard the Low Rainfall Miracle?

**Jim Egan[1], Brian Purdie[1], Ashley Flint[1], Willie Shoobridge[2] and Leigh Davis[2]**
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Research


## Key messages

- **Canola and mustard (juncea canola and biodiesel types) lines produced similar low yields in the extremely dry 2006 season across Eyre Peninsula.**
- **Early maturing lines of both canola and mustard were the highest yielders, while later maturing lines produced very little seed at the driest sites.**
- **Dune, the first juncea canola variety released in Australia, will be available only to New South Wales and Victorian growers in 2007. Dune and further juncea canola releases may be available in other regions, including Eyre Peninsula, in 2008.**
- **These first juncea canola varieties will be conventional types (not TT), with advantages of better early vigour and reduced risk of shattering, so less need to windrow.**

## Why do the trials?

Mustard (*Brassica juncea*) has been promoted in recent years as a potentially better suited and more profitable break crop option than canola (*Brassica napus*) for low rainfall districts. Advantages claimed for mustard over canola include lower costs of production, mainly through the ability to direct head rather than windrow, better seedling vigour and greater yield stability over a range of seasonal conditions. Earlier trials had suggested that mustard tends to outyield canola when yields are below 1–1.5 t/ha.

An intensive breeding effort has been directed at mustard in Australia over the past decade and more to develop locally adapted varieties. Initially breeding was aimed at developing mustards with canola quality oil, termed juncea canola, and the first such variety is expected to be released by DPI Victoria in 2007. More recently the focus has broadened to include mustard as a source of oil suitable for biodiesel production, i.e. lower oleic acid types. To develop this opportunity, SARDI has recently established a biodiesel mustard breeding program. With the first commercial varieties of juncea canola and then biodiesel type mustards expected to be available on Eyre Peninsula in the next two years, growers are interested in seeing how these mustards measure up against canola varieties in a range of environments across the peninsula.

Similar comparisons were reported in the EPFS 2005 Summary (page 46), and earlier work on mustards in the EPFS 2004 Summary (page 39).

## How was it done?

A juncea canola line (JR046, from the DPI Victoria breeding program) was sown directly alongside a conventional canola variety (Emblem) in paired replicated small plots adjacent to canola National Variety Trials (NVT) at three sites (Lock, Karkoo and Mt Hope) on Eyre Peninsula in 2006. At a fourth site, adjacent to the NVT pulse trials at Rudall, three juncea canolas, a biodiesel mustard and the new low rainfall canola variety Tarcoola were compared in a replicated block trial design. A further two comparisons were drawn from oilseed trials at MAC which included both mustard lines and canola varieties. All small plots were the standard crop evaluation dimensions of 10 m long by 1.5 m (eight rows) wide, replicated three times. A standard seeding rate of 4 kg/ha was used for all lines.

All trials were direct headed at maturity, with the exception of the very low yielding Rudall site where two 1 m long x 6 row quadrats were hand-harvested from each plot for grain yield estimation. Grain samples were retained from all sites for oil analysis, but these results are not yet available.

While not all of the juncea canola and mustard lines tested in these trials will be released as commercial varieties, they are representative of the yields and oil content likely to be achieved with the first varieties.

## What happened?

Yield results for all sites are shown in Tables 1 and 2. The three simple comparisons of JR046 juncea canola and Emblem canola across Lower and Central Eyre Peninsula were sown between 14 May and 16 May, i.e. in the generally accepted optimal sowing window (Table 1). Despite the good start, rainfall was negligible at all sites after mid-July, leaving crops to draw on stored soil moisture to complete their growth, flowering and grain fill. Crop maturity was much earlier than normal, allowing harvest between 26 October at Mount Hope and 3 November at Karkoo. Grain yields in these trials were in line with April–October rainfall totals, ranging from below 0.1 t/ha (not commercially harvestable) at Lock to just over 1 t/ha at Mt Hope. No shattering was observed in the juncea canola plots at any of the sites, and only minimal shattering (estimated at 2–5%) in Emblem canola at Mt Hope. No clear (statistically significant) differences in yield between JR046 juncea canola and Emblem canola were measured at the three sites.

Table 2 shows the yield results for a range of juncea canola and biodiesel mustard lines at Minnipa (two trials) and Rudall. Growing season rainfall at these two sites was extremely low (111 mm), again with no effective rainfall after mid-July. Crops matured several weeks earlier than normal, and those at Minnipa were harvested in the last week of October. While canola in these trials yielded only 0.1 t/ha or less, some mustard lines were able to double this yield at Minnipa, with the best being a Victorian line (JM06016) which achieved 0.23 t/ha. All mustard lines were inferior to canola (Tarcoola) in the pitifully low yielding trial at Rudall.

The failure of early sown oilseeds to give better yields than those sown a month later at Minnipa is interesting, but may be due to poorer establishment in the early sown plots. Maturity was the key factor to how varieties and lines performed in the extreme 2006 season — earlier maturing lines were able to set some seed (e.g. Tarcoola canola, JR055 (Dune), SARDI 515M mustard) whereas later maturing lines failed.

***Table 1*** ***Yield (t/ha) of juncea canola (JR046) compared to Emblem canola at Eyre Peninsula sites in 2006. Yields in t/ha and as % of Emblem (in brackets).***

| Variety or Line | Type | Lock | Karkoo | Mt Hope |
|---|---|---|---|---|
| JR046 | Juncea canola | 0.06 (186%) | 0.38 (75%) | 1.13 (107%) |
| Emblem | Conventional canola | 0.03 (100%) | 0.51 (100%) | 1.06 (100%) |
| Date sown | | 16 May | 14 May | 15 May |
| Apr–Oct rain (mm) | | 116 | 167 | 181 |

***Table 2*** ***Yield (t/ha) of mustard lines (juncea canola and biodiesel types) compared to canola varieties at Eyre Peninsula sites in 2006. Yields in t/ha and as % of canola (in brackets).***

| Variety or Line | Type | MAC early sown | MAC S2 Mustard | Rudall* |
|---|---|---|---|---|
| JR046 | Juncea canola | 0.07 (93%) | – | – |
| JR050 | Juncea canola | 0.12 (151%) | – | – |
| JR055 (Dune) | Juncea canola | – | 0.13 (125%) | 0.04 (50%) |
| JC05002 | Juncea canola | – | 0.10 (101%) | 0.007 (9%) |
| JC05006 | Juncea canola | – | 0.02 (17%) | 0.002 (3%) |
| SARDI 515M | Mustard (biodiesel) | 0.16 (197%) | 0.14 (133%) | – |
| SARDI 518M | Mustard (biodiesel) | 0.05 (67%) | 0.04 (39%) | 0.04 (45%) |
| JM06016 | Mustard (biodiesel) | – | 0.23 (219%) | – |
| Tarcoola | Conventional canola | – | 0.10 (100%) | 0.08 (100%) |
| 44C73 | Clearfield canola | 0.08 (100%) | – | – |
| LSD (P=0.05) | | 0.034 | 0.055 | 0.037 |
| Date sown | | 28 April | 29 May | 2 June |
| Apr–Oct rain (mm) | | 111 | 111 | 111 |

**Extremely low yields at Rudall estimated from hand-harvested quadrats in replicated plots.*
*– indicates that the line or variety was not tested at this site.*

## What does this mean?

The low rainfall 2006 season across Eyre Peninsula provided an extreme test of mustard's drought tolerance relative to canola. Mustards were significantly higher yielding than the canola check variety in only two of the six comparative trials, both at Minnipa where yields were generally below 0.2 t/ha. In the other lowest yielding trials, canola outyielded mustards at Rudall, but there were no yield differences at Lock. There were also no yield differences in the higher yielding Karkoo and Mt Hope comparisons. So overall, there was no clear demonstration that mustards could outperform canola in low rainfall conditions.

These findings may have been clouded by the overriding importance of maturity in determining how lines and varieties handled the extreme dry late winter–spring in 2006. The earliest maturing lines, regardless of canola or mustard, were generally the highest yielding under these conditions. Our results were obviously biased by the choice of lines for testing.

Evaluation and selection in low rainfall environments, including Minnipa, in recent years has led to the development of new or potential oilseed varieties for these districts. Three of particular relevance to this study are:

**Dune juncea canola** — tested as JR055. This is the first juncea canola variety to be released in Australia, and a small quantity of seed will be available in 2007 to growers in New South Wales and Victoria only under a closed loop marketing arrangement. This is a conventional variety (not TT) potentially suited to low rainfall districts.

**SARDI 515M** — a conventional biodiesel type mustard line developed by SARDI. This line has early maturity and good oil quality, and may be progressed towards release subject to good performance data.

**Tarcoola conventional canola** — tested as BLN2026*SL902. See 'Low rainfall canola and mustard' article in this EPFS 2006 Summary.

Although these varieties could provide the most immediate new oilseed options for low rainfall districts, it is encouraging to note the large number of mustard lines that were significantly higher yielding than these in the S2 trial at Minnipa in 2006.

## Acknowledgements

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# Section 3

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# Pastures

## Alternative Pasture Options at Streaky Bay

**Emma McInerney**
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Research

### Key messages

- **Cereals are the most productive pasture option.**
- **All pastures were of adequate feed quality to maintain stock condition.**
- **Vetch and brassicas had high enough protein to finish weaner lambs.**
- **The issue of pasture ability to compete with Lincoln weed remains unanswered and requires further work.**

### Why do the trial?

Finding alternative pastures in the Streaky Bay district was identified as a major priority by the local Sheep Group. Self-regenerating medic-based pastures in the area are often slow growing and provide insufficient feed to meet demand during autumn to early winter. Modern farming systems have led to the grass freeing of pasture paddocks in the chase for better production from crops in the following year. However, the practice has resulted in reduced dry matter (DM) production, and weed problems such as Lincoln weed still persist. The Streaky Bay group wanted to investigate pasture options to increase available feed and manage Lincoln weed better.

A range of species was trialled including cereals, brassicas, ryegrasses, phalaris, medics and vetch. The cereals were chosen based on their potential as break crops (cereal rye and Rufus triticale) or their potential ability to produce high DM through good early vigour (Fleet, Barque, Wallaroo and Brusher). Grazing brassica varieties (Rangi rapeseed, Bulbous and Hobson's turnip) were selected to assess whether they could produce enough DM to make worthwhile break crops, as were the vetch varieties (Morava and Cummins) and the medic mix (Angel, Toreador and Caliph). Atlas PG is a phalaris, which has been successfully trialled in low rainfall regions in New South Wales and was included in the trial with ryegrass (Tetila and Safeguard) to see how far the boundaries could be pushed for these typically high rainfall pastures.

### How was it done?

The trial was sown on 30 May with 55 kg/ha 18:20:00. The cereals and vetch were sown at 50 kg/ha, brassicas at 3.5 kg/ha, ryegrass at 20 kg/ha, phalaris at 5 kg/ha and medic at 9 kg/ha. The trial was sprayed in June and July for insects. Cuts were taken on 7 September to calculate DM production of each treatment and sub-samples were sent to FeedTest for nutritional analysis. Pastures had reached their production peak with cereals forming heads, the medics were beginning to dry off, and Bulbous and Hobson's turnip had formed small bulbs.

### What happened?

Cereals were clearly ahead of any other pasture for DM production though some insect damage was seen in the brassicas. The Morava vetch – Wallaroo oat treatment was predominantly oats as very little vetch germinated. Ryegrass performed as well as the brassicas and vetch, while phalaris, medic and vetch performed poorly (Table 1).

**Try this yourself now**

**Location**
Streaky Bay–Haslam
Neville, Karen and Dion Trezona
Streaky Bay Sheep and Ag Bureau Group

**Rainfall**
Av. annual: 285 mm
Av. GSR: 210 mm
2006 total: 196 mm
2006 GSR: 113 mm

**Paddock history**
2005: wheat
2004: wheat
2003: pasture (spray topped)

**Soil type**
Grey calcareous sand

*Table 1 Average DM production for pastures at Streaky Bay, 2006.*

| Treatment | DM (kg/ha) |
|---|---|
| Altlas GP phalaris | 230 a |
| Medic mix | 238 a |
| Cummins vetch | 383 ab |
| Morava vetch | 422 ab |
| Rangi rapeseed | 627 ab |
| Bulbous turnip | 720 b |
| Hobson's turnip | 738 b |
| Safeguard ryegrass | 771 b |
| Tetila ryegrass | 843 b |
| Fleet barley | 1384 c |
| Rufus triticale | 1400 c |
| Barque barley | 1860 cd |
| Morava vetch plus Wallaroo oats | 1882 d |
| Brusher oats | 1893 d |
| Cereal rye | 2255 d |
| LSD (P=0.05) | 476 |

*Treatments followed by the same letter are not statistically different from each other.*

*Table 2 Summary of FeedTest results from pastures at Streaky Bay, 2006.*

| Treatment | Crude protein (CP %) | ME# (MJ/kg DM) | Fibre (NDF %) |
|---|---|---|---|
| Recommended | 16x, 8+ | 11x, 8+ | 30x, 30+ |
| Atlas PG phalaris | N/A — sample was too small | | |
| Medic mix | N/A — sample was too small | | |
| Cummins vetch<br>Morava vetch | 18.5 | 11.2 | 37.0 |
| Rangi rapeseed<br>Bulbous turnip<br>Hobson's rapeseed | 19.9 | 13.5 | 27.0 |
| Safeguard ryegrass<br>Tetila ryegrass | 13.5 | 13.3 | 35.0 |
| Fleet barley | 12.2 | 12.1 | 43.6 |
| Rufus Triticale | 12.7 | 11.7 | 44.2 |
| Barque barley | 11.0 | 12.1 | 43.0 |
| Morava vetch plus Wallaroo oats | N/A — sample was too small | | |
| Brusher oats | 9.4 | 12.8 | 34.4 |
| Cereal rye | 11.6 | 11.2 | 48.0 |

*xRecommended nutritional requirement for finishing weaner lambs*
*+Recommended nutritional requirement for ewes and wethers*
*#Metabolisable Energy, measured in Megajoules (MJ)*

All of these pasture types are suited to meet ewe and wether nutrition requirements for maintaining body condition (Table 2). Only vetch and the brassica can supply enough protein to meet recommendations for weaner growth (16%). Rufus and Fleet will meet the protein demands of lactating ewes (12%). All the treatments had high energy levels, sufficient to meet the demands of growing lambs, and fibre content was adequate.

The first year of production from a perennial such as phalaris is typically very poor, as crowns are not formed until the second year after summer dormancy. With lower than average rainfall in 2006, the establishment of phalaris was poor and it produced very little DM (230 kg/ha). In this environment it will never perform as well as cereals for stockfeed and or compete successfully with Lincoln weed in subsequent seasons.

Brassicas are used as break crops in many systems but are limited on Upper Eyre Peninsula by yields, DM production and the risk of exposing paddocks to erosion (see article 'Don't rule out grazing brassicas on Upper Eyre Peninsula yet?' in this manual). Brassicas provide good value feed, which is high in protein and energy but low in fibre and therefore may require a source of additional roughage in the form of hay or straw.

## What does this mean?

In dry seasons, the nutritional requirements of stock are met by all the species trialled. The trial showed that a cereal-based pasture provided the best level of DM production in 2006. For example, the grazing potential of Rufus triticale and Atlas phalaris (assume consumption of 1 kg DM/DSE/day):

***Rufus triticale:***

1400 kg DM/ha available, allow roughly 400 kg/ha wastage, allow 250 kg/ha for ground cover
= 750 grazing days/ha/DSE
= 750 DSE/ha for 1 day
= 3 DSE/ha for 250 days.

***Atlas PG phalaris:***

230 kg DM/ha available, allow 60 kg/ha wastage, allow 100 kg/ha for ground cover
= 70 DSE grazing for 1 day/ha
= 3 DSE/ha for 23 days.

Rufus triticale provides over 10 times more grazing days and ground cover after grazing than Atlas phalaris, making it a more productive option for that paddock. The limiting factors of high DM production are early establishment with good soil moisture and nutrition, and the control of weeds and insects. Lincoln weed requires a higher level of management throughout the farming system and control is more complicated than the choice of a competitive pasture.

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FeedTest is registered to DPI Victoria.

# Matching Land Capability to Pasture Production on Upper Eyre Peninsula

**Tiffany Ottens**
Rural Solutions SA, Streaky Bay

Demo


## Key messages

- **Pasture varieties did not perform to their full potential due to seasonal conditions.**
- **Early sowing, weed and insect control is important when renovating pastures.**
- **More research is needed into the management strategies of annual and perennial pastures on different land types on Upper Eyre Peninsula.**

## Why do the trial?

The aim of this project is to identify, assess and promote options that best match land use to land capability. A major component in achieving this is to develop pasture and grazing systems that are profitable and environmentally sustainable. This project established a number of demonstration sites that explored the potential of new pasture species (to Upper Eyre Peninsula) and compared them to traditional pasture options.

To date the best pasture options in this region have been medics and annual grasses (refer to EPFS 2004 Summary page 59, and 2005 page 56) but their production is sometimes limited due to seasonal conditions (e.g. dry seasons and/or herbicide residues in the cropping phase affecting regeneration of the pastures). Anecdotal accounts from farmers are also saying that pastures are not performing as well compared to those prior to the introduction of more intensive cropping practices. Tightening grain margins and risk management strategies have created a renewed interest in livestock, and it is important that issues with pasture production and grazing management are investigated.

## How was it done?

A 'Land System' is an area with a particular set of features that are distinguishable from surrounding land. These features include geology, topography, soils, climate and vegetation. Areas that represented different land systems across Upper Eyre Peninsula were chosen to take part in the project. Land systems included Haslam (gently undulating rises with highly calcareous sandy loams and sands); Wookata (gently undulating rises and low hills with highly calcareous sandy loams); Hambridge (parallel sandhills with swales of calcareous sandy loams); Kaylee (calcrete plain with shallow reddish sandy loams); and Le Hunte (plains with calcareous, highly calcareous and shallow sandy loams and parallel sandhills).

A mixture of both perennials and annuals were used in the demonstrations. Pasture varieties were:

- Annuals — Italian ryegrass (cv Tetlia), Medic (cv Cavalier), and Vetch and Barley (cv Blanchfleur and Sloop SA).
- Perennials — Cocksfoot (cv Kasbah), Phalaris (cv Atlas PG), Lucerne (cv Venus) and Veldt grass. (Medic was used as a common control.)

Species selection was based on soil type — Veldt grass, Kasbah cocksfoot and lucerne prefer sandier, free-draining soils. Atlas PG phalaris and Italian Ryegrass prefer heavier soils and good nutrition (particularly the ryegrass which requires high nutrient application to achieve potential).

Trial site locations are shown in Table 1. The trials were sown between 20 and 28 June at the following seeding rates — Italian Ryegrass (25 kg/ha); Medic (15 kg/ha); Vetch–Barley mix (20 and 30 kg/ha, respectively); Cocksfoot and Phalaris (7 kg/ha, with a medic cover crop at 12 kg/ha); Lucerne (6 kg/ha, with a barley cover crop at 30 kg/ha); and Veldt grass (5 kg/ha).

Fertiliser (applied at seeding) — 110 kg/ha of 32:10:00 at Lake Hamilton and Lock, and 69 kg/ha of 32:10:00 at Streaky Bay, Penong and Mt Damper.

All sites were initially sprayed with Dimethoate for insects, and baited for snails and mice. Sites were assessed for germination, initial ground cover and DM production.

## What happened?

The project did not commence until January 2006 which did not allow for weed control in 2005. As a result, the sites were sown later in the year in an attempt to get the best weed control possible given the circumstances. However, due to the unusually dry year this was detrimental to their performance, and severely limited data collection. DM cuts were planned for middle to late September (to allow for development of perennial species), but the dry conditions restricted later season growth with the vetch and medic drying off by September. As a result, DM cuts were not taken and results are from visual observations only.

The annual grass species provided the best ground cover early, with the Italian ryegrass and barley–vetch mix considered to provide the highest DM levels, even though the latter was not sown at a high enough density. Surprisingly, the Italian ryegrass had excellent growth on the sandier sites. The medic took slightly longer to develop and was poor in growth and DM production.

Perennial species take longer to establish than annuals and in the first year produce lower levels of DM. These varieties were sown with cover crops to help protect the germinating species. Emergence of the phalaris and cocksfoot was excellent and, given the dry conditions, the growth achieved by the phalaris was pleasing. This is somewhat surprising as trials conducted in New South Wales over three dry seasons suggested that the cocksfoot would outperform the phalaris. Strong winds and the dry conditions seriously affected the lucerne, with no persistence recorded at any site. At this stage it is unknown whether the perennials will recover from the long, dry period over summer. An evaluation of the sites will occur in March 2007 to determine their persistence.

## What does this mean?

Farmers need to look at their land capability, financial, social and whole farm integration perspectives to establish the best pasture system for their property. The work shows how difficult it is to establish productive pastures in low to medium rainfall environments with issues such as soil type, weed and insect control, rainfall (timing and amount) and grazing management all vital management considerations. Over the next year we will be looking into various grazing management options of existing pasture systems and further investigate perennial pasture options. This work will include production levels, financial viability and time management implications of the various systems.

The Eyre Peninsula Sustainable Agriculture Project has received further funding for another year of investigations into land capability and pasture systems. We will be working closely with the Eyre Peninsula Grain & Graze project throughout the coming year to find the key to pasture production and grazing management on Upper Eyre Peninsula.


## Acknowledgements

These demonstrations were conducted with funding through the National Landcare program and coordinated by the Eyre Peninsula Natural Resource Management Board. Many thanks go to all the farmers and their families involved in the pasture demonstrations. Your time, enthusiasm and use of your land were much appreciated.

Thanks to Terry Blacker and Ian Richter, SARDI, George Pedler and Darren Rule, Cummins Ag Services, for your help and use of your machinery. Special thanks to Andy Bates, Ken Henry, Tim Prance, Daniel Schuppan, David Davenport and Kieran Wauchope for your technical expertise and continual support throughout the year. Finally, a big thank you to Liz Guerin for making everything work behind the scenes.


***Table 1 Trial site locations and rainfall measurements.***

| Site | Cooperator | Av. rainfall (mm) | 2006 total (mm) | 2006 GSR (mm) | Land system |
|---|---|---|---|---|---|
| **Penong** | Ben and John Polkinghorne | 300 | 212 | 110 | Haslam (calcareous loamy sand) |
| **Streaky Bay** | Dion Williams | 298 | 202 | 113 | Haslam–Wookata (highly calcareous loamy sand) |
| **Mt Damper** | Chris McBeath | 362 | 269 | 116 | Hambridge (calcareous sandy loam) |
| **Mt Damper** | Sean O'Brien | 362 | 269 | 116 | Hambridge (reddish brown sandy loam) |
| **Lock** | Andrew Wiseman | 340 | 283 | 124 | Le Hunte (loamy sand) |
| **Lake Hamilton** | Robin Speed | 437 | 346 | 183 | Kaylee (clay loam) |

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# Stock Nutrition on Medic Pasture

**Emma McInerney**
SARDI Minnipa Agricultural Centre

Research



## Key messages

- **In 2006, grass-free medic pastures provided a balanced pasture suitable for growing out weaners, therefore no benefits to stock performance were measured as a result of leaving grasses in medic pasture or feeding hay when grasses were removed.**
- **Vitamin A, D and E treatment did not increase growth rates of sheep grazing on medic pastures in 2006.**
- **Merino lambs grew very well at 260 g/day.**
- **More work is needed on the nutrition of stock grazing medic pastures, as 2006 was a poor trial year.**

## Why do the trial?

Most farmers remove grasses from their pastures with a selective herbicide to improve yield in the following crops. While this practice is a definite benefit to the business, many farmers have commented that the grass-free medic pastures lead to poor performance in their livestock. Farmers have also reported health problems such as red-gut and ammonia toxicity, which can occur on high protein diets such as lush legume pastures. In 2003, one farmer near Cleve lost 35 crossbred lambs due to red-gut.

Legume pastures undergo a flush of growth just prior to flowering, where nitrate concentrations increase and energy (ME) levels fall, increasing the risk of red-gut and ammonia toxicity. These lush pastures also lack fibre.

Vitamin A deficiency can occur on lush pastures with high nitrates.

Vitamin D is obtained from the sun and only becomes a problem if phosphorus and calcium are unbalanced in the diet. It is recommended that hay be offered to stock on legume pastures that are high in phosphorus and calcium. Hay also gives the stock fibre, which helps the gut function.

Vitamin E deficiency is likely to occur in stock that have been fed on grain and hay for extended periods of time, with no access to green feed. Stock requirements for Vitamin E increase with high nitrates in the diet.

The trial aimed to assess the production benefits of balanced nutrition by offering hay or grasses to stock grazing medic pastures and determine the value of vitamin A, D and E supplements.

## How was it done?

- A self-regenerating medic-based pasture was fenced into three 13 ha paddocks, and two of these were sprayed with Targa in late May.
- 120 merino wether lambs (June–July 2005 drop), purchased locally on 22 May at weights between 34 and 40 kg, were drenched, vaccinated, weighed, drafted and tagged into three randomly selected feed treatment groups.
- Half the sheep in each group were given a Vitamin A, D and E injection and all the sheep were put in trial paddocks on 4 July. A second dose of A, D and E was given on 18 August.
- The three feed treatments were grassy medic, grass-free medic only, and grass-free medic with hay. Each of these treatments had half the sheep treated with vitamin A, D and E.
- Sheep were weighed on 30 June, 28 July, 18 August and 8 September.
- Sheep were run for a period of 66 days at a stocking rate of approximately 5 DSE/ha until paddock feed ran out.

## What happened?

Medic pastures produced a good deal of early bulk (late May), providing ample paddock feed in July when the trial started. Further pasture growth was restricted by lower than average growing season rainfall and frosts. Pasture growth in spring was poor.

The paddock had been cropped for several years previously, so while an attempt was made to leave one paddock grassy the percentage of grasses present was very small.

**Searching for answers**

**Location**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 4.1 t/ha or
1.2 DM t/ha (pasture)

**Paddock history**
2005: Wyalkatchem wheat
2004: Yitpi wheat
2003: pasture (spray topped)

**Soil type**
Red sandy loam

The performance of stock on each feed treatment was measured by weight gain. Table 1 shows there was no weight gain difference between the treatments. The vitamin A, D and E treatment was not beneficial to weight gain on any of the feed treatments. The sheep had very good growth rates at an average of 260 g/day. Stock growth rates of 240 g/day are exceptionally good for Merino lambs on paddock feed. Hay is low in energy and high in fibre, so offering it to stock did not have any benefit to the nutritional value of the feed and it would have been a more costly option.

The FeedTest analysis of the pasture (Table 2) shows that leaving grasses in the pasture did not improve the nutritive quality of the medic pasture. Both pastures provided adequate protein and fibre to stock, and only lacked a little on energy. Stock performed well on this pasture as it almost met the recommended nutritional requirements.

## What does this mean?

Grass-free medic is usually higher in protein and has less energy, which makes it an unbalanced stock feed. However, the medic pasture in 2006 provided good feed, suitable for growing out weaner lambs. There was no benefit to livestock growth rates from leaving grasses in the pasture or by supplementing the pasture with hay. The vitamin A, D and E treatment was of no benefit to stock on medic pastures in 2006. Benefits from the treatment will only be seen if there is a deficiency through poorly balanced nutrition. The risk of livestock health issues such as red-gut and ammonia toxicity may be greater in years with different seasonal conditions, such as a wet spring. To generate any outcomes from this work, the trial will need be repeated in a better year with many more sheep to account for growth rate variations.


## Acknowledgements

Grain & Graze is funded by Meat & Livestock Australia, Australian Wool Innovation, GRDC and Land & Water Australia. A big thank you to MAC staff (Brendan Frischke, Brett McEvoy, Shane Moroney and Ben Ward) who helped with setting up the trial, buying sheep, weighing sheep, fencing the paddock into cells, rigging up water and re-drafting sheep after some early box-ups.

Targa is a registered product of Du Pont, and FeedTest is registered to DPI Victoria.


***Table 1 Weight gains and growth rates of wether lambs at Minnipa, 2006.***

| | Grassy medic | Grass free medic | Grass free medic plus hay |
|---|---|---|---|
| Weight gain (kg/head) no Vitamin A, D and E | 15.8 | 16.9 | 18.0 |
| Weight gain (kg/head) with Vitamin A, D and E | 15.8 | 16.1 | 15.1 |
| Growth rate (g/day) | 240 | 260 | 270 |

***Table 2 FeedTest analysis of pasture (per kg DM) at Minnipa, 1 August 2006.***

| | Medic (grass free) | Grassy medic | Recommended | |
|---|---|---|---|---|
| | | | Maintenance[3] | Production[4] |
| Crude protein (%) | 26 | 26 | 8 | 16 |
| Fibre (NDF[1] %) | 38 | 40 | 10 | 20 |
| Digestibility (%) | 66 | 67 | 45 | 70 |
| ME[2] (MJ) | 9.7 | 9.9 | 7.4 | 11 |
| Pasture-available DM (t/ha) | 0.87 | 0.70 | | |

*[1]NDF — neutral detergent fibre*
*[2]ME — metabolisable energy*
*[3]Refer to 'Feeding and managing sheep in dry times', ration for maintenance*
*[4]Example ration for finishing*

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# Lake Hamilton Rotational Grazing Demo


## Daniel Schuppan

Rural Solutions SA, Port Lincoln


Demo

## Key messages

- **Ewes should be set stocked during lambing followed by rotational grazing from marking through to lambing the following year.**
- **Smaller paddocks with strategic rotational grazing can improve pasture quantity and increase stocking rates.**
- **Fencing paddocks to land class (topography and soil type) will improve grazing management.**
- **Planning water infrastructure is critical — set up prior to fencing if possible.**

## Why do the demo?

Many grazing properties have the potential to be more productive, and still be sustainable with regard to ground cover and perennial species composition. The aim of this demonstration is to explore the issues and benefits of alternative systems to traditional set stocking grazing systems.

Graziers are taking up new techniques such as rotational grazing, cell grazing, strategic grazing, crash grazing, block grazing, techno grazing, holistic grazing, and deferred grazing. Call it what you like, it is all about managing your pastures and livestock to achieve the best results by getting the balance between the pasture and animal requirements right.

A rotational grazing demonstration was established on Robin Speed's property at Lake Hamilton.

## How was it done?

The 603 ha paddock selected, with one main watering point in the middle, comprised large areas of extensive calcrete mixed with areas of shallow red soil on the flats and shallow rises. Hills along the western side showed a lot of limestone, with some native vegetation cover.

With technical support from Rural Solutions SA staff, a paddock plan was developed. Issues such as water points, sheep movement and size of paddocks needed to be considered.

Land capability was the major factor that influenced the fence placement, with some paddocks being larger due to more surface rock and less effective grazing. The hills were fenced off with five cells made on the more productive ground (Figure 1). Two smaller paddocks across the main road were also included in the system.

The hills were fenced off using five plain wires (with three able to be electricrified later), and cyclone was used for the fencing between paddocks. Paddock areas were calculated using GPS technology.

A soil test was taken and the results indicated sufficient levels of nitrogen and potassium for pasture production but the phosphorus levels were low.

The sheep were all put in one mob with the aim to rotate through the seven paddocks during winter as determined by pasture growth. The ewes were set stocked during lambing. A feed budget completed from October 2006 to May 2007 planned for each paddock to be grazed for approximately two 2-week periods, providing 14-weeks rest between grazing. No supplementary feeding was undertaken. Stocking rate data were collected, photo points were established and managed, and pasture quantity and quality was assessed. The results of feed tests are available upon request.

## What happened?

Before the demonstration, the sheep were allowed to graze all over the paddock and they tended to camp on the hills resulting in over grazing of the higher ground and wasted feed on the better soil. The more intensive system trialled here worked effectively during the winter months when stock required minimal water and could be rotated. However, when the stock required constant access to water, the system was less effective as water was only connected to two paddocks and rotations were limited.

**Searching for answers**

**Trial information**

**Location**
Lake Hamilton: Robin Speed

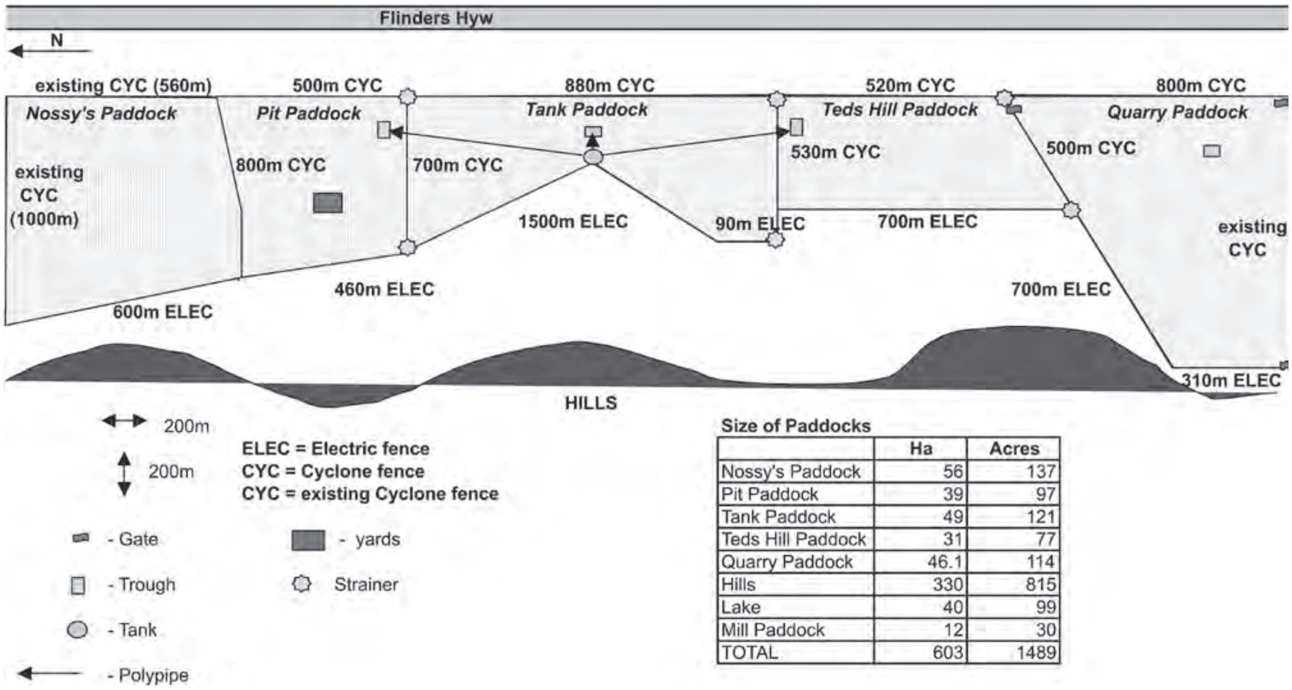
**Rainfall**
Av. annual: 436 mm
Av. GSR: 363 mm
2006 total: 345 mm
2006 GSR: 183 mm

**Soil type**
Calcrete plains and ridges with shallow grey and red soils

Despite this constraint there were a number of benefits:

- Having smaller paddocks increased the stocking pressure — paddocks could be grazed and then rested.
- Paddocks that were grazed heavily during winter were visibly green for longer at the end of the season.
- The historical annual stocking rate for the paddock was 1.47 DSE/ha, but for 2006 the average stocking rate was 1.7 DSE/ha, an increase of 13%. Considering the site only received 183 mm of growing season rainfall compared to an average of 363 mm, this confirms there is considerable potential to increase stocking rate.
- The flexibility provided by additional paddocks enables Robin to wean lambs earlier than he normally does.

***Figure 1** Paddock design on Robin Speed's property at Lake Hamilton.*




Size of Paddocks

| | Ha | Acres |
|---|---|---|
| Nossy's Paddock | 56 | 137 |
| Pit Paddock | 39 | 97 |
| Tank Paddock | 49 | 121 |
| Teds Hill Paddock | 31 | 77 |
| Quarry Paddock | 46.1 | 114 |
| Hills | 330 | 815 |
| Lake | 40 | 99 |
| Mill Paddock | 12 | 30 |
| TOTAL | 603 | 1489 |

## What does this mean?

Smaller paddocks and higher stocking pressure force the sheep to eat all the pasture (not selectively grazing) resulting in higher stocking rates. It would be expected that pasture quality will improve in time as results on other sites show heavy grazing for short periods results in 'sweeter' feed (no tall rank feed).

Access to sufficient water must be provided to every paddock.

Grazing systems require careful management to avoid periods of feed shortages and potential paddock degradation. Initiating a feed budget and stock movement plans will assist in grazing management.

In 2007, stocking rates, pasture composition and dry matter production will be monitored and watering points will be provided in each paddock. Trial strips of fertiliser at 1 kg P per DSE/ha are to be conducted.

## Acknowledgements

Funding was provided by the Eyre Peninsula Natural Resource Management Board through a sustainable agriculture NLP Project. Thanks to Robin Speed whose cooperation and time spent on setting up infrastructure and keeping records is appreciated.

Government of South Australia
Eyre Peninsula Natural Resources Management Board

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Program

# Pasture Evaluation at Mount Damper

**Eric Kobelt and Alan Humphries**
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Research

Pastures

## Key messages

- **High seeding rates, up to 5 kg/ha, to encourage high lucerne plant densities are the basis of a good productive stand.**
- **Excellent weed and pest control, adequate growing season rainfall, and no wind erosion are required to establish late-sown pastures.**
- **Combine high winter growth of annuals with benefits of perennial legumes to achieve potential year round production.**
- **Potential for larger scale demonstration with best-bet options combining both annual and perennial components.**

## Why do the trial?

The Mount Damper trial is evaluating perennial legumes with the potential to have better adaptation and grazing tolerance than conventional lucernes. This is one of several trials in the southern Australian cereal zone testing a range of perennial legumes for recharge and salinity control. Lucerne is a proven pasture option for recharge control but its wider adoption has been limited by several deficiencies for which genetic improvement is sought. Major deficiencies include lack of grazing tolerance and poor establishment and, in other areas (e.g. New South Wales), acid soils limit lucerne use. A diverse range of lucerne varieties and imported lucerne lines are being tested in the Mount Damper trial, including material collected from harsh environments overseas, including areas with dry climates and uncontrolled grazing.

**Searching for answers**

**Location**
Mount Damper: Sean O'Brien
Minnipa Farmers Group

**Rainfall**
Av. annual: 362 mm
Av. GSR: 251 mm
2006 total: 269 mm
2006 GSR: 116 mm

**Soil type**
Reddish brown sandy loam

**Plot size**
5 m x 1.5 m x 4 replications.

***Table 1 Mount Damper Perennial Legume Trial — selected results for the best lucerne and alternative trial entries, 2005 and 2006.***

| Line or Variety | Vigour (0–10*) | Plant density (plants/m$^2$) | | Plant height (cm) | | DM yield (kg/ha) | |
|---|---|---|---|---|---|---|---|
| | 16 Nov 05 | 16 Nov 05 | 20 Sep 06 | 7 Apr 06 | 20 Sep 06 | 7 Apr 06 | 30 Oct 06 |
| Lucernes: *Medicago sativa* subspecies: Mss = *sativa*, Msc = *coerulea*, Msf = *falcata* | | | | | | | |
| Cancreep | 8.5 | 31 | 13.4 | 18.7 | 7.8 | 119 | 869 |
| PA1 Msc | 7.5 | 28 | 10.8 | 18.4 | 5.5 | 102 | 482 |
| PA2 Mss | 8.7 | 35 | 14.2 | 15.7 | 6.7 | 109 | 783 |
| PA3 Msv | 7.7 | 26 | 13.7 | 17.7 | 8.6 | 99 | 885 |
| PA4 Mss | 8.6 | 36 | 14.2 | 20.6 | 9.2 | 120 | 730 |
| PA18 Msv | 5.9 | 29 | 14.4 | 19.4 | 7.9 | 115 | 818 |
| PA21 Mss | 6.7 | 32 | 12.2 | 18.7 | 7.2 | 121 | 758 |
| PA25 Mss | 7.9 | 47 | 14.7 | 24.2 | 8.0 | 137 | 1026 |
| PA27 Msf | 7.6 | 27 | 12.5 | 19.5 | 6.8 | 113 | 628 |
| SARDI Five | 6.8 | 34 | 14.8 | 19.9 | 7.9 | 129 | 1165 |
| SARDI Ten | 8.5 | 32 | 17.5 | 19.6 | 11.2 | 117 | 931 |
| SARDI Seven | 7.9 | 30 | 12.4 | 19.1 | 8.4 | 118 | 955 |
| Alternative species: Ca = *Cullen australasicum*, Sainfoin = *Onybrychis vicifolia* | | | | | | | |
| SARDI Seven 1kg/ha | 9.0 | 8 | 7.5 | 26.9 | 19.2 | 52 | 560 |
| PA29 Ca | 6.5 | 20 | 7.0 | 23.7 | 12.7 | 43 | 610 |
| PA31 Ca | 6.4 | 16 | 7.7 | 28.6 | 11.7 | 42 | 515 |
| Othello Sainfoin | 9.9 | 9 | 5.3 | 20.3 | 12.0 | 26 | 306 |
| Statistics: | | | | | | | |
| LSD (P=0.05) | *1.5* | *8.9* | *2.6* | *5.9* | *2.3* | *13* | *178* |
| *Site mean* | *5.2* | *1 9* | *7.7* | *15.7* | *5.9* | *49* | *388* |

**Vigour scored, 10 = trial maximum*

A range of other 'alternative' perennial legumes, which have shown some potential, are also being tested and compared to the lucernes. These include some native species like Cullen, collected from low rainfall inland areas of Australia.

## How was it done?

After good knockdown weed control, the trial was sown in late July 2005 into a good seedbed, with 60 kg/ha of 00:20:00 fertiliser. Insects were controlled by bare earth treatment at sowing and again seven weeks later.

The trial has 54 entries, 20 being alternative species and 34 lucerne entries of broad origins. All entries (except one) were sown at 4 kg/ha. Emergence and establishment was generally good but varied because of the large range of seed sizes sown at the same seeding rate. One low seeding rate lucerne treatment (SARDI Seven at 1 kg/ha) was included to have comparable numbers of seeds sown as for the large seeded species tested.

The trial was fenced to exclude sheep grazing until after yield measurements. Weeds were controlled in 2006 by grazing and a winter clean spray. In 2007, longer periods of extensive grazing will further test the grazing tolerance and persistence of the trial entries.

Plant counts were at taken at emergence, and two measurements were taken of yield, plant density, height and vigour during the growing season. To measure yield and persistence, the trial will continue to be treated as a monoculture of perennials for another year. From 2007, the trial will be monitored less intensively for persistence and production for several more years and become a valuable resource for perennial pasture breeding.

The trial is one of several sown with the same lines in 2005 for a CRC Salinity project. Other CRC Salinity trial sites include Walpeup and Hamilton (Victoria), and Barmedman (New South Wales). These lines are also being trialled in the Murray Mallee for a CNRM project, sown in 2005 at Wanbi and sown again in 2006 at Sherlock and Karoonda.

## What happened?

Results to date from Mount Damper are limited to the first year and by a very ordinary 2006 season. Many entries performed poorly in one or more counts; this is not surprising since most entries have never been tested before, and are unbred and unselected introductions or natives collected from pastoral environments. Many of the alternative species are also large seeded, resulting in much thinner establishment densities compared to the smaller seeded lucernes and lucerne check varieties.

Several lucerne test lines performed well, matching the check lucerne varieties in most characteristics measured. Results for the best performing lines and checks are presented in Table 1. Of note is the line PA25, a SARDI-bred line with very minimal selection and breeding derived from introduced wild germplasms.

Also promising in this (and other) trial is the performance of lines of the native species *Cullen australasicum*, a semi-erect forage shrub that can grow to over 1 m high and has widespread natural distribution in southern and central Australia.

The three best lines of large seeded alternative species have been included which compare favourably with the low seeding rate SARDI Seven treatment, also having low establishment plant densities. The seed size by weight of the Cullen lines (PA29 and PA31) is 2.1 times that of lucerne while Orthello seed size is 5.3 times that of lucerne. The 1000 seed weights for lucerne, *Cullen* and Orthello are 3.0, 6.5, and 16.1 g, respectively.

Noteworthy are the differences between high and low seeding rate SARDI Seven treatments. The high sowing rate of SARDI Seven, with much higher plant density, produced higher yields, despite having lower vigour and height.

## What does this mean?

Trial evaluation is ongoing and requires at least another year of data to confirm yield and determine grazing tolerance and persistence. Results to date suggest further selection and breeding of better test lines (e.g. PA25).

The positive effect of seeding rate and plant density on lucerne yield has clear implications for investing in:

- establishment inputs to achieve good stand density both pre- and post-sowing.
- stand management to maintain lucerne plant density.
- breeding and selection for improved persistence and grazing tolerance of perennial legumes.

Recommendations to improve persistence and production of lucerne pastures are:

- Sowing or encouraging an annual pasture component with lucerne, whether winter active or dormant, will improve the cool season yield. The annual pasture component could be either a sown cereal or an annual pasture mix.
- Sowing winter-dormant lucernes, that are more grazing tolerant, require less grazing management for persistence. A realistic grazing management for very winter-dormant lucerne is continuous grazing in winter only, with a two or three paddock rotation at other times.

Further demonstration style trials of best-bet perennial plus annual pasture mixes, in collaboration with Eyre Peninsula Grain & Graze, is recommended.

## Acknowledgements

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# Grazing Management in Sheoak Grassy Woodlands

**Jodie Reseigh**[1]**, Brett Bartel**[2] **and Di DeLaine**[3]
Rural Solutions SA [1]Clare, [2]Adelaide and [3]Port Lincoln

Research



## Key messages

- **Landholders on Eyre Peninsula are aiming to improve the management of sheoak grassy woodlands for conservation, biodiversity and production outcomes.**
- **Trial sites have been monitored annually since 2001 for a number of attributes including presence of species, numbers of native perennial grass plants, and contribution of dominant species to total dry weight of pasture.**
- **Early trends illustrate a decline in the frequencies of the problem species Stork's bill (geranium) (*Erodium* species) at the property in the Hundred of Wright, and an increase in the contribution of native grass species Spear grass (*Austrostipa* species) and Wallaby grass (*Austrodanthonia* species) to total dry matter at the property in the Hundred of Colton, both which are managed with rotational grazing.**
- **Initial trends need to be monitored over time to be confirmed, as the results may be due to seasonal fluctuations or factors that are not part of the trial design.**
- **It is imperative that long-term monitoring is continued so that changes in native grassy ecosystems as a result of improved management can be observed. A termination of funding and monitoring would result in loss of data and information.**
- **Ideally, 7–10 years of data are necessary to demonstrate trends and recommend management prescriptions.**

## Why do the trial?

The condition and extent of sheoak grassy woodlands on Eyre Peninsula has dramatically declined. This project aims to investigate grazing management options for sheoak grassy woodlands to maintain or improve productivity while improving conservation and biodiversity values on Eyre Peninsula.

Traditional grazing management (set stocking or continuous grazing) of livestock on pastures dominated by native grass species (formally sheoak grassy woodlands) has resulted in pastures becoming degraded, predominately with the loss of desirable perennial grasses and many native herbaceous species, and a decline in productivity and biodiversity. The perennial native grasses Spear grass (*Austrostipa* species) and Wallaby grass (*Austrodanthonia* species) remaining are generally small in size and prostrate. These pastures are also often dominated by annual grasses such as Silver grass (*Vulpia* species), Wild Oats (*Avena fatua*), Brome grasses (*Bromus* species) and herbaceous plants including Saffron Thistle (*Carthamus lanatus*) and Stork's Bill (*Erodium* species).

Native grasslands are one of the most threatened native ecosystems in Australia. This project aims to demonstrate that conservation of these systems is possible without compromising productivity. With the appropriate rotational grazing systems it may be possible to improve productivity from these areas, while increasing the biodiversity values. This article follows on from previous articles in EPFS 2002 Summary (page 50) and EPFS 2005 Summary (page 70).

## How was it done?

The grazing trial comprises two properties, one in the Hundred of Colton and the other in the Hundred of Wright in the Elliston area, where the owners have implemented a rotational grazing regime following subdivision of large paddocks. Nine rotationally

**Searching for answers**

grazed paddocks ranging from 32 to 160 ha in size, and one control paddock of 500 ha, are included in the trial in the Hundred of Colton. The trial in the Hundred of Wright consists of three rotationally grazed paddocks (21 ha) and a control paddock (187 ha).

Landholders aim to graze the paddocks at high stocking densities (greater than 150 DSE/ha) for short periods of time (1–20 days). The overall stocking rate is approximately 1 DSE/ha/year, with appropriate rest periods. A rest period is considered central to the rotational grazing strategy as the rest period allows the perennial native grass species to recover before being grazed again. Average stocking rates in the rotationally grazed areas are generally similar to, and in some cases higher than, the district average.

All trial paddocks and a control paddock (paddock set stocked or continuous grazed) are monitored annually in late spring (generally November), the period of maximum plant species diversity and the period that allows accurate identification of grass and other plant species, as reproduction features (seeds and flowers) are generally present. Changes in pasture composition and productivity are monitored during sampling. This trial design, based on the design of Kahn et al. (2005) for the Mid

North of South Australia, measures changes in pasture composition and productivity to be compared over time. In addition, comparisons can be made between each of the trial paddocks and the control paddock. One 100 m long transect per paddock has been established and the following pasture attributes measured:

***Presence or absence***

At 4.5 m intervals along each transect, the presence of all plant species is recorded in a 50 x 50 cm quadrat (15 quadrats). This attribute indicates species frequency and diversity within the paddock.

***Contribution of dominant species to total dry weight of pasture***

In each quadrat, the dry weight rank of the dominant plant species is visually assessed. This gives a measure of species contribution to total pasture dry weight relative to other species in the pasture.

***Number of native perennial grass plants per quadrat***

The number of native perennial grass plants present per quadrat along each transect is recorded. The numbers of native perennial grass plants per quadrat is an indication of the condition of the pasture as perennial grasses provide stability to pastures.

***Available pasture mass***

Pasture cuts are taken on each property to determine a pasture height – dry weight relationship. Landholders can then use this information to calculate the available pasture mass from a measure of plant height; this information can assist landholders in determining appropriate stocking rates.

***Photo points***

Photo points have been established at each site to monitor visual changes in composition of the pasture.

## What happened?

***General overview***

The trial has been monitored for five consecutive years. Despite this relatively short length of time, some preliminary results are emerging from the trial, although these are considered trends at this stage. Continued monitoring over time is required to confirm these results as they may be due to seasonal fluctuations or factors that are not part of the trial design.

Initial results indicate a decline in the frequency of 'problem' weed such Stork's Bill (Table 1) at the Hundred of Wright property and an increase in the contribution of native grasses to the dry matter at the property in the Hundred of Colton (Table 2).

The decline in the frequency of Stork's Bill cannot be attributed to the plants annual or biennial life cycle as the species has become completely absent from paddocks 1 and 2 for three years (2003–05) despite being present in paddock 3 and the control paddock in 2004. This trend needs to be investigated over a longer period of time but may coincide with stock grazing paddocks in winter–spring when the species is present and readily grazed.

The result of an increase in contribution of native grasses to the dry matter may be regarded as significant for the rotationally grazed paddocks despite the trend also being observed in the control paddock as this paddock has largely been ungrazed due to a cropping regime and also relocation of the transect. It is therefore not surprising that an increase in native grasses contribution to total dry weight has been recorded. At the commencement of the grazing trial, native grasses had a very small contribution to the pasture dry weight, and large increases in total dry weight of native grasses has been observed. Increases in contribution of native grasses to the herbage mass vary from 4% in paddock 1 to 51% in paddock 3; in comparison, the control paddock has only increased by 3% (utilising 2004 figures for this paddock).

***Table 1 Frequencies of Erodium cicutarium (Cut-leaf stork's bill) at the Hundred of Wright property.***

| Paddock | Year of monitoring | | | | |
|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 |
| **Paddock 1** | 7 | 0 | 0 | 0 | 0 |
| **Paddock 2** | 7 | 13 | 0 | 0 | 0 |
| **Paddock 3** | 0 | 0 | 0 | 7 | 0 |
| **Control** | 0 | 0 | 0 | 13 | 0 |

***Table 2 Percentage contribution of native grasses to total dry weight (BOTANAL) at the Hundred of Colton property. Results for the control 2005(*) must be interpreted with caution as the control transect was relocated due to the landholder cropping the area previously monitored. Results for Paddock 7 and 8 are unavailable for the years 2001–03 as these paddocks were added to the trial in 2004.***

| Paddock | Year of monitoring | | | | |
|---|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 | 2005 |
| **Paddock 1** | 0.2 | 17 | 3.1 | 3.3 | 4.1 |
| **Paddock 2** | 2.9 | 4 | 1 | 2.2 | 11.1 |
| **Paddock 3** | 18.6 | 58 | 60.1 | 33.8 | 36.3 |
| **Paddock 4** | 0.5 | 4.7 | 9.8 | 6.8 | 4.1 |
| **Paddock 5** | 20 | 74.5 | 58.8 | 20.3 | 48.3 |
| **Paddock 6** | 0.6 | 19.2 | 6.1 | 1.8 | 3 |
| **Paddock 7** | na | na | na | 3.2 | 1.2 |
| **Paddock 8** | na | na | na | 0 | 4.4 |
| **Control** | 0.3 | 4.9 | 1.1 | 9.7 | 11* |

Data collected in future monitoring will help determine if these initial indications are due to seasonal changes or as a result of changed management. These preliminary indications are thought to be attributed to an increase in total ground cover as a result of changed grazing regime (Jones, 1999).

Generally, control paddocks with set stocking (continuous grazing) had annual grass weeds such as wild oats and brome species dominating the pasture biomass, reflecting the seasonal availability of feed in set stocked paddocks (Table 3). In rotationally grazed paddocks, annual grass weeds also contributed to the pasture biomass but to a lesser extent, with native grasses, pasture legumes and annual broadleaved weeds also contributing.

***Stocking rates***

Overall stocking rates of trial paddocks at the Hundred of Colton property that are rotationally grazed are generally similar and in some years higher than the district average of approximately 1 DSE/ha. Average stocking rates for the property in the Hundred of Colton range from 0.5 to 1.1 DSE/ha/year (mean = 0.8 DSE/ha/year) in the rotationally grazed paddocks, and 0.4 to 1.0 DSE/ha/year in the control paddock (mean = 0.9 DSE/ha/year). Some fluctuation in stocking rate has occurred due to external factors such as a change in property ownership, desire to see increased recruitment of native grass species, fire and other management factors. Paddocks are grazed with higher stock density for a shorter period of time, with periods of rest, allowing the pasture grasses to recover from the defoliation and regrow.

The property in the Hundred of Wright has stocking rates in the rotationally grazed paddocks averaging 0.2 DSE/ha/year, which is lower than the control paddock's 0.87 DSE/ha/year. This can be attributed to a number of reasons including stocking the paddock with the landholder's rams and the grazing pressure of kangaroos. The landholder has observed that whether the paddock is stocked with sheep or not, kangaroos will continuously graze the land, i.e. when the paddock is undergoing its rest phase (from sheep) the grasses are not being allowed to recover.

## What does this mean?

Initial indicators suggest landholders on Eyre Peninsula are able to manage sheoak grassy woodlands for conservation, biodiversity and production outcomes using rotational grazing strategies, although changes in native grassy ecosystems as a result of improved management are likely to be long term. The initial trends observed require longer term monitoring to confirm that the results are not artefacts of seasonal conditions. Therefore, it is essential that monitoring be continued to confirm or dispute the initial trends and explore other changes as a result of grazing management for sheoak grassy woodlands on Eyre Peninsula.

Once any benefits of rotational grazing of these systems are quantified, the next stage will be to undertake cost-benefit analysis. This will involve analysing the establishment costs (fencing and watering) versus potential increases in production, and determining if there is a financial benefit for implementing a rotational grazing strategy.

## Acknowledgements

This project acknowledges the assistance of Eyre Peninsula NRM staff. The project has been funded by the EP NRM Board and the Natural Heritage Trust. We acknowledge the contribution of the landholders of Eyre Peninsula who continue to be involved in this study.

## Further information

Further information about this trial and the full copy of the results can be obtained from Jodie Reseigh, Rural Solutions SA, Clare (ph 08 8842 6257); Brett Bartel, Rural Solutions SA, Adelaide (ph 08 8226 9771); or Di DeLaine, Rural Solutions SA, Port Lincoln (ph 08 8688 3412).

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Kahn, L., Earl, J. and Nicholls, M., 2005. Planning as a tool to improve production and function of grasslands in the Mid-North of South Australia. *Proceedings of the 4th Stipa Conference on Management of Native Grasses and Pastures: Grassland Conservation and Production: Both Sides of the Fence.* Burra, South Australia. Stipa Native Grasses Association. University of Melbourne.

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***Table 3** Average pasture biomass for rotational grazed and control paddocks (2001–05) at trial sites at the Hundred of Colton and Wright. Different superscripts indicate that means differ significantly (Tukey's test, p≤0.05).*

| Grazing description | No. | Annual grass weeds | Plant functional groups | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Native grasses | Pasture legumes | Annual weeds | Perennial weeds | Native herbs | Native sedges |
| **Hundred of Colton** | | | | | | | | |
| **Rotational grazed** | 34 | 43.3 (±5.2)a | 16.0 (±3.6) | 15.5 (±2.5) | 22.8 (±3.1)c | 2.2 (±0.5) | 0.2 (±0.1) | na |
| **Control** | 5 | 80.0 (±6.7)b | 5.7 (±3.1) | 8.3 (± 4.8) | 5.4 (±2.2)d | 0.02 (±0.02) | 0.4 (±0.3) | na |
| **Hundred of Wright** | | | | | | | | |
| **Rotational grazed** | 15 | 10.6 (±1.6)g | 31.8 (±3.3) | 3.0 (±1.6) | 38.3 (±4.9) | na | 3.4 (±0.7)e | 12.8 (±3.9) |
| **Control** | 5 | 20.7 (±5.0)h | 35.5 (±9.5) | 0.9 (±0.4) | 33.7 (±4.5) | na | 6.8 (±1.5)f | 2.5 (±1.9) |

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SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Section 4

**Section editor:**
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# Livestock

## Sheep Productivity Analysis

**Brian Ashton**
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Extension

### Key messages

- **If sheep are to contribute to mixed farming systems they have to be productive. Critical profit drivers need to be identified.**
- **Many farmers are running very efficient sheep flocks. Some are not.**
- **Stocking rate is a key profit driver but can be pushed too hard on our fragile soils and variable climate.**

### Why do the work?

Eyre Peninsula farmer groups identified that they were keen to work out the best crop:sheep mix for their farms. Before this can be done, farmers need to know if their sheep flock is near the potential productivity or if there is room for improvement. It is not helpful to compare a good crop enterprise that is producing near potential yields to a poor sheep enterprise that is just 'eating the weeds'.

While many farmers feel they are close to the potential yield with their crops, they do not know what their potential is with sheep. Over the last 15 years or so farmers have, correctly, been focusing on improving their crop enterprise.

*Table 1   Productivity of 29 sheep flocks on Eyre Peninsula in 2005–06.*

| | Average | Minimum | Maximum |
|---|---|---|---|
| Wool income | $28 580 | $3 000 | $60 000 |
| Income from sale of sheep and lambs | $42 739 | $4 500 | $163 100 |
| Change in the value of sheep flock over the year | $1 521 | -$6 600 | $30 000 |
| Total income from sheep | $72 840 | $11 800 | $215 819 |
| Cost of sheep bought | $5 271 | 0 | $39 000 |
| Sheep variable costs | $20 344 | $1 000 | $76 478 |
| Variable costs per DSE | $11.40 | $3.60 | $45.70 |
| Gross margin per DSE | $26.20 | $3.10 | $51.40 |
| Stocking rate per pasture hectare | 3.9 DSE | 0.5 DSE | 20.3 DSE |
| Gross margin per pasture hectare | $129 | $7 | $375 |
| Lambing percent | 92% | 68% | 139% |
| Wool cut per pasture hectare (kg greasy) | 14 kg | 1 kg | 43 kg |

**Try this yourself now**

### What was done?

Five workshops were held with groups who had expressed interest in this area. Farmers who came to these workshops were asked to fill in a record sheet of 17 key figures that showed their sheep productivity over the last year. These data were entered onto a spreadsheet.

The data provided a very simple look at how productive each sheep flock was. It did not look at all the issues involved and the figures were sometimes only estimates.

At the workshops, the farmers then discussed how productivity could be increased in their district. A list of 'limiting factors' was made.

Some of the farm records were either too complex, lacked vital information or were unusual enterprises; these were not analysed. Twenty-nine enterprises were analysed, and the results, to be considered a guide only, are in Table 1. Some figures just reflect the scale of the enterprise.

The stocking rate was calculated on the arable area not in crop (i.e. pasture). Non-arable land was considered to be 1/3 of arable land because this is generally the dollar value of this land. On some properties this did add greatly to the return per pasture hectare (e.g. where non-arable land carries good sheep numbers in winter).

Stocking rate was graphed against average annual rainfall (Figure 1). At 300 mm, the average stocking rate was 2.2 DSE/ha, at 400 mm it was 6.6 DSE and at 500 mm it was 11 DSE. Actual stocking rates varied widely about this trend line.

Gross margin per hectare closely followed stocking rate (Figure 2). The trend was for gross margin to increase by $21/ha for each extra DSE carried.

Farmers discussed ways to increase the stocking rate and return from sheep without increasing the risk.

Early winter grazing capacity of pastures seems to be a limiting factor. Removing grasses from pastures exacerbates this problem but is necessary for the following crop. Practical ways need to be implemented to overcome this problem. Ideas include establishing improved pastures on poor cropping ground (lucerne, saltbush, puccinellia, veldt grass), confinement feeding, later lambing, rotational grazing, sowing a part of the pasture area to high density cereals and additional watering points.

It was agreed that pastures need to be looked after better if they are to carry near-potential stocking rates safely (e.g. spraying for insects, fertilising).

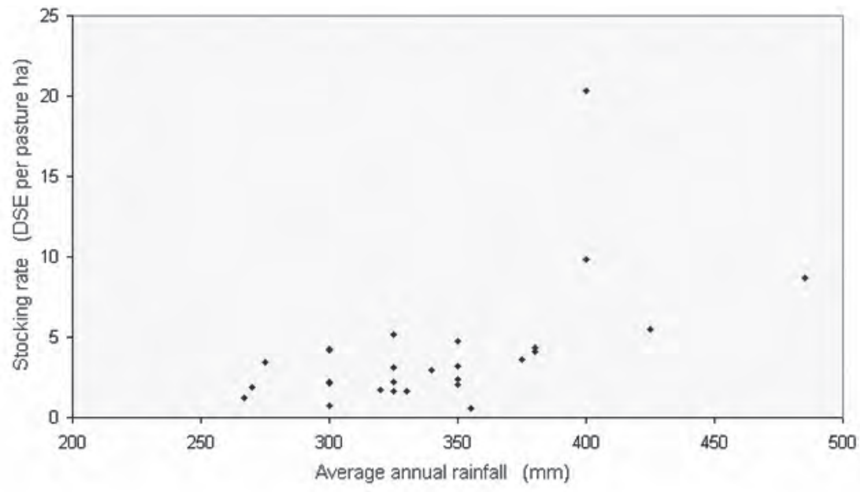


***Figure 1 Eyre Peninsula sheep stocking rate vs annual rainfall, 2005–06.***

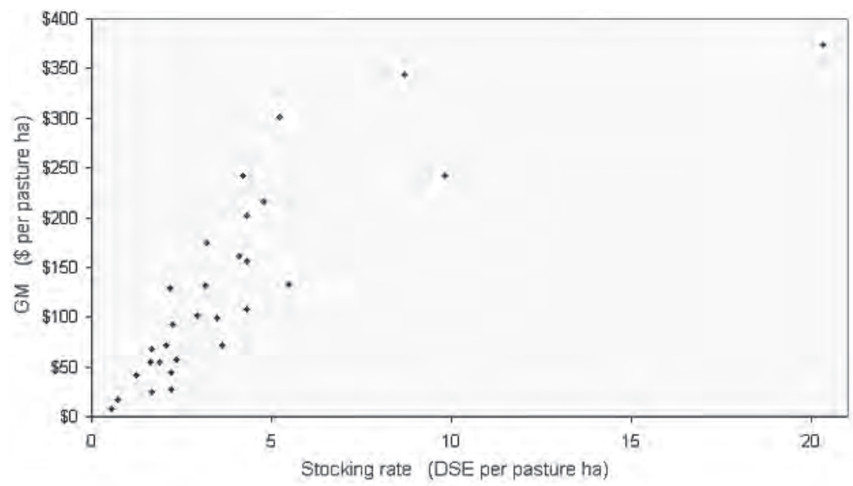


***Figure 2 Eyre Peninsula sheep stocking rate vs gross margin, 2005–06.***

## What does this mean?

- Farmers are keen to increase the returns they get from their sheep. There are many ways to do this but farmers need to work out what is best for individual farms.
- Don't increase stocking rate if return per head drops greatly, or risk and workload increases greatly.

This work is being followed up by the Profitability Workshops as part of the Grain & Graze program (see article 'Eyre Peninsula Farm Profitability Workshops — is there a best cropping to livestock ratio?' in this manual).


## Acknowledgements

Grain & Graze is jointly funded by GRDC, Meat & Livestock Australia, Australian Wool Innovation, and Land & Water Australia.

# Increasing Lambing Percent — What is Economic?

**Brian Ashton**
Rural Solutions SA, Port Lincoln

Extension

Livestock

## Key messages

- **Increasing your lambing percentage may be a simple way to increase your profit.**
- **A simple practice change may increase lambing by 10% — worth a lot to you.**
- **A more complex change may be necessary but will be harder to put into practice.**
- **Don't sacrifice other 'profit drivers' to achieve a high lambing percent.**

Achieving a good lambing percentage is one of the things that makes up a productive and profitable sheep flock. It is even more important now as about half the income from a Merino ewe comes from the sale of her offspring.

A good lambing percentage is over 100% for Merino ewes. Many people now average about 110%. People with Border Leicester X Merino ewes should aim for 140%. These ewes cost about twice as much and produce less wool compared to Merinos.

Lambing percent is important but does not solely determine profit. Profit per hectare is determined by the kilograms of meat and wool produced per hectare multiplied by the price of the meat and wool less the costs. It is economic to use managerial practices that increase lambing percent as long as stocking rate does not decrease or costs do not blow out.

The following check list of management practices can be used to economically increase lambing percentage. There may be one thing on this list that you can do that will simply and easily increase your lambing percent. I encourage you to give these ideas a go.

If you are unsure about applying these practices, work out the dollar benefit of achieving 10% more lambs.

There may be things on the list that would be major changes to your system, such as a change to later lambing or a change of breed. These changes must be considered more carefully. Discuss it with neighbours who have already made the change or contact a consultant.

## The things that are simple and have a big effect on lambing percent are:

- ram health and condition at mating
- ewe health and condition at mating
- fox control
- ewe condition at lambing — not too lean, or too fat — condition score 3 to 3.5
- shelter and good feed in lambing paddocks
- avoid disturbing the ewes at lambing.

Scanning your ewes for number of lambs carried (not just number wet and dry) is a useful practice to learn about your flock (e.g. the percentage of drys and the percentage with multiple lambs). It is recommended you have your ewes scanned for at least a couple of years.

It may be economic to continue this practice but this will depend on how you use the information. For example, if dry ewes can be re-mated it may be worthwhile. If twinning ewes can be put in a better lambing paddock, and more twins saved, this can easily pay for the scanning. If twin-bearing ewes are given similar paddocks to single-bearing ewes it is unlikely there will be a benefit from scanning.

**Best practice**

## Increasing lambing percentage checklist

***GENERAL***

- Lambing in July or August will increase lambs born by 15–25%, but the later lambs may need better management (e.g. high protein feed) over summer. Lambing time must fit in with other activities (e.g. shearing and lamb sale time).
- If you join before 1 January use the 'ram effect' or use teasers. Breeding season varies between Merinos and British breeds.
- Choose lambing paddocks with shelter. Set paddocks aside early.
- Join for six weeks.
- Join maiden ewes in their own mob and use experienced rams (e.g. the 2.5 year olds).
- Use smaller paddocks for joining.
- Control predators before and during lambing.

***EWES***

- Condition score 3, or better, at joining.
- Ewes below this will respond to 3.5 kg of lupins a week for five weeks, starting three weeks before mating.

- Pregnancy scan for multiples from 80 to100 days after the start of mating. Only scan ewes if you can use the information gained (e.g. draft mobs and give twinners best paddocks, re-mate, (or sell) dry ewes).
- Don't make major changes to the diet, or stress ewes, for six weeks after mating.
- Crutch and vaccinate 4–6 weeks before lambing. Avoid shearing at this time.
- Avoid disturbing the ewes during lambing. If necessary, do it early in the afternoon.
- Wean 14 weeks after the start of lambing. Educate lambs to eat grain before weaning. Wean lambs onto green feed, or other high protein feed, that has a low worm burden.

***RAMS***

- Number of rams: 1% + 1 for each mob. Use more rams with maiden ewes, with big paddocks or when there is more than one watering point.
- Rams should be in condition score 3. Feed 3.5 kg of lupins a week starting eight weeks before joining.
- Rams over fat score 4 will have reduced fertility.
- Check rams two months prior to joining for mouth, lameness, small or defected testes, penis damage.
- Provide shade for rams before and during joining.
- Ideally, shear rams so that there will be 35 mm wool at joining to reduce effect of high temperatures and reduce flystrike.
- Consider buying rams with good genetics for fertility (e.g. a high ASBV for 'number of lambs weaned').

Contact Eyre Peninsula Grain & Graze (ph 08 8680 5104) for a copy of MLA's 'Wean More Lambs' booklet or to run a 'Wean More Lambs' workshop.

## Acknowledgements

Grain & Graze is jointly funded by GRDC, Meat & Livestock Australia, Australian Wool Innovation, and Land & Water Australia.

***Brian 'Smokey' Ashton fat scoring ewes.***

# Pregnancy Scanning of Ewes on Lower Eyre Peninsula

**Daniel Schuppan**
Rural Solutions SA, Port Lincoln

Survey



**Best practice**

**Trial information**
Lower Eyre Peninsula
Av. rainfall: 550 mm

## Key messages

- **Most Lower Eyre Peninsula farms have lambing percentages of 80–90%; it is feasible to lift this to 100%.**
- **Many factors influence lambing percentages. Scanning is a practice that can help you improve your management.**
- **Pregnancy scanning allows you to know your lambing potential and identify how much lamb wastage is occurring.**
- **Ewes can be separated according to pregnancy status and fed according to their nutritional requirements.**
- **Splitting mobs requires more paddocks and increased management.**

## Information on pregnancy scanning

Pregnancy scanning of ewes has been conducted for many years in Australia and overseas. Changes in technology have made the process quicker and easier with the use of portable real-time ultrasound machines. Ewes can be scanned standing up in a crate at the end of a race. Scanning can be done at a rate of 400 ewes per hour if only scanning for wet versus dry ewes. The scanning operator supplies the scanning crate and all the producer needs is a standard race and two people to assist in pushing the sheep up.

The best time to scan for wet versus dry ewes is from 35 to 40 days after the removal of rams up until lambing. For multiples, the optimal time is between 80 and 100 days from the commencement of joining.

The cost in 2006 varied between 50 cents and 60 cents per ewe plus travel depending on mob size, and whether ewes were scanned for multiples.

## Why do the trial?

A group of farmers in the bushfire affected area on Lower Eyre Peninsula established a Sheep Production Group to meet regularly and discuss different sheep management topics. Producers were aiming to quickly rebuild their sheep numbers by trying to improve their lambing percentage. Pregnancy scanning was one of the tools they identified to help in the process by improving their understanding of their flock's reproductive performance.

A Producer Initiated Research Development (PIRD) application was developed for Meat & Livestock Australia (MLA) to obtain funding to complete the work. The PIRD funded technical support from Rural Solutions SA and covered some of the scanning operator's travel cost.

## How was it done?

Eleven farmers were interested in scanning and organised for their ewes to be scanned within two main times in February and April, depending on joining time.

The farmers made decisions on how to manage their dry ewes such as to sell, keep or re-mate. The farmers that made the decision to scan for multiples aimed to manage the twinning ewes separately to the single ewes. This was so the higher energy and protein demand of twinning ewes could be managed by providing higher supplementary feeding rates and giving them preference to the best pasture and lambing paddocks.

Each farmer recorded their scanning and lambing results, plus additional information such as condition score of the ewes and rams, weather conditions at lambing, shelter in paddocks, and if foxes were baited.

## What happened?

Figure 1 provides an average across all mobs on an individual farm. The percentage of dry ewes is the total number of dry ewes scanned divided by the total number of ewes scanned on the farm. Some individual mobs on farms had higher scanning percentages than others. Each farm is shown with two different lambing percentage — the lambing percentage (mated) and the lambing percentage (scanned).

$$\text{Lambing percentage (mated)} = \frac{\text{number of lambs marked}}{\text{number of ewes joined}}$$

$$\text{Lambing percentage (scanned)} = \frac{\text{number of lambs marked}}{\text{number of ewes scanned in lamb}}$$

When comparing lambing percentages it is important that the same comparison is being made. The ewe death rate is from scanning to marking.

In total, 10 600 Merino ewes were scanned, of which approximately one half were joined to Merino sires and the other half to terminal meat sires. Average lambing percentage of the Merinos and first cross lambs was the same across all farms. On average, 13% of the ewes

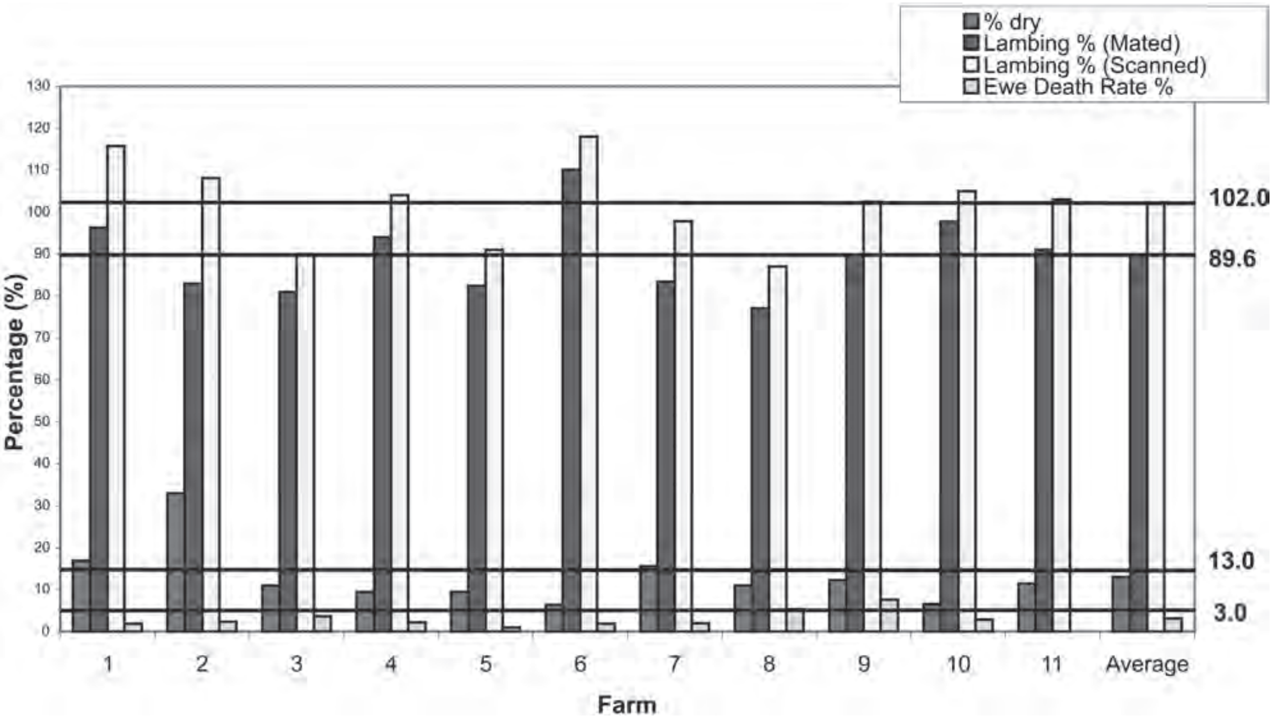


***Figure 1** Lambing percentage of individual Lower Eyre Peninsula farms, 2006.*

scanned were dry, with some farmers achieving as low as 6.5% dry ewes. The average lambing percentage across all farms on ewes scanned was 102% and on ewes mated was 89.6%. One farmer achieved above 100% lambing on the number of ewes joined, which shows that it can be achieved and that there is scope for some farmers to improve their lambing percentage by 10–20%. At a stocking rate of 8 DSE/ha for a self-replacing Merino flock, this could improve gross margins by $20–30/ha, less the extra feed required for the extra lambs.

There was little difference in the number of ewes scanned in lamb between farms. The main difference was in lambing percentage between farms, which is a product of management.

The time of lambing was split equally between autumn and winter but lambing percentages between these two times were not compared. The observation was made, however, that ewes lambing later generally had a higher percentage of ewes in the mob with twins.

Due to a good spring in 2005 and a good autumn in 2006, very little supplementary feeding was required over the study period because all ewes were in an optimal condition score of 3–3.5 at mating through to lambing. This affected the trial as there was adequate paddock feed available to meet the nutritional requirements of both single and multiple carrying ewes, therefore there was no need to feed them separately as planned. A supplementary feeding calculator (worksheet) was going to be used to identify how much energy and protein was being supplied from the pasture, and then how much grain or hay needed to be supplemented to optimise nutrition for the pregnant ewes.

Lamb wastage can only be accurately identified on farms that scanned for multiples. The results showed that there was lamb wastage of 20–30% on properties that scanned for multiples. On average across the twinning mobs that scanned for multiples and were managed separately there was an average of 145% lambing.

## What does this mean?

The economics of pregnancy scanning needs to be worked out for each individual farm and will depend on its intended purpose. Advantages include:

- identifying dry ewes that could be sold if feed gets short
- re-mating dry ewes
- managing twinning ewes differently
- use as a marketing tool to sell in-lamb ewes
- improving understanding of flock reproductive potential.

There is potential to increase lambing percentages by paying more attention to managing the ewes from scanning through to marking.

## Acknowledgments


Meat & Livestock Australia for provision of the PIRD, and to the growers for participating in the activity.


MEAT & LIVESTOCK AUSTRALIA

Government of South Australia
Primary Industries and Resources SA

# Mating Merino Ewe Weaners


## Brendan Frischke

SARDI Minnipa Agricultural Centre


Demo

## Key messages

- **Merino weaner ewes can achieve lambing percentages of 25% or more when mated in good condition and at 8–9 months old.**
- **Mating weaners complicates flock management and may not be worthwhile.**

## Why do the trial?

Mating ewe weaners can increase flock lambing percent. We wanted to demonstrate the importance of body weight when selecting suitable weaners and to assess the impact of mating ewe weaners in a mixed grazing and cereal enterprise.

## How was it done?

Forty-four ewe weaners were weighed and mated to two merino rams on 16 February 2006. The weaner ewes were 8–9 months of age (May 2005 drop). The weaners were not condition scored but were inspected to ensure that they were generally of good health. The joining date was determined by ram availability, which was one week after rams were removed from the main ewe mob. The joining period was five weeks.

## What happened?

There were no lambs born in the first two weeks of the expected lambing period. Although lambs born were not weighed, they were considerably smaller than the adult ewe's offspring. Table 1 shows the number of ewes mated within each weight range and the number of ewes giving birth. One ewe was identified with twins but lost one lamb within 24 hours. Several other ewes also lost lambs in the first 24 hours. Assuming only one pair of twins, 39% (17/44) of the weaners lambed. However, the marking percentage was 30% (13/44). Two more lambs died post-marking, reducing the weaning percent to 25%. No ewes died during the period from mating to the end of lambing.

## What does this mean?

Results from other research have suggested lambs can be successfully mated provided they have a minimum live weight at mating of 40 kg and are at least condition score 3. This trial was unable to demonstrate the importance of a minimum live weight. This was probably because there were too few ewes in each weight range to provide reliable results. The late appearance of the first lambs indicates that the young ewes either did not conceive in the first cycle or took some time to begin cycling. This observation is consistent with trials conducted on Lower Eyre Peninsula. The lambing percentage achieved is also similar to trials on Lower Eyre Peninsula.

This exercise shows it is possible to successfully breed from weaner ewes. Mating weaner ewes will increase lambs born on the property, but there are many implications that need to be considered. It may be best used as a strategy to help boost flock numbers if needed and not as normal practice.

Weaners that lambed were identified so that their production can be assessed in future years.

***Important considerations:***

- To join weaners at the same time as the main ewes requires them to get up to weight earlier (seven months) and requires more rams. This trial supports other evidence that Merino weaners need to be 8–9 months old.
- Mating immediately after the main ewes introduces a later lambing for the ewe weaners and resulting management issues.
- It may not be possible to adequately class weaners prior to breeding from them.
- At Minnipa, our ewe hoggets are used in our farming system for grazing weeds — we don't have wethers. In 2006, because the weaners were lambing, we were unable to shift them during lambing, or immediately after marking, and therefore had no suitable sheep for spray graze strategies or to graze down a pasture beginning to run up.

**Try this yourself now**

**Location:**
MAC
Closest town: Minnipa

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
Actual annual: 236 mm
Actual GSR: 111 mm

Livestock


## Acknowledgements

Thanks to Brett McEvoy and Shane Moroney for their technical help.


***Table 1 Percentage of weaner ewes giving birth.***

| Pre-mating live weight (kg) | Ewes mated | Ewes giving birth | Ewes giving birth (%) |
|---|---|---|---|
| 36–39.9 | 3 | 2 | 67 |
| 40–43.9 | 9 | 3 | 33 |
| 44–47.9 | 21 | 9 | 43 |
| 48–51.9 | 9 | 3 | 33 |
| >52 | 2 | 0 | 0 |
| Total | 44 | 17 | 39 |

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

# Nutrition of Livestock

## Brian Ashton
Rural Solutions SA, Port Lincoln

Extension

Best practice

## Key messages

- **Grain & Graze is helping farmers increase their knowledge about nutrition of sheep.**
- **Don't wait for the 'magic' supplements.**
- **Find out what your sheep lack and supplement their feed.**
- **Energy is usually the most limiting nutrient.**
- **Protein may be limiting for young or growing stock.**
- **Liquid molasses (e.g. Molofos) may encourage sheep to eat dry feed.**

## Why do the work?

Grain & Graze groups around Eyre Peninsula identified that they wanted to know more about nutrition of stock. Presumably this is a result of the high prices now prevailing for well-finished stock.

The key question farmers ask is 'Is it economic to feed my stock and how much, of what supplement, should I feed?'

## What was done?

The Grain & Graze project held three 'Lot feeding and nutrition' workshops, and has been involved in five 'Drought management' workshops. The EPARF field day had a major nutrition and pastures focus. In particular, San Jolly of Productive Nutrition Pty Ltd gave a stimulating talk.

## What does this mean?

- Farmers often look for new supplements that will make their stock boom. These rarely exist. Energy is usually the most limiting nutrient. Pasture is the cheapest source of energy and cereal grain the next cheapest.

  If your stock are deficient in copper or cobalt, a cheap supplement may make them boom and the results could be fantastic. You need to know the mineral status on your farm (see EPFS 2005 Summary, page 108).
- Drought feeding (in the paddock or in a containment area) is a simple practice and usually well worthwhile.
- Production feeding (fattening) can be economic. The ration needs to be balanced — in particular, protein level becomes as important as energy. Minerals and fibre are also important. Work it out carefully.
- In a feedlot or containment area you must feed some roughage. In San's words, 'If you take the roughage out, you're in trouble'.
- How to make stock do well on dry paddock feed has long been an aim of farmers. Dry feed is low in energy and low in protein. Once the best of the stubble or dry feed has been eaten, sheep cannot eat enough stubble to maintain their weight.
- Lick blocks were invented to encourage use of dry feed. They often work but, at about $1000/t, are usually too expensive.
- Lupins, high in energy, protein and fibre, and low in starch, are the ideal supplement. Many farmers on Eyre Peninsula have had great success feeding 1–2 kg of lupins per sheep per week. However, farmers who do not grow lupins are reluctant to buy them.
- Urea in the water (or on the straw) has been tried as sheep can create protein from urea. Unfortunately, in southern Australia this rarely works as energy is limiting so the sheep cannot utilise the urea. This was confirmed by a trial at MAC in the 1980s.

### Molofos 12

Molofos 12 is a commercial mixture of molasses, urea and minerals. It is an expensive source of energy (much more expensive than cereal grain) but, if there is ample quality dry feed, the use of Molofos may be economical.

A MLA-funded PIRD trial at Booleroo Centre in 2004 showed good results with Molofos. The group there compared ewes given access to ad lib Molofos for eight months to a group of ewes with no supplement at all. They repeated the trial the next year. In the first year the cost of the supplement was $5.55 and the increase in return was $16.45/ewe. The following year the results were reported as similar. This is a great result, but the Molofos may not have been the most cost-effective supplement (e.g. they may have had a similar result by feeding lupins — $5.55 buys a lot of lupins).

Another trial compared sheep in a feedlot that were fed 100 g/day of Molofos, to sheep given no molofos. In this case there was no response. This confirms that Molofos may have a place where there is plenty of reasonable quality dry feed, and not so likely on rations already high in energy.

In a drought situation sheep do not usually need encouragement to eat the roughage and so, if possible, you should feed the cheapest source of energy. Sometimes feeding cereal grain has problems during introduction or grain poisoning.

One farmer at Cleve has had good results with Molofos. If you try it, record how it goes and let us know.

## Acknowledgements

Grain & Graze is jointly funded by GRDC, Meat & Livestock Australia, Australian Wool Innovation, and Land & Water Australia.

## Useful reference

*MLA Prograzier, Summer* 2006/7 page 24. 'Molasses helps with dry matter'.

For further information contact San Jolly, Productive Nutrition Pty Ltd (ph 08 8344 8816, mob 0418 446 499).

THE UNIVERSITY OF ADELAIDE AUSTRALIA

Grain & Graze
Profit through knowledge
EYRE PENINSULA

# Grazing Cereals in Medium and Low Rainfall Environments

Research


**Emma McInerney**

SARDI Minnipa Agricultural Centre


## Key messages

- **Grazing cereals is a tool for risk management in low and medium rainfall environments.**
- **Late grazing of cereals in medium rainfall affected grain yield.**
- **Grazing cereals is useful only if the feed is required.**
- **Locally adapted wheat varieties performed better than long growing season winter wheats.**

## Why do the trial?

As the costs of production rise, farmers have been pushed to make more from their cropping and livestock enterprises by increasing the percentage of land cropped and increasing stocking rates. Grazing cereals can help achieve this for those farmers who are focused on improving returns by lifting production.

Grazing cereals has been practiced for many years, yet its purpose and benefits have changed in modern farming systems. Today, farmers face the complications of herbicide residues, resistant weed populations, tillage options, disease management, feed gaps and ailing regeneration of pastures. The search for greater profit and improved management of feed gaps and pastures are incentives for grazing cereals.

Pasture feed gaps are resolved by either reducing stock numbers to match the available feed, increasing feed supply (e.g. pastures, hay, grain) or by allowing stock to lose condition. A feed deficit often occurs from early autumn in medium rainfall zones, through to June in low rainfall zones. Decreasing soil temperatures will slow down plant growth rates and pasture paddocks may not have time to recover or get ahead of stock going into winter. Eyre Peninsula farmers have observed that regenerative pastures produce less dry matter (DM) bulk than they used to. The practice of grass-freeing pastures in break years has led to productivity gains for cropping, but the quantity and quality of pastures has been reduced. Grazing cereals have a role to play in filling this autumn –early winter feed gap.

Trials at Minnipa and Edillilie in 2006 supported results from last year (2005 EPFS Summary, page 61) and once again demonstrated that grazing cereals will reduce their grain yield at Minnipa, while there is extra potential to increase returns from cereal crops at Edillilie as yields were not penalised by grazing at early growth stages.

## How was it done?

The Grazing Cereal Trial at Minnipa evaluated DM production, grain yield and quality, response to extra N and total crop value on cereals that were grazed once only. The trials at Edillilie assessed cereal recovery and DM production after a single early grazing or a double grazing (early and late), which was simulated by mowing. Grain yield and quality, response to not applying extra N, higher seeding rates, winter wheat production compared to traditional wheats and total crop value were also assessed.

## What happened?

***Minnipa results***

Grazing at Minnipa reduced grain yields on average from 0.75 t/ha for ungrazed to 0.55 t/ha for grazed. Grain incomes were higher on average for ungrazed treatments ($166/ha) than grazed treatments ($120/ha).

Screening levels were increased by grazing, particularly for Wallaroo oats and Keel barley, which lifted from 5.5% to 8.7% and 15.3% to 31.9%, respectively. Wheat screenings were below 2% and therefore of negligible financial consequence.

For the second year it was found that additional N did not increase grain yield on grazed or ungrazed treatments. Urea was applied at 40 kg/ha on 1 August to coincide with the earliest rainfall event post-grazing (19 July), but there was inadequate moisture post-application to generate a response in yield or quality.

The Minnipa site was sown on 12 May and crash grazed on 19 July at a stocking rate of 227 DSE/ha for one day. Barque barley produced the most DM (Table 2) at Minnipa, followed by

**Searching for answers**

**Location**
Closest town: Minnipa
Cooperator: MAC
**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
Actual annual: 236 mm
Actual GSR: 111 mm
**Yield**
Potential wheat: 1.02 t/ha
Actual: 0.8 t/ha (Yitpi)
Potential barley: 1.42 t/ha
Actual: 1.0 t/ha (Keel)
Potential oats: 1.02 t/ha
Actual: 0.2 t/ha (Wallaroo)
**Paddock history**
2005: grass-free pasture
2004: grass-free pasture
2003: Barque barley
**Soil**
Land system: flat
Major soil type description:
red calcareous sandy clay loam

**Location:**
Closest town: Edillilie
Cooperator: Brett and Vicky Siegert
**Rainfall**
Av. annual: 475 mm
Av. GSR: 380 mm
Actual annual: 435 mm
Actual GSR: 236 mm
**Yield**
Potential wheat: 3.62 t/ha
Actual: 1.9 t/ha (Wyalkatchem)
Potential barley: 4.02 t/ha
Actual: 2.4 t/ha (Keel)
Potential oats: 3.62 t/ha
Actual: 2.0 t/ha (Wallaroo)
**Paddock history**
2005: canola
2004: pasture
2003: wheat
**Soil**
Land system:
flat, base of Marble Range
Major soil type description:
loamy buckshot over clay

Keel. Table 1 indicates that grazing did not reduce the grain yields of Keel and Barque, although grazing resulted in higher screenings and a price penalty for Keel. Keel yielded the highest overall and was most profitable. However, when DM value is added to grain value, Barque is more profitable as a grazed crop than ungrazed. Wyalkatchem also recovered well from grazing and did not experience reduced grain yield. Wallaroo yielded the poorest and was further reduced by grazing, as were Wedgetail and Yitpi yields.

Cereals sown at Minnipa for early feed should be selected first for their DM production to serve the purpose of meeting a feed demand. Should the season permit and feed demands have been met, the opportunity for crop recovery and grain harvest may exist.

***Edillilie results***

Across all crop types at Edillilie, there was no yield penalty as a result of grazing crops early (20 July). The trial was sown 18 May and grazed (early) at growth stage 3–4 leaf (wheat, oats) to early tillering (barley) with a mower to approximately 50 mm above the ground. Some early grazed plots were also late grazed (10 August) with a mower to approximately 50 mm above the ground. The double grazing reduced grain yield by 39%, or 0.9 t/ha, across all crops.

There is a difference in gross income between crop types but very little between the grazing management of each variety. In contrast to 2005 results, oats and barley were more valuable crops than wheat. The GM of a self-replacing Merino in 2006 went down to $25/DSE/year from $30 in 2005, and there was a general increase in grain prices. The success of grazing cereals is dependent on productivity and commodity prices so GMs will be highly variable from year to year.

A late application of urea at 76 kg/ha was broadcast (2 August) over all treatments except Wyalkatchem–N. This N application increased grain yields, backing up data from 2005. Results show there was no difference in grain yields or DM production between Wyalkatchem and Wyalkatchem–N, but the decision to not apply extra N each season will always depend on soil N reserves (previous year's crop) and financial consideration (cost of fertiliser versus potential loss of production).

Grazing strategies influenced the level of screenings across all crops. Averages show that screenings for early grazing (7%) were no worse than for ungrazed crops (8%), but late grazing (12%) increased screenings.

Wedgetail and Whistler winter wheats have longer growing seasons and are used in the eastern states as dual-purpose crops. Grain yield comparisons against locally adapted wheats Wyalkatchem and Yitpi (av. 1.8 t/ha) showed that the shorter growing season varieties performed 0.3 t/ha better than the winter wheats (av. 1.5 t/ha), and appeared to recover from grazing as well as the winter wheats. Grazing will delay the growing season of cereals, which can be especially detrimental on Eyre Peninsula in a tight finish year for those varieties that already have longer growing seasons.

Wyalkatchem wheat and Barque barley were trialled at higher seeding rates, which improved the grain yield of both crops. Seeding rates for all other treatments were set to target an establishment of 200 plants/m$^2$ for wheat, 180 for barley and 190 for oats (below district practice).

Oat and barley varieties produced the highest amount of DM. The higher seeding rate improved early DM production for Barque barley although it did not benefit Wyalkatchem (Table 4). Grazing commenced relatively early in 2006. Although this compromised DM production, it allowed the crops to recover in a season with less than average rainfall.

Barque at a higher seeding rate produced the most DM from the early grazing (321 kg DM/ha) and the double grazing (507 kg DM/ha), as well as producing the highest grain yields overall, followed by Barque and Keel on DM production and grain yield. Wallaroo was not a high DM producer at the early grazing (164 kg DM/ha) but recovered well for the second grazing (382 kg DM/ha), though finished with poor grain yields.

There was little difference in total crop value (grain plus grazing value) between crop types, whether ungrazed, or grazed once or twice at Edillilie in 2006.

## What does this mean?

In medium rainfall zones, grazing cereals has potential benefits to the whole farming system such as increasing total farm area cropped, increasing livestock production through higher stocking rates, and improving pasture utilisation and production. Early grazed cereals can recover sufficiently to cause no grain yield penalties and therefore value-add the crop, while supplying feed during the autumn feed gap.

For low rainfall zones, grazing cereals can be a risk management tool or a planned pasture component of a feed budget. Low rainfall croppers are typically adept at managing risk with strategies such as early sown crops, which are ideal pasture options or fallbacks when feed is short. A crop may be designated to get stock through an early winter feed gap,

***Table 1 Grain yield and gross income for the Grazing Cereal Trial at Minnipa, 2006.***

| Grazed | | | | Ungrazed | | | |
|---|---|---|---|---|---|---|---|
| Treatment | Yield (t/ha) | Price ($/t) | Grain gross income ($/ha) | Treatment | Yield (t/ha) | Price ($/t) | Grain gross income ($/ha) |
| **Wallaroo** | 0.07 a | 260 | 18 | Wallaroo | 0.36 b | 260 | 94 |
| **Wedgetail** | 0.38 bc | 231 | 88 | Wedgetail | 0.56 de | 230 | 129 |
| **Barque+N** | 0.53 cd | 209 | 111 | Barque+N | 0.71 defgh | 209 | 148 |
| **Barque** | 0.52 cd | 209 | 107 | Barque | 0.55 cd | 209 | 115 |
| **Yitpi** | 0.64 de | 240 | 154 | Yitpi | 0.98 ghi | 241 | 236 |
| **Wyalkatchem** | 0.66 def | 229 | 151 | Wyalkatchem | 0.83 efghi | 230 | 191 |
| **Yitpi+N** | 0.68 defg | 241 | 164 | Yitpi+N | 0.97 ghi | 241 | 234 |
| **Keel** | 0.92 fghi | 187 | 172 | Keel | 1.02 hi | 209 | 213 |

*Grain yields in treatments followed by the same letters are not statistically different from each other.*
*ANOVA was conducted on log transformed data.*
*Grain prices were calculated from base price (plus Yitpi premium) less freight, levies and variable treatment costs, sourced ABB as at Nov 2006. Gross income = price x yield.*

*Table 2 Dry matter production and gross income from Grazing Cereals Trials at Minnipa, 2006.*

| Variety | DM production on July 19 (kg DM/ha) | Grazing gross income ($/ha) | Total crop value ($/ha) |
|---|---|---|---|
| Yitpi | 211 | 14 | 168 |
| Wedgetail | 212 | 14 | 102 |
| Wallaroo | 217 | 15 | 33 |
| Yitpi + N | 219 | 15 | 179 |
| Wyalkatchem | 221 | 15 | 166 |
| Keel | 270 | 18 | 190 |
| Barque + N | 342 | 23 | 134 |
| Barque | 418 | 28 | 135 |
| *LSD (P=0.05)* | *69* | | |

*DM value is based on 2006 Rural Solutions SA Merino GM of $25/DSE/year and the assumption that 1 DSE will consume approximately 1 kg DM/day.*
*Total crop value = gross income from grain plus gross income from grazing of grazed treatments.*
*At grazing, barley was early tillering; wheat and oats were four leaf.*

with the potential to use for hay production, as a standing crop later in the season or for grain harvest. Sowing a cereal for feed is the simplest way of providing bulk feed for stock and only complicated by its place in crop rotations. Issues such as disease and herbicide resistance are important considerations in crop type and varietal selection.

Managing feed supply during the autumn–early winter period should be part of whole-farm feed budgeting. If the feed deficit is severe, other livestock management strategies may be put in place to alleviate the pressure put on pastures. It may be feasible for stock to be sold, agisted or put in feedlots if paddocks are susceptible to erosion from over-grazing.

*Table 3 Average grain yields and grain gross income at Edillilie, 2006.*

| Treatment | Grazing strategy | | | | | | Average variety yield (t/ha) |
|---|---|---|---|---|---|---|---|
| | Ungrazed | | Single, early | | Double, late | | |
| | Grain yield (t/ha) | Grain gross income ($/ha) | Grain yield (t/ha) | Grain gross income ($/ha) | Grain yield (t/ha) | Grain gross income ($/ha) | |
| Wedgetail | 1.75 | 365 | 1.72 | 354 | 1.04 | 232 | **1.50** |
| Whistler | 1.60 | 307 | 1.96 | 329 | 1.09 | 254 | **1.57** |
| Wyalkatchem–N | 1.87 | 372 | 1.88 | 321 | 1.02 | 270 | **1.59** |
| Yitpi | 1.88 | 328 | 1.78 | 407 | 1.36 | 294 | **1.68** |
| Wyalkatchem | 2.14 | 447 | 2.28 | 401 | 1.24 | 338 | **1.89** |
| Wallaroo | 2.46 | 640 | 2.36 | 613 | 1.12 | 391 | **1.98** |
| Wyalkatchem high seed | 2.26 | 478 | 2.35 | 462 | 1.46 | 333 | **2.02** |
| Barque | 2.33 | 502 | 2.59 | 472 | 1.78 | 372 | **2.23** |
| Keel | 2.76 | 548 | 2.71 | 498 | 1.86 | 400 | **2.44** |
| Barque high seed | 2.85 | 567 | 2.87 | 533 | 1.79 | 394 | **2.50** |
| Average yield by grazing strategy (t/ha) | 2.21 | | 2.26 | | 1.38 | | |
| *LSD (P=0.05)* | | | *0.55* | | | | *0.23* |

*Average grain prices as follows — Barque, Keel $199; Wallaroo $260; Wedgetail $211; Whistler $188; Wyalkatchem $209; Wyalkatchem–N $201; Yitpi $211.*
*Grain prices calculated from base price (plus Yitpi premium) less freight, levies and variable treatment costs, sourced ABB as at Nov 2006. Gross Income = price x yield.*

*Table 4 Dry matter production and grazing gross income at Edillilie, 2006.*

| Treatment | Grazing treatment | | | |
|---|---|---|---|---|
| | Single, early | | Double, late | |
| | DM prod. 20 July (kg DM/ha) | Grazing gross income ($/ha) | DM prod. 10 Aug (+ early) (kg DM/ha) | Grazing gross income ($/ha) |
| Whistler | 72 a | 5 | 214 (+72) a | 19 |
| Wyalkatchem–N | 119 ab | 8 | 292 (+119) bc | 28 |
| Wyalkatchem high seed | 119 ab | 8 | 260 (+119) ab | 26 |
| Yitpi | 121 ab | 8 | 242 (+121) ab | 25 |
| Wyalkatchem | 127 ab | 9 | 279 (+127) abc | 28 |
| Wallaroo | 164 b | 11 | 382 (+164) bcb | 37 |
| Wedgetail | 176 bc | 12 | 254 (+176) ab | 29 |
| Barque | 242 cd | 16 | 490 (+242) d | 50 |
| Keel | 278 de | 19 | 442 (+278) cd | 49 |
| Barque high seed | 321 e | 22 | 507 (+321) d | 56 |

*DM production in treatments followed by the same letters are not statistically different from each other.*
*DM value based on 2006 Rural Solutions SA Merino GM of $25/DSE/year and the assumption that 1 DSE will consume approximately 1 kg DM/day. Value of double grazed treatments = early + late.*

## Acknowledgements

Grain & Graze is jointly funded by GRDC, Meat & Livestock Australia, Australian Wool Innovation, and Land & Water Australia. Technical support from SARDI staff Terry 'Wrecker' Blacker (Port Lincoln), Ian Richter, Ben Ward and Carey Moroney (Minnipa), and co-operation from Brett Siegert (farmer, Edillilie) and Wayne Jacobs (sheep lending farmer, Minnipa) is gratefully acknowledged.

THE UNIVERSITY OF ADELAIDE AUSTRALIA

SARDI SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Grain & Graze

# Cereals for Early Feed

**Emma McInerney**
SARDI Minnipa Agricultural Centre

Research

**Searching for answers**

**Location**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Paddock history**
2005: Maritime barley

**Soil type**
Calcareous sandy loam

## Key messages

- **Oats produced the most dry matter after repeated grazings.**
- **Manage timing of grazing to allow cereal recovery.**
- **Establish as much bulk as possible in a cereal pasture by increasing seeding rate and consider dry sowing.**

## Why do the trial?

Upper Eyre Peninsula farmers have been looking for an early feed option that not only fills the autumn–early winter feed gap, but is also low risk and easy to manage. Cereals are a reliable feed source until pastures are able to get away. Traditionally there was widespread 'trashing-in' of oats which had the flexibility of providing either early feed and/or grain harvest or hay, but the practice has decreased over the last 20 years due to more intensive cropping rotations. This trial evaluated which cereal species and variety will produce the most early feed.

## How was it done?

The trial was sown at Minnipa on 10 May at the following seeding rates — Frame wheat (63 kg/ha), Brusher and Wallaroo oats (57 kg/ha), Maritime barley (71 kg/ha), Speedee triticale (66 kg/ha), Rufus triticale (53 kg/ha), Frame wheat high seeding rate (76 kg/ha) and Maritime barley high seeding rate (85 kg/ha). Plant counts were taken on 28 June. Dry matter (DM) cuts were taken on 25 July, 8 August and 22 August at the same place within each plot, approximately 30 mm above the ground. On 22 August an additional cut was taken from each plot from a different area to compare accumulated DM production against total production after three simulated grazings (cut with hand shears).

## What happened?

Observations nine days after seeding indicated that emergence for Maritime barley and Frame wheat at high seeding rates was more advanced, and that Wallaroo oats was establishing poorly. However, plant counts at 2–3 leaf stage showed no differences between crops. DM cuts on 25 July and 8 August also showed similar DM production between varieties.

For the final DM cut on 22 August, oats and wheat were at late tillering, and barley and triticale were starting to run up to head. At this time, there were differences in DM production between crops and those that produced the most DM early also tended to recover the best after three simulated grazings. The oat varieties and higher seeding rates of Frame and Maritime produced the most DM (see Table 1 for DM at the final sampling).

Cereal DM production (averaged across all crops) declined after repeated grazings — 25 July (189 kg DM/ha), 8 August (185 kg DM/ha) and 22 August (126 kg DM/ha).

The cut measuring accumulated growth (for each ungrazed crop) to 22 August produced a total of 933 kg DM/ha. Total production from three cuts (simulating several grazings) produced an average of only 500 kg DM/ha.

## What does this mean?

The decline in production after repeat cuts is likely to reflect the poor growing conditions in 2006 (competition from marshmallow, and lower than average growing season rainfall) but more importantly it signifies the penalty for removal of the plant growing point, thus limiting recovery between grazings. This shows the importance of being clear about the purpose the cereal crop, i.e. early feed with the possibility of grain harvest, hay cut, standing crop, or to strategically supply feed and provide a grazing break to other paddocks without expecting a grain yield. Each purpose may require a different management package to get the most from the crop (and the livestock that make use of it).

The higher total DM production at 22 August from the ungrazed treatments also demonstrates the limited ability of cereals to recover after the removal of the growing point.

DM production, and hence feed value, is influenced by plant density. In low rainfall environments DM production will peak at a certain seeding rate, beyond which there will be no further DM production increases. The relationship between plant density and DM production needs to be investigated further.

DM production was well below ideal for grazing. The trial was sown on 10 May when soil temperatures had started to decline. A seeding time 2–3 weeks earlier would have benefited early plant growth.

Oats was the most resilient cereal after repeated grazings and performed as well as barley and wheat at higher seeding rates. Early sowing combined with a higher seeding rate and careful grazing management is the best way to get the most value from cereal pastures.

*Table 1 Dry matter production from cereals at Minnipa after two previous grazings*, 2006.*

| Treatment | DM (kg/ha) |
|---|---|
| Speedee triticale | 77.0 a |
| Frame wheat | 98.8 ab |
| Rufus triticale | 103.2 ab |
| Maritime barley | 123.6 ab |
| Brusher oats | 133.4 bc |
| Frame wheat high seed | 133.8 bc |
| Maritime barley high seed | 149.5 bc |
| Wallaroo oats | 184.5 c |

*Treatments followed by the same letter are not statistically different (P=0.05)*
** Grazing simulated by hand cutting plots*


## Acknowledgements

Grain & Graze is funded by Meat & Livestock Australia, Australian Wool Innovation, GRDC and Land & Water Australia. Thanks to Ben Ward, Dot Brace, Trent Brace and Danielle Brook (SARDI MAC) and Tim Prance (Rural Solutions SA) for technical assistance.




# Don't Rule Out Grazing Brassicas on Upper Eyre Peninsula yet

Research Demo


**Alison Frischke**

SARDI Minnipa Agricultural Centre


## Key messages

- **Grazing Brassicas show limited value for use as a break crop on upper Eyre Peninsula when sown after the usual cropping program.**
- **The potential of canola and mustard for grazing needs to be examined on Eyre Peninsula.**

## Why do the trial?

Evidence is mounting that Brassicas reduce *Rhizoctonia* inoculum and subsequent infection in cereal plants sown into the Brassica stubble on grey calcareous soils. Generally these Brassica crops produced little bulk and were low yielding at the end of the season.

Grazing Brassicas (fodder Brassicas) have been bred for the higher rainfall zones as forage crops and as disease breaks within rotations. They are grown in spring and summer and have been used as a graze-only option. While grazing Brassicas have not been bred for our low rainfall climate with hot and often dry springs, or for hostile subsoils, they have been trialled over the past three seasons to see whether sufficient growth could be achieved to provide an adequate break for *Rhizoctonia* and also provide some grazing value.

## How was it done?

Grazing Brassicas were sown into small plot trials (Streaky Bay 2004; Miltaburra 2005, 2006; Piednippie 2006), and in broadacre areas at Leon Mudge's (Miltaburra 2004) and Chris Lymn's (Wudinna 2006) properties. Varieties trialled included Hobson's rape, Rangi rape, and Bulbous turnip. Trials were sown during the usual crop planting period, and the broadacre plantings were sown after the usual cropping program. Crops were sown and managed with herbicide, insecticide and fertiliser regimes typical for canola crops in low rainfall areas.

## What happened?

Germination and early plant vigour of the Brassicas was very good. In 2004, Leon Mudge was able to graze Rangi rape and Bulbous turnip in the spring and believes it had better bulk than his regenerating pastures. However, for the remaining trials and demonstrations across three different winter and spring conditions, the grazing Brassicas failed to produce much bulk (hence were not grazed). Canola grown alongside these areas consistently produced more bulk.

**Searching for answers**

**Trial information**

**Location**
Miltaburra
Cooperator: L, M, C & D Mudge

**Rainfall**
Av. annual: 306 mm
Av. GSR: 212 mm

**Soil type**
Grey calcareous sand

**Location**
Wudinna
Cooperator: Chris Lymn

**Rainfall**
Av. annual: 320 mm
Av. GSR: 240 mm

**Soil type**
Red sandy loam

**Location**
Piednippie
Cooperator: Neville Trezona

**Rainfall**
Av. annual: 285 mm
Av. GSR: 210 mm

**Soil type**
Grey calcareous sand

## What does this mean?

Experiences so far suggest that grazing Brassicas are not a viable grazing and disease break option for Upper Eyre Peninsula. However, both Leon and Chris believe that if they could plant the grazing Brassicas earlier (when soil and air temperatures are warmer) they would get much better production.

Canola and mustard varieties may provide a much better alternative because they are winter growing and are better adapted for our climate and soil types. Dr John Kirkegaard (CSIRO Plant Industry, Canberra) achieved promising results in 2004 and 2005 in a project evaluating grazing canola in medium and high rainfall areas near Canberra. Canola produced high quality feed and recovered well to produce respectable grain yields, lifting the gross margin by 31% above canola managed purely as a grain crop. Dr Kirkegaard will continue to evaluate dual purpose canola in 2007 and 2008 in medium and high rainfall areas where the likelihood of adequate rainfall and longer seasons may make the concept a more viable option.

Emma McInerney's (Eyre Peninsula Grain & Graze, SARDI MAC) grazing cereal work (see article 'Grazing cereals in medium and low rainfall environments' in this manual) has shown that cereal crops grazed at Minnipa (low rainfall) have provided good feed value but have failed to recover sufficiently for profitable grain yield compared to an ungrazed wheat crop. In medium rainfall areas however, they have recovered well and not compromised grain yield over two seasons and are a viable cropping–grazing option, providing benefits to the whole farming system. It is likely that grazing canola crops may produce similar results, i.e. on Upper Eyre Peninsula canola could provide a good feed source and disease break but not much of a grain harvest, while on Lower Eyre Peninsula there would be value in both the cropping and grazing. The economics of any increase in following cereal crop yields and income will be critical to the success of grazing canola considering canola is a high value, high input crop (hence carries greater risk).

The Eyre Peninsula Grain & Graze project intends to explore the potential for grazing canola in 2007.

## Acknowledgements

Grain & Graze is funded by Meat & Livestock Australia, Australian Wool Innovation, GRDC, and Land & Water Australia. Thanks go to Dion and Kym Williams (Streaky Bay), Leon Mudge and family (Miltaburra), and Neville Trezona (Piednippie) for the use of their land for small plot trials, and to Leon Mudge and Chris Lymn (Wudinna) for sharing their experiences.

# Comparing Sheep Breeds

Information

## Brian Ashton

Rural Solutions SA, Port Lincoln


## Key messages

- **There are now many sheep breeds available but it is not easy to compare them.**
- **There are also many bloodlines within each breed.**
- **If you are considering a change, try to obtain objective, non-biased information.**
- **Consider how well the breeds fit into your system but remember a simple system is often best.**

## Why was this done?

Several Eyre Peninsula farmer groups brought up the question of how to compare sheep breeds, especially wool breeds versus meat breeds. This is very difficult because:

- for any breed there are good and poor sheep
- it takes 5–10 years to change over, by which time the reason for the change may have also changed
- there are always things we don't know about a new breed or bloodline
- a lot of information is biased.

However, many people have had real success with a well thought out change. Since most people will change gradually, they will be running both breeds for a time. It is important, and not difficult, to run a trial to compare the two breeds or bloodlines — then you really know the advantages and disadvantages of each. Contact Eyre Peninsula Grain & Graze for information on how to run a trial and to obtain record-keeping sheets.

### Producing prime lambs

The most common question farmers have, with the current good price for lamb meat, is whether to produce prime lambs.

Cross-bred ewes are very popular in high rainfall areas because they are used to produce second cross lambs. Their major disadvantage is the capital cost of the ewes. Several studies have shown they do not have a better gross margin per DSE than Merino ewes.

First cross lambs from Merino ewes is an option that many Eyre Peninsula farmers have tried. This has worked extremely well as long as a supply of good Merino ewes is available. If too many people go this way, the price of Merino ewes will go too high and a pure Merino enterprise would then be more economic. It depends on the supply and demand of ewes.

The effort needed to produce and market good cross-bred lambs needs to be remembered. They need better nutrition than Merino ewe lambs that are being retained as replacements. Merino wether lambs need good nutrition if they are to be sold as prime animals.

A good option is to mate just enough Merino ewes (the good wool producers) to Merino rams to replace the ewe flock. The remaining ewes can be mated to a terminal sire.

If you have a small flock, I believe it is not a good idea to have a number of breeds. Keep it simple to make marketing and management easier. Complex systems are not worth it unless the scale is big.

### Woolless sheep

There are a number of breeds that shed their wool. The first one to be widely adopted here was the Damara, a fat tail breed. These were good for the live export market but it was very difficult to get enough carcase weight onto them. Some people are now converting these flocks to Dorpers, Wiltshire Horn, Wiltipol or other woolless breeds.

The key advantage of these breeds is reduced labour requirement. As they are not growing wool, which is high in protein, they also appear to thrive on lower quality feed. A disadvantage is they are not dual-purpose. They rely 100% on good meat prices.

It is very important to run these sheep separately from wool breeds so that contamination of the wool does not occur.

### Dual purpose breeds

There are two breeds that are striving to get the best of both worlds — the SAMM and Dohne. They have less wool than a Merino but have better growth and reproduction rates.

The problem with all breeds is that there is little objective data available on them. One breed claims that the sheep have up to '150% lambing'. Does this mean that one mob, on one farm, achieved 150% lambing? What we really need to know is what they will average, with normal management, on Eyre Peninsula.

There have been a number of trials comparing sheep breeds around Australia. If you are interested in making a change you need to use this objective data rather than the 'sales pitch' used by the seller.

### Comparing bloodlines within a breed

The best objective data that can be used to compare bloodlines is information from Sheep Genetics Australia. If the two studs you are comparing are members of SGA, all the measurements (ASBVs) for the sheep can be directly compared. You also need to compare the animals visually for non-measured traits. Then discuss with the stud master or an existing client about practical issues — disease risk, location, ram price, etc. Do not use the SGA figures alone.

SGA figures on sheep can only be compared within breeds. The exception is that terminal sire comparisons can be made between breeds, i.e. Dorsets, Suffolks, Texels, etc. can be compared. The figures from Merinos cannot be compared to the figures from SAMMs or Dohnes or Borders, etc.

## References

There are many references where objective comparisons have been made. Not all of these are relevant but contact us if you want a copy. Also use the internet, but remember that a lot of information is from a biased source.

## Acknowledgement

Eyre Peninsula Grain & Graze is funded by Meat & Livestock Australia, Australian Wool Innovation, GRDC, and Land & Water Australia.

# Understanding Black Wool Genetics in Merinos

**Alison Frischke**[1] **and Malcolm Fleet**[2]

[1]SARDI Minnipa Agricultural Centre, [2]SARDI Turretfield

Extension


## Key messages

- **A black lamb:**
  - **has inheritance which is consistent with a simple recessive gene**
  - **indicates that a carrier ram has been used and the ewe is also a carrier**
  - **has several recognised patterns on which white spots may be extensive**
  - **occurs because ram breeders currently cannot readily screen rams to prevent black lambs in client flocks**
  - **DNA parentage tests can be purchased to match black lambs to their sire in a syndicate mating.**
- **A white lamb with a black spot or other pigmented fibre:**
  - **likely involves several unknown factors**
  - **certain types can be readily controlled**
  - **removing affected breeding sheep is the most practical method of controlling these faults at this time.**
- **In the near future, the Australian Sheep Industry CRC and Sheep Genomics hope to have developed a genetic test that identifies sheep carrying genetics for black lambs. The problem of black spots on white lambs may take longer to resolve.**

## Why write the article?

The Australian Merino wool industry has a valued reputation as a supplier of 'white wool', with relatively low dark fibre content. In order to protect this reputation, woolgrowers must remain vigilant about removing known coloured fibre gene carriers from their flocks.

At a farmer group meeting, the question was asked whether there is a rule of thumb used to estimate the number of rams carrying a gene that expresses coloured wool, in relation to the number of lambs born expressing coloured wool (either as a patch or an entire coat). This article explains how coloured wool genetics work, and how to best manage flock genetics to avoid black wool.



*Figure 1 Lambs showing Recessive Black Agouti patterns; Badgerfaced-spotted (a) and Black (b), or Random spot (c) markings.*


## What happens?

Several types of coloured sheep can arise in Merino flocks, including those termed:

- Recessive Black (Agouti) patterns: Sheep will have either many spots or large patches, a dark belly, or be coloured all over. Patterns will look different between sheep, but they will have a similar symmetrical pattern, e.g. two black ears and/or two black spectacles (area around eyes). The sheep are commonly referred to as 'self-colour black' or 'badgerface'.
- Piebald or Random Spot: Sheep will usually have one or few spots or a patch of varying size anywhere on the body. They do not have symmetrical face markings.

### Agouti pattern

If a lamb is born black, the pattern of inheritance involved is simple — both parents must carry the recessive genetic predisposition. This can be represented by using the symbol $A^{Wt}$ as the usual *Agouti* allele for white sheep, and Aa as the recessive alternative for black. A white non-carrier sheep (standard Merino) will have a pair of alleles for white ($A^{Wt}$ /$A^{Wt}$). A black lamb will have both alleles for black ($A^a$/$A^a$). A white carrier sheep will have alternate alleles for white or black ($A^{Wt}$/$A^a$) and when both parents are carriers then one in four lambs are expected to be black (Table 1).

Table 1 shows how the two alternate alleles from each parent can combine in four ways, with a 75% chance of a white lamb and 25% chance of a black lamb.

***Table 1 Mating of a carrier ram and a carrier ewe.***

| | | Ram sperm | |
|---|---|---|---|
| | | $A^{Wt}$ | $A^a$ |
| Ewe egg | $A^{Wt}$ | $A^{Wt}$ / $A^{Wt}$ White | $A^{Wt}$ / $A^a$ White |
| | $A^a$ | $A^{Wt}$ / $A^a$ White | $A^a$ / $A^a$ |

Only this combination will produce a black lamb.

We can very quickly see that without knowing the frequency of carrier ewes in a flock it will be unclear how many carrier rams there are in a syndicate (group) of rams mated to a flock of ewes based on the number of black lambs thrown.

Consider the situation where 1% of the ewe flock (1 in 100) are carrier ewes and a carrier ram is introduced. We expect only 25% of the lambs born from a carrier-by-carrier mating to be black. Therefore, the expectation for a carrier ram in this flock would be only one black lamb among 400 lambs born to this ram (i.e. 1/100 x 1/4 = 1 in 400).

For those good at maths, consider the following. A mob of 20 rams are mated to 1000 ewes. Assuming there are:

- 50 lambs born per 50 ewes mated
- one ram used per 50 ewes mated (i.e. 50 lambs born per ram)
- only one carrier ram among the 20 rams syndicate mated (20 rams mated across the flock of ewes)
- four black lambs are born out of the 50 lambs from the carrier ram
- expect one black lamb out of four lambs from carrier x carrier matings (i.e. 16 carriers)
- 16 carriers in 50 ewes mated is 32%; since the ram has randomly selected these ewes, we can extend this percentage across the whole flock, which indicates that 32% of the flock are carriers (very high).

In a commercial flock it could take several matings before a black lamb occurs or use of the carrier ram may not be revealed. However, about half of the progeny of a carrier ram will be carriers and if used as replacements this will increase the probability of future black lamb occurrences should a carrier ram be used.

With syndicate matings, tracking down the sire responsible and his progeny (if needed) requires pedigree or parentage information. DNA pedigree or parentage services can be used to identify the ram responsible for a black lamb(s), and if needed the black lamb mothers and other progeny of the carrier ram(s). In a ram-breeding situation, it is important to remove all known or suspected carrier sheep to reduce problems for clients. In a commercial flock it is sufficient to remove known carrier rams and their black progeny.

To confirm that a single ram is a carrier of an Agouti allele for black lambs, controlled matings of the ram with a small mob of black ($A^a$/$A^a$ ) or known white ($A^{Wt}$/$A^a$ ) carrier ewes may be carried out. If any black or patterned lambs are thrown, you will know the ram is a carrier. Alternatively, if no black lambs are born, one needs at least five white progeny born from black ewes, or 11 white progeny from white carrier ewes before accepting that the ram is most likely (95%) not a carrier. The retention of black ewes for such controlled matings in a white wool producing farm presents risks of wool contamination so extra care is needed to ensure separation of the coloured sheep and their wool.

A strong candidate gene, *Agouti*, for recessive black patterns has been known for some time. SARDI was involved with Macquarie University and AWI in the original location of the gene to sheep chromosome 13 in a region where *Agouti* was expected to be located. Dr Belinda Norris of CSIRO, working in the CRC Sheep Genomics project 'Identifying genes contributing to pigmented wool phenotypes', is currently characterising (sequencing) the *Agouti* gene so that variations responsible for black lamb patterns can be detected in white carrier sheep.

***Table 2 Percentage of carrier ewes based on the number of carrier rams and black lambs born.***

| Syndicate mating Carrier ($A^{Wt}/A^{a}$) rams per 20 rams | Percentage of carrier ewes ($A^{Wt}/A^{a}$) Black lambs born per 1000 lambs | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | 8.0 | 16.0 | 24.0 | 32.0 | 40.0 | 48.0 | 56.0 | 64.0 | 72.0 | 80.0 |
| 2 | 4.0 | 8.0 | 12.0 | 16.0 | 20.0 | 24.0 | 28.0 | 32.0 | 36.0 | 40.0 |
| 3 | 2.7 | 5.3 | 8.0 | 10.7 | 13.3 | 16.0 | 18.7 | 21.3 | 24.0 | 26.7 |
| 4 | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | 12.0 | 14.0 | 16.0 | 18.0 | 20.0 |
| 6 | 1.3 | 2.7 | 4.0 | 5.3 | 6.7 | 8.0 | 9.3 | 10.7 | 12.0 | 13.3 |
| 8 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
| 10 | 0.8 | 1.6 | 2.4 | 3.2 | 4.0 | 4.8 | 5.6 | 6.4 | 7.2 | 8.0 |
| **Assumptions: Simple Mendelian inheritance and each ram produces 50 lambs from 50 ewes mated.** | | | | | | | | | | |

### Piebald Pattern

The genetics of the Piebald (Random Spot) pattern on the other hand is more complicated and not well understood. There are strong indications that multiple factors are involved and resolving this problem is expected to be more difficult than recessive black. Nevertheless, some impacts can be made by reducing other types of pigmentation on sheep (see SARDI fact sheet).

## What does this mean?

### Short term

As a commercial producer, if you are producing *Agouti* black patterns, you need to remove the carrier ram to prevent future occurrences. The sire may be identified if single sire mated or through DNA parentage testing services. As a ram breeder, it is important that all known or suspect carriers and semen are removed to prevent future problems for clients. You may wish to conduct a controlled mating with coloured ewes or known carrier ewes depending on practicality, or if the ram progeny of an identified carrier ram (around 50% of progeny will be carriers) could be highly valued.

In the case of Piebald (Random Spot) lambs, these should be marked as culls and removed (for slaughter) as soon as practical. Culling the dam and/or sire cannot be certain to produce benefits but may be undertaken as a precaution if desired.

### Long term

The CRC Sheep Genomics research project hopes to develop commercially available tests to screen white sheep for different pigmentation patterns. Breeders will be able to use this test to ensure that they are selling sheep that are free of unwanted, hidden pigmentation genes. The availability of this product is however still some years away and will depend on the complexity of the research.

Further information to help understand the pigment pattern types, genetics and the pigmentation research project can be sourced from the website for the Sheep CRC (http://www.sheepcrc.org.au/pigment) and PIRSA–SARDI (http://www.sardi.sa.gov.au/pages/livestock/meat_and_wool/darkwool1.pdf).


## Acknowledgements

Australian Sheep Industry CRC website.

# TRI-SOLFEN to Aid Mulesing

**Brian Ashton**
Rural Solutions SA, Port Lincoln

Demo




## Key messages

- **TRI-SOLFEN is a new product to aid mulesing wound management. The company claims use of the product results in less mis-mothering, less blood loss and provides pain relief.**
- **New products can easily be tested by on-farm trials but your results should not be considered in isolation; check with results from other trials as well.**

## Why do the work?

Farmers and the community want to reduce the negative impact of mulesing while retaining the benefits of breach strike protection to the sheep for the rest of its life.

## What was done?

Students at the Cleve Area School (Simm's Farm) decided to try the new product with the help of local farmers and Brian Ashton. They used the 141 lambs born on Simm's Farm in 2006.

Lambs were given all the normal treatments at lamb marking — ear tags, vaccination, castration (males), tailing and mulesing. They were also weighed. Students carried out all these treatments under instruction from experienced farmers.

After mulesing by the students, Brian Ashton treated all the lambs with an odd tag number with TRI-SOLFEN. They were also given a spray mark on the head. Lambs with an even tag number were not given this treatment. All lambs were then given a fly prevention treatment.

Lambs were immediately released to an area with their mothers. Students and adults tried to observe the behaviour of the lambs, particularly mothering up and signs of pain and discomfort. This did not show up any distinct differences between treated and untreated lambs but it was very difficult to make an objective judgement.

Fifteen days later the lambs were weighed. There was no difference in lamb weight gain between treatment groups. Wether lambs put on 3.77 kg and ewe lambs 3.25 kg (lambs were empty at the first weighing).

## What does this mean?

Test all new products by leaving some animals untreated. However, the results from one small trial should be used with caution.

These lambs were quite big at tailing — average weight of 21.6 kg. Only 8 mL of the product were applied to each lamb. Possibly a higher rate should have been used because of the size of the lambs.

## Acknowledgements

Eyre Peninsula Grain & Graze is funded by Meat & Livestock Australia, Australian Wool Innovation, GRDC, and Land & Water Australia. Students and staff of the agriculture course at the Cleve Area School. Ben Ranford, local farmer, for supply of the TRI-SOLFEN and for assistance with the trial. TRI-SOLFEN is a registered trade mark of Animal Ethics Pty Ltd.

# Section 5

Section editor:
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# Farming Systems

Research

## Yield Prophet as a Model for Predicting Wheat Yield on Upper Eyre Peninsula

**Jim Egan**[1] **and Jon Hancock**[2]
[1]SARDI Port Lincoln, [2]SARDI Minnipa Agricultural Centre

### Key messages

- **The French–Schultz potential yield model is a rule of thumb, but does not adjust for the pattern of growing season rainfall or soil types.**
- **Yield Prophet has accurately simulated wheat yields on Eyre Peninsula over the last three years and will be a valuable tool for in-crop decision-making.**
- **Accurate soil characterisation is critical to successful crop modelling.**

### Why do the work?

The Agricultural Production SIMulator (APSIM) has been developed to model soil water relationships, crop growth and development, and ultimately predict grain yield and quality. Yield Prophet (YP) is a farmer-friendly, internet-based computer interface to APSIM, with the potential to be a useful tool for looking at soil water, soil nitrogen, probable grain yields and the likelihood of responses to nitrogen applications through the season. While APSIM, and more recently YP, have been widely used in the eastern states, very little validation has been done on Eyre Peninsula. If they can be shown to be reasonably accurate in our environment, then this will give farmers a very useful tool to assist crop management decision making. YP was therefore run at a number of sites on Eyre Peninsula in the 2004 to 2006 growing seasons to assess how well it could model wheat growth and predict grain yields in this environment.

### How was it done?

The 2004 and 2005 test sites were at the Secondary (S4) Wheat trial site at MAC. In 2005 an additional two sites were monitored, in the same paddock as the S4 wheat trial, in areas identified by EM38 mapping as having medium and high EM (electromagnetic conductivity) values, potentially indicative of high subsoil salinity. The 2006 testing included four farmer wheat paddocks in the Lock district of Central Eyre Peninsula, as well as two sites on contrasting soil types at MAC.

Once sites were identified and registered for YP, soil samples were taken to a depth of 1.2 m where possible and analysed to characterise the soil profile. Accurate soil characterisation is critical to successful crop modelling with YP, since these values determine the model's calculations of soil water availability to the growing crop. Measurements were made of soil water, soil nitrogen, organic carbon, pH, subsoil constraints (boron and salt), field capacity and wilting point. The difference between field capacity (the maximum amount of water that a soil can hold) and wilting point (the theoretical point below which plant roots can no longer extract water) determines the plant-available water capacity for a soil. These data, along with crop management details, were entered into the YP database for each site. As each season progressed, rainfall figures were regularly updated and reports were generated, including probability curves of predicted grain yield. YP simulates crop growth for the


season using actual site rainfall recordings to date, and then historic rainfall figures (last 100 years) for the remainder of the growing season to generate the range of likely crop yield outcomes and hence a yield probability curve.

### What happened?

The soil type, growing season rainfall (GSR), simulated yield from YP, potential yield from a modified French–Schultz model (as explained in the following article, 'Water use efficiency of crops and pastures') and the actual grain yield data are presented in Table 1.

In 2004, Frame wheat within the Secondary Wheat trial at MAC was used for the YP predictions initially. The season was not kind to the late maturing Frame variety however, which suffered a high level of head tipping following several very high moisture stress days from late September onward. Frame yields

*Table 1 Wheat yield predictions (t/ha) from Yield Prophet and French–Schultz, compared to actual yields, at Eyre Peninsula sites in 2004 to 2006.*

| Year | Site | Soil type | GSR (mm) | Yield Prophet predicted grain yield (t/ha) | Modified French–Schultz potential yield (t/ha) | Actual grain yield (t/ha) |
|---|---|---|---|---|---|---|
| 2004 | MAC paddock S6E | Sandy loam | 233 | | 2.3 | |
| | Frame wheat | | | 1.0 | | 0.42 |
| | H45 wheat | | | 1.0 | | 1.1 |
| | S4 wheat trial mean | | | 1.0 | | 0.79 |
| 2005 | MAC paddock N7/8 | Sandy loam | 267 | | 3.1 | |
| | Low EM zone | | | 2.0 | | 2.1 |
| | Medium EM zone | | | 1.9 | | 2.5 |
| | High EM zone | | | 2.1 | | 2.4 |
| 2006 | Polkinghorne, Lock | Grey loam | 105 | 0.9 | 0.88 | 1.20 |
| | Cummins, Lock | Loam | 115 | 0.2 | 0.98 | 0.45 |
| | Hentschke, Lock | Sand dune | 109 | 0.9 | 0.92 | 0.70 |
| | Hentschke, Lock | Swale | 109 | 0.1 | 0.92 | 0.04 |
| | MAC | Sandy loam | 111 | 0.5 | 1.0 | 0.56 |
| | MAC | Heavy flat | 111 | 0.2 | 1.0 | 0.29 |

were extremely variable between replicates in the trial, and averaged only 0.42 t/ha — the lowest yielding entry in the trial — which was well below the YP prediction of 1.0 t/ha. But YP predictions for other varieties were also 1.0 t/ha, which was much closer to their actual performance (e.g. H45 averaged 1.06 t/ha, while the average across all entries in the S4 trial was 0.79 t/ha). The YP prediction was 44% of the potential French–Schultz yield.

The 2005 YP predictions, based on Pugsley wheat, were very similar for all three soil zones and were slightly lower than actual yields of Pugsley on these soils (2.1–2.5 t/ha). The YP predictions ranged from 61% (on medium EM) to 67% (on high EM) of the French–Schultz potential yield. Grain protein predictions from YP were also monitored in 2005. These ranged from 13.8 to 16%, compared to measured values of 12.7–13.3% (i.e. an overestimation of grain protein of between 1.0 and 2.7 percentage points).

In 2006, YP again predicted grain yield quite accurately in a very dry season.

## What does this mean?

YP wheat yield predictions were close enough to actual in each of the three seasons of evaluation for us to have confidence in its use as a crop management tool on Eyre Peninsula, provided that soil parameters are characterised as per the recommended procedures. It was far more accurate than the French–Schultz potential yield model, even when this was modified to include summer rainfall and reduced evaporation rates in drier seasons. Differences in varietal performance between seasons do not appear to be well modelled by YP, although better specification of local varieties may improve this current limitation.

The similarity of actual yields to the predicted yields from YP, as determined by seasonal conditions and soil constraints on water-holding capacity, suggests that current farming practices are enabling farmers to achieve the grain yields that they should realistically expect, even though these may fall short of the theoretical French–Schultz potential.


## Acknowledgements

We would like to thank James Hunt of Birchip Cropping Group for his valuable assistance in running YP, the farmers involved for their interest and input, and Wade Shepperd, Leigh Davis and Willie Shoobridge of MAC for their technical assistance. EPFS funded the research.

Yield Prophet is a registered program offered as a commercial service by the Birchip Cropping Group, under licence from the Agricultural Production Systems Research Unit (APSRU) in Queensland. The Yield Prophet web site is <http://www.yieldprophet.com.au>.

GRDC Grains Research & Development Corporation

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THE UNIVERSITY OF ADELAIDE AUSTRALIA

# Water Use Efficiency of Crops and Pasture

**Jon Hancock**
SARDI Minnipa Agricultural Centre

Demo

## Key messages

- **Crops used more soil water than anticipated.**
- **Extraction of soil water between different crops was similar on good soil types but varied when subsoil constraints were present.**
- **Water use efficiency varied between crop types.**

## What is Water Use Efficiency?

Water use efficiency (WUE) is about the ability of plants to convert water into growth and products. One easy technique for estimating WUE in the field is to calculate a simple water budget so that the amount of water used by the crop can be identified. This 'available' water is then divided into grain yield to give WUE in kg/ha/mm. Available water is calculated by adding available stored soil water at the beginning of the season to growing season rainfall and subtracting plant-available water remaining at harvest and water lost to evaporation.

In 1984, Reg French and Jeff Schultz wrote two important papers defining WUE standards for wheat in South Australia. From this, two rules of thumb were derived; that maximum WUE of wheat is 20 kg/ha/mm and that 110 mm of water are usually lost to evaporation during the growing season of a wheat crop. These rules, along with growing season rainfall, allowed potential yields of wheat to be calculated.

Throughout this manual, potential yields have been calculated using a modified version of the French–Schultz potential yield model. The modification to distinguish between crop types allows some pre-season rainfall to be included as plant-available water and also recognises that water loss to evaporation will be lower in dry years. This is important as in a dry year, when the soil surface is mostly dry, less than the standard 110 mm of water will be lost to evaporation, so using 110 mm would grossly underestimate potential yield.

This modified version of the French–Schultz potential yield model is defined as follows:

### For April–October rainfall more than 200 mm:

Potential yield of wheat (kg/ha) = (water use*-110) x 20

Potential yield of barley (kg/ha) = (water use-90) x 20

Potential yield of pulses (kg/ha) = (water use-130) x 15

Potential yield of canola (kg/ha) = (water use-110) x 15

Potential yield of pasture (kg/ha) = (water use-70) x 45

### For April–October rainfall less than or equal to 200 mm:

Potential yield of wheat (kg/ha) = (water use-(110-evaporation factor+)) x 20

Potential yield of barley (kg/ha) = (water use-(90-evaporation factor)) x 20

Potential yield of pulses (kg/ha) = (water use-(130-evaporation factor)) x 15

Potential yield of canola (kg/ha) = (water use-(110-evaporation factor)) x 15

Potential yield of pasture (kg/ha) = (water use-(70-evaporation factor)) x 45

**Water use is April–October rainfall plus a third of the monthly rainfall above 20 mm for November, December, January and February plus half of monthly rainfall above 20 mm for March.*

*+Evaporation factor is one third of the difference between 200 mm and the actual April–October rainfall.*

**Searching for answers**

**Location**
MAC
**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm
**Paddock history**
2005: GF pasture
2004: pasture
2003: pasture
**Soil type**
Sandy loam / red clay loam
**Plot size**
10 m x 3 m

**Location**
Mudamuckla: Peter Kuhlmann
**Rainfall**
Av. annual: 293 mm
Av GSR: 219 mm
2006 total: 203 mm
2006 GSR: 102 mm
**Paddock history**
2005: oats (grazed)
2004: wheat
2003: pasture
**Soil type**
Grey calcareous sandy loam / calcareous loam
**Plot size**
10 m x 3 m

**Location**
Tuckey: Jason Burton
**Rainfall**
Av. annual: 324 mm
Av. GSR: 241 mm
2006 total: 240 mm
2006 GSR: 94 mm
**Paddock history**
2005: vetch
2004: barley
2003: wheat
**Soil type**
Sandy loam / red clay loam
**Plot size**
10 m x 3 m

## Why do the demonstrations?

Demonstrations were set up to compare water extraction of wheat, barley, peas, canola and medic pasture. Variation in the ability of different crops to extract soil water will not only affect their potential yield but may also have flow-on effects to the following crop in the rotation by altering the amount of soil water that carries over to the next season.

## How was it done?

Prior to seeding, soil samples were taken from each site, to a depth of 1.2 m where possible, and analysed to characterise the soil profiles. Measurements were made of soil water, soil nitrogen, organic carbon, pH, subsoil constraints (boron and salt), field capacity and wilting point. Field capacity is the maximum amount of water that a soil can hold and wilting point is the theoretical point below which plant roots can no longer extract water.

Strips of wheat, barley, peas, canola and medic were sown alongside the canopy management trials at Minnipa, Mudamuckla and Tuckey on 2, 5 and 6 June, respectively. The strips were sown on 23 cm row spacings; the variety and sowing rate details are shown in Table 1. The demonstrations, at two sites within each paddock, were chosen to represent either a poorer performing area (heavy loam, referred to as heavy in this article) or a good performing area (lighter sandy loam, referred to as loam).

Rain exclusion shelters were erected over part of each crop at anthesis to prevent these areas from receiving any late season rainfall. At maturity, cuts were taken from each crop outside the exclusion shelter, weighed and thrashed to get a measure of total DM production and grain yield. The soil beneath each rain exclusion shelter was sampled to 1.2 m if possible and rooting depth noted. Soil samples were weighed, oven dried and weighed again to determine the crop lower limit (the actual point below which plant roots can no longer extract water).

## What happened?

All crops yielded less on the heavier soil types, reflecting the nature of these soils to hold water very tightly — a costly property in dry years (Table 2). On the heavy soils, there was a substantial difference between crop types in their ability to extract soil water due to differences in crop tolerance to the subsoil constraints present. This resulted in the crop lower limit changing for the different crop types (Figures 1, 2 and 3) and would partly explain yield differences on these soils. On the loam soils, there was

***Table 1 Varieties and sowing rates.***

| Crop | Variety | Sowing rate (kg/ha) |
|---|---|---|
| **Wheat** | Yitpi | 60 |
| **Barley** | Keel | 60 |
| **Peas** | Kaspa | 100 |
| **Canola** | Stubby | 5 |
| **Medic** | Herald–Toreador–Caliph | 10 |

***Table 2 Dry matter at maturity and grain yield at WUE sites, 2006.***

| Crop | Site | DM at maturity (t/ha) | Grain yield (t/ha) | Harvest index (%) | Potential grain yield (t/ha) | Percentage of potential yield achieved (%) |
|---|---|---|---|---|---|---|
| **Wheat** | MAC Heavy | 1.23 | 0.46 | 37 | 1.01 | 46 |
| | MAC Loam | 2.12 | 0.85 | 40 | 1.01 | 84 |
| | Mudamuckla Heavy | 1.42 | 0.52 | 37 | 0.92 | 57 |
| | Mudamuckla Loam | 2.73 | 1.16 | 42 | 0.92 | 126 |
| | Tuckey Heavy | 2.19 | 0.38 | 17 | 0.68 | 56 |
| | Tuckey Loam | 3.07 | 1.14 | 37 | 0.68 | 168 |
| **Barley** | MAC Heavy | 1.64 | 0.76 | 46 | 1.41 | 54 |
| | MAC Loam | 1.62 | 0.84 | 52 | 1.41 | 60 |
| | Mudamuckla Heavy | 1.47 | 0.74 | 50 | 1.32 | 56 |
| | Mudamuckla Loam | 2.36 | 1.23 | 52 | 1.32 | 93 |
| | Tuckey Heavy | 0.75 | 0.02 | 3 | 1.08 | 2 |
| | Tuckey Loam | 2.49 | 1.06 | 43 | 1.08 | 98 |
| **Peas** | MAC Heavy | 0.58 | 0.06 | 10 | 0.46 | 12 |
| | MAC Loam | 1.22 | 0.34 | 28 | 0.46 | 74 |
| | Mudamuckla Heavy | 0.76 | 0.12 | 15 | 0.39 | 30 |
| | Mudamuckla Loam | 1.24 | 0.19 | 15 | 0.39 | 48 |
| | Tuckey Heavy | 0.99 | 0.01 | 1 | 0.21 | 5 |
| | Tuckey Loam | 1.16 | 0.21 | 18 | 0.21 | 98 |
| **Canola** | MAC Heavy | 0.50 | 0.09 | 19 | 0.76 | 12 |
| | MAC Loam | 1.12 | 0.35 | 32 | 0.76 | 47 |
| | Mudamuckla Heavy | 0.41 | 0.02 | 05 | 0.69 | 3 |
| | Mudamuckla Loam | 0.82 | 0.05 | 7 | 0.69 | 8 |
| | Tuckey Heavy | 0.63 | 0.02 | 3 | 0.51 | 4 |
| | Tuckey Loam | 0.46 | 0.00 | 1 | 0.51 | 1 |

little difference in the crop lower limit for each crop type (i.e. each crop had the same access to soil water; Figures 4, 5 and 6) so differences in yield would be due to the ability of each crop to use water for growth.

The barley at the Tuckey heavy site did particularly poorly relative to the other sites, probably due to its intolerance to the high levels of salt and boron present at this site. The barley in this plot looked particularly bad all season but surprisingly there wasn't any more water left in the profile after barley than after the other crops.

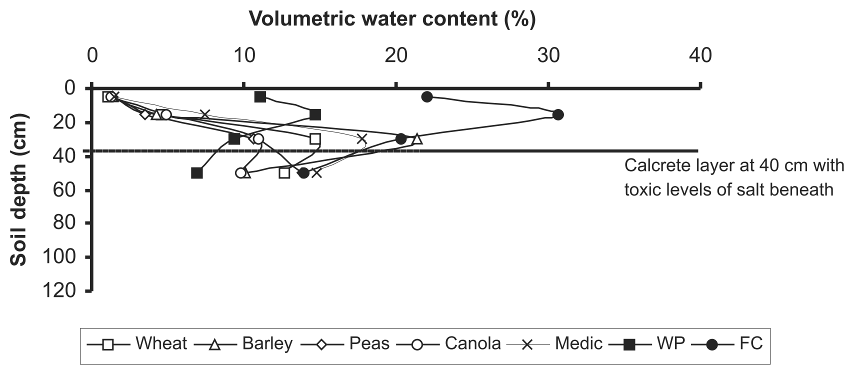


*Figure 1 Crop lower limits, wilting point and field capacity at MAC Heavy site.*

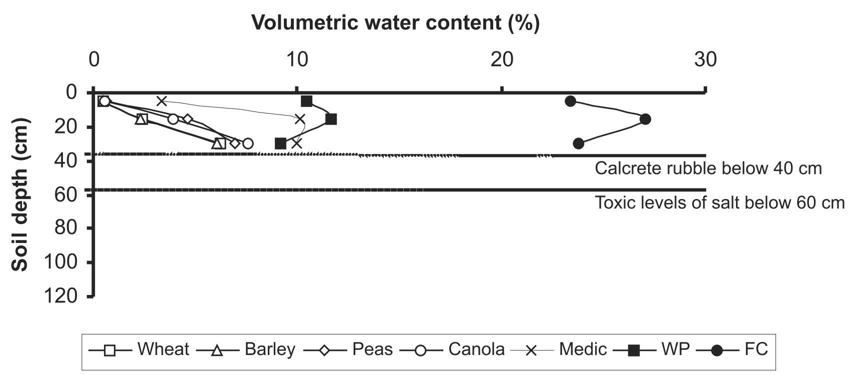


*Figure 2 Crop lower limits, wilting point and field capacity at Mudamuckla Heavy site.*

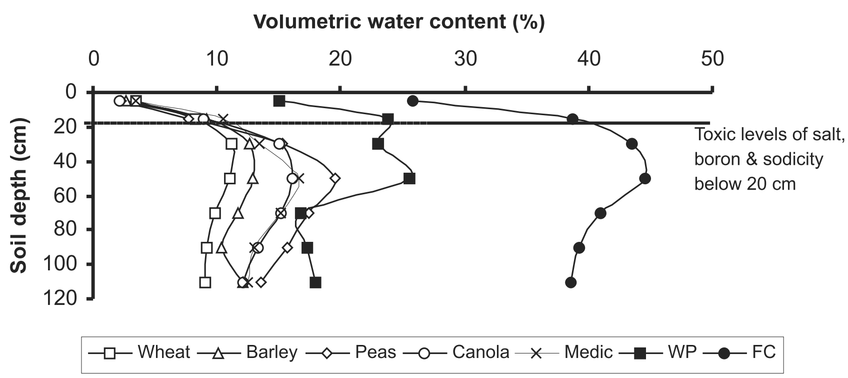


*Figure 3 Crop lower limits, wilting point and field capacity at Tuckey Heavy site.*

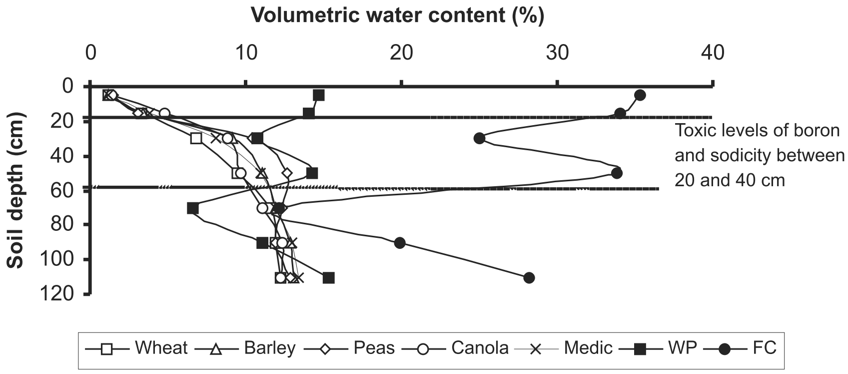


***Figure 4** Crop lower limits, wilting point and field capacity at MAC Loam site.*

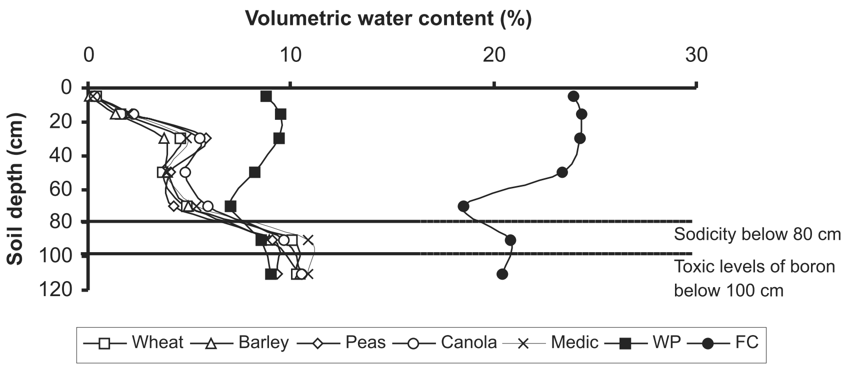


***Figure 5** Crop lower limits, wilting point and field capacity at Mudamuckla Loam site.*

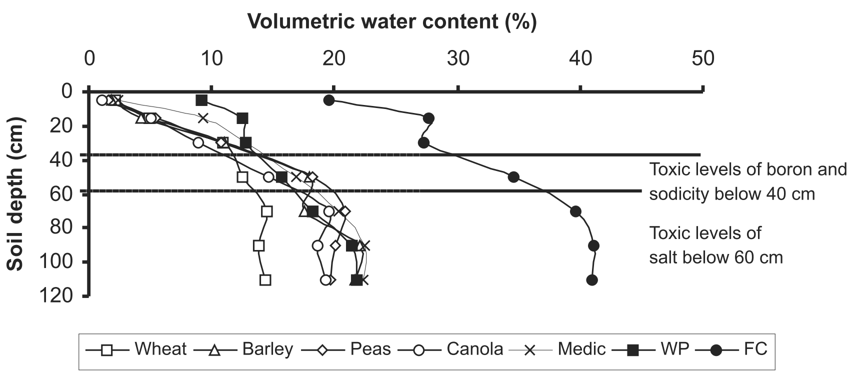


***Figure 6** Crop lower limits, wilting point and field capacity at Tuckey Loam site.*

## What does this mean?

The vast differences in the performance of each crop type on loam soils is not largely due to differential extraction of soil water by different crop types, but due to differences in how efficiently the crops can use the water. On heavy soils though, crop types differ in tolerance to subsoil constraints which affects water availability and also affects crop performance. Differences in the efficiency of crops to use water, often referred to as evapotranspiration efficiency, is controlled by both differences in evaporation efficiency (how well plants protect the soil from evaporation) and transpiration efficiency (how well plants are able to use the water they get).

The relevance of the theoretical wilting point needs to be questioned in our environment as at each site plants were able to extract water at least up to, and in many cases beyond, wilting point. Permanent wilting point was calibrated on sunflower plants grown in pots, but it seems that in our systems plants are able to extract considerably more soil water. The use of soil water beyond wilting point in the deeper layers indicates that plants are able to use more soil water than is anticipated.

## Acknowledgements


I would like to thank Jason and Julie Burton (Tuckey) and Peter and Julianne Kuhlmann (Mudamuckla) for the use of their land. I also would like to thank Wade Shepperd of MAC for technical assistance throughout the season. EPFS funded the research.


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# Canopy Management on Upper Eyre Peninsula

**Jon Hancock**
SARDI Minnipa Agricultural Centre

Research



## Key messages

- **Reduced plant density improved grain yield on the poorer soil types.**
- **District practice management consistently performed well on the better soil types.**

## Why do the trial?

These trials evaluated the impact of manipulating crop canopy development on water use, DM production, and grain yield and quality. In low rainfall environments, there is concern that excessive early crop growth depletes soil moisture reserves early so that plants become drought stressed during the crucial grain fill stage. This is a condition known as 'haying off', reducing grain size and yield.

In higher rainfall regions, management of crop canopies can be achieved in various ways, including strategic application of N fertiliser. However, in low rainfall regions, where soil N reserves are often close to crop requirements, alternative approaches are required.

## How was it done?

Trials were sown in two contrasting soil types within a paddock at Minnipa, Mudamuckla and Tuckey on 2, 5 and 6 June, respectively. The two sites within each paddock were selected to coincide with a poorer performing area (heavy loam, referred to as heavy in this article) and a good performing area (lighter sandy loam, referred to as loam). Wheat (cv. Wyalkatchem or Yitpi) and mixes of wheat and oats were sown into replicated plots at varying densities (Table 1) with 65 kg/ha of 10:22:00 deep banded on 23 cm row spacing. Various approaches were implemented to alter canopy size. Some treatments received an additional 15 or 30 kg N/ha as urea deep banded at sowing. Due to the dry nature of the season, no additional N was applied in-crop. A growth regulator, Cycocel 750A (Chlormequat), was applied at 1 L/ha to some treatments at mid- and late tillering, and the oats were selectively removed through an application of Topik at late tillering.

## What happened?

Although the 2006 growing season started out looking promising with a reasonably early break, there was very little spring rainfall, meaning that crops had to draw on subsoil water for grain fill. It was surprising how well the crops managed to hang on and fill grain without any screenings problems. Grain yield (Table 1) tended to increase at lower seeding rates on the heavier soil types. The Mudamuckla heavy site was an exception because yield increased under the extreme treatments of a 33% wheat mix with oats, 60 plants/m$^2$ or mowing. District practice, or the control treatment, consistently performed well on the loam soils.

At sites on the loam soil type, there was a positive correlation between anthesis DM and grain yield (as shown by the hollow symbols in Figure 1). On the heavier soils though, maximum grain yield was achieved with anthesis DM of around 1.7 t/ha. Grain yield declined as anthesis DM declined or increased from this value.

## What does this mean?

Results from the very dry season of 2006 have shown that there was no substantial yield improvement through canopy management on good soil types. With little yield benefit on good soils in a particularly dry year, there is almost certainly not going to be a yield response from these techniques in wetter years. Similar trials conducted in 2004 and 2005 also support this, as in these years crops with greater bulk tended to yield the best.

**Searching for answers**

**Location**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 1.01 t/ha
Actual: up to 0.59 t/ha

**Paddock history**
2005: pasture
2004: pasture
2003: pasture

**Soil type**
Sandy loam / red clay loam

**Plot size**
10 m x 2 m x 4 replications

**Location**
Mudamuckla: Peter Kuhlmann

**Rainfall**
Av. annual: 293 mm
Av GSR: 219 mm
2006 total: 203 mm
2006 GSR: 102 mm

**Yield**
Potential: 0.92 t/ha
Actual: up to 0.88 t/ha

**Paddock history**
2005: oats (grazed)
2004: wheat
2003: pasture

**Soil type**
Grey calcareous sandy loam/ calcareous loam

**Plot size**
10 m x 2 m x 4 replications

**Location**
Tuckey: Jason Burton

**Rainfall**
Av. annual: 324 mm
Av. GSR: 241 mm
2006 total: 240 mm
2006 GSR: 94 mm

**Yield**
Potential: 0.68 t/ha
Actual: up to 0.88 t/ha

**Paddock history**
2005: vetch
2004: barley
2003: wheat

**Soil type**
Sandy loam / red clay loam

**Plot size**
10 m x 2 m x 4 replications

*Table 1 Grain yield (as % of control) of wheat in canopy management trials, 2006.*

| Treatment | Minnipa Wyalkatchem | | Minnipa Yitpi | | Mudamuckla Yitpi | | Tuckey Yitpi | |
|---|---|---|---|---|---|---|---|---|
| | Heavy | Loam | Heavy | Loam | Heavy | Loam | Heavy | Loam |
| 33% wheat, 67% oats | 56 | 39 | 57 | 38 | 158 | 65 | 58 | 49 |
| 67% wheat, 33% oats | 87 | 78 | 88 | 76 | 106 | 94 | 105 | 75 |
| 60 plants/m$^2$ | 117 | 101 | 111 | 110 | 170 | 78 | 94 | 82 |
| 120 plants/m$^2$ | 117 | 101 | 108 | 86 | 111 | 97 | 122 | 89 |
| Control (180 plants/m$^2$) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 240 plants/m$^2$ | 74 | 95 | 79 | 71 | 70 | 110 | 100 | 93 |
| 15 kg N/ha applied at sowing | 93 | 91 | 104 | 82 | 92 | 107 | 89 | 99 |
| 30 kg N/ha applied at sowing | 81 | 69 | 83 | 76 | 76 | 100 | 119 | 100 |
| GR* applied mid-tillering | 102 | 104 | 103 | 88 | 55 | 103 | 129 | 101 |
| GR applied late tillering | 97 | 90 | 81 | 99 | 129 | 101 | 73 | 102 |
| Mown late tillering | 83 | 90 | 73 | 84 | 170 | 83 | 62 | 94 |
| *LSD (P=0.05)* | *18* | *24* | *17* | *18* | *52* | *22* | *45* | *9* |
| Control (t/ha) | 0.23 | 0.45 | 0.29 | 0.54 | 0.24 | 0.82 | 0.34 | 0.86 |

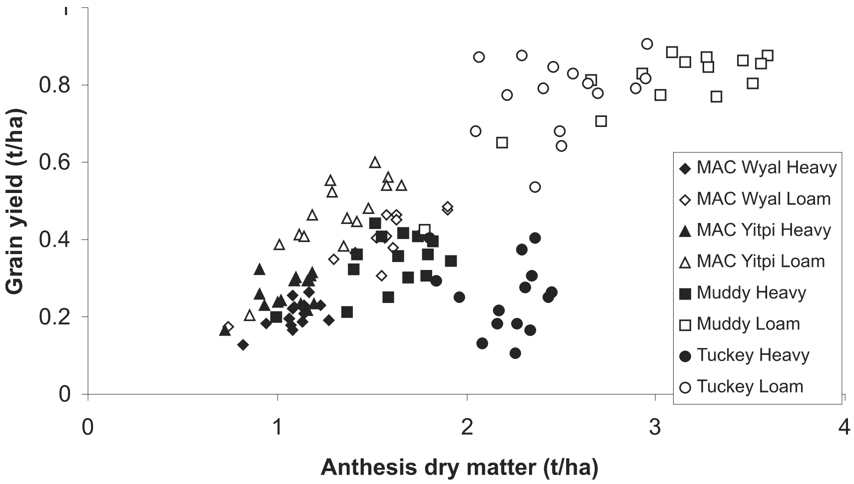


***Figure 1** Relationship between anthesis DM and grain yield.*

On poorer soil types however, reduced crop canopies, achieved through reduced sowing rates, improved crop grain yield in 2006. Whilst there is little value in farming for a drought, perhaps there is scope for reducing inputs on less productive country to improve profitability across a whole paddock.

The next step in this research is to tackle some of these techniques on a broad scale. Once paddock zones have been identified from yield and EM maps, different management techniques will be trialled in each zone to determine how conventional practice compares to variable rate technology.


## Acknowledgements

I would like to thank Peter and Julianne Kuhlmann (Mudamuckla) and Jason and Julie Burton (Tuckey) for the use of their land for trial sites. The generosity of Crop Care in providing the Cycocel 750A® for use in these trials is greatly appreciated. I also would like to thank staff of MAC for technical assistance throughout the season, particularly Wade Shepperd, Trent Brace and Kay Brace. EPFS funded the research.


Topik is a registered product of Syngenta, and Cycocel 750A is a registered product of Crop Care.

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# Variable Rate Trials at Mudamuckla

**Peter Kuhlmann**
Farmer, Mudamuckla

Demo

## Key messages

- **Variable Rate Technology enables broadacre on-farm trials to be conducted.**
- **The profitability of different management options varied according to paddock history and soil type.**

## Why do the trials?

The trials were designed to determine the most profitable rates of inputs and follows on from results in the EPFS 2005 Summary (pages 26–27).

## How was it done?

The trials were sown to Yitpi wheat with knife points and press wheels in two paddocks (paddocks 22 and 42), which included shallow limestone outcrops. Seeder width strips were sown for the length of the paddock and traversed sandier hills and heavier flats. Control strips were sown on alternate strips (to allow a direct comparison) using a GPS AG Autosteer with 2 cm accuracy. Rates of seed, fluid fertiliser (phosphoric acid) or urea were varied in an attempt to find the best gross income for the different soil types (Tables 1 and 2). The strips were harvested with a full header front (1.7–2.0 ha/plot) using yield mapping.

**Try this yourself now**

**Location**
Mudamuckla

**Rainfall**
Av. annual: 293 mm
Av. GSR: 219 mm
2006 total: 203 mm
2006 GSR: 102 mm

**Yield**
Potential: 0.92 t/ha
Actual: up to 0.89 t/ha

**Paddock 22 history**
2005: Barque barley
2004: Krichauff wheat
2003: Yitpi wheat

**Paddock 42 history**
2005: GF pasture
2004: Krichauff wheat
2003: Krichauff wheat

**Soil**
Grey calcareous sandy loam

Farming Systems

***Table 1 Grain yield, quality and gross income of treatments in paddock 22.***

| Treatment | Seed rate (kg/ha) | P rate (kg P/ha) | N rate (kg N/ha) | Grain yield (t/ha) | Grain protein (%) | Screenings (%) | Gross income* ($/ha) |
|---|---|---|---|---|---|---|---|
| No N | 60 | 5.5 | 0 | 0.89 | 13.5 | 0.9 | 170 |
| High seed, no fert | 80 | 0 | 0 | 0.80 | 13.4 | 1 | 164 |
| No fert | 60 | 0 | 0 | 0.76 | 12.9 | 0.9 | 158 |
| Standard | 60 | 5.5 | 10 | 0.82 | 13.6 | 0.8 | 143 |
| High seed | 80 | 5.5 | 10 | 0.78 | 13.4 | 0.8 | 129 |
| High P | 60 | 7 | 10 | 0.77 | 13.6 | 0.8 | 126 |
| Very high P | 60 | 9.5 | 10 | 0.78 | 12.5 | 0.9 | 116 |
| High N | 60 | 5.5 | 15 | 0.66 | 13.8 | 0.8 | 102 |

**Gross income is yield x price (with quality adjustments) less on-farm treatment costs delivered to Thevenard.*

***Table 2 Grain yield, quality and gross income of treatments in paddock 42.***

| Treatment | Seed rate (kg/ha) | P rate (kg P/ha) | N rate (kg N/ha) | Grain yield (t/ha) | Grain protein (%) | Screenings (%) | Gross income* ($/ha) |
|---|---|---|---|---|---|---|---|
| Standard | 60 | 5.5 | 6 | 0.49 | 14.1 | 1.2 | 71 |
| No N | 60 | 5.5 | 0 | 0.43 | 14.4 | 1.4 | 65 |
| Very high P | 60 | 9.5 | 6 | 0.51 | 13.8 | 0.9 | 63 |
| High P | 60 | 7 | 6 | 0.47 | 13.3 | 1.2 | 62 |
| Low P | 60 | 4 | 6 | 0.40 | 13.9 | 1.1 | 58 |
| High fert | 60 | 7 | 9 | 0.45 | 14.3 | 2.8 | 52 |
| No fert | 60 | 0 | 0 | 0.26 | 13.6 | 2.4 | 45 |
| High N | 60 | 5.5 | 9 | 0.38 | 14.4 | 1.7 | 44 |
| High seed, no fert | 80 | 0 | 0 | 0.18 | 14.0 | 2.2 | 25 |
| High seed | 80 | 6 | 8 | 0.19 | 13.8 | 2.8 | -5 |

**Gross income is yield x price (with quality adjustments) less on-farm treatment costs delivered to Thevenard.*

## What happened?

The crops were sown into moist soils in early June with some conserved moisture from the January and March rains. Weed control was good. Average rains in June and July set the crops up with above average potential. There was no further rain gauging over 1.5 mm after mid-July. On shallow soils with heavy flats, early biomass was encouraged by higher seeding rates, but nitrogen application visually reduced yields. Grain quality was very good and did not vary between treatments.

## What does this mean?

The current standard rates of seed, phosphorus and nitrogen used on our farm was the most profitable in the 2005 trial and one of the trials in 2006 across the range of soil types. The results from the two paddocks highlight the varied responses to nutrition and seeding rates even in an extremely dry spring. Variable Rate Technology will allow management of these zones to minimise the losses in the majority of years. More trials are needed to confirm if extra nutrition on the higher yielding parts of the paddock would be economic.

## Acknowledgements

Thanks to 'Jock' Rynne who sowed the strips, Andre Eylward who harvested the strips and sorted out the yield data, and ABB Grain at Thevenard for testing the grain samples.

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Agricultural Research Foundation Inc.

***Wade Shepperd and Andrew and Stuart Hentschke taking soil samples at Lock.***

# Systems Analysis for Sustainability

**Neil Cordon[1], Amanda Cook[1], Cathy Paterson[1], Justine Graham[2], Tiffany Ottens[3]**

[1]SARDI Minnipa Agricultural Centre, [2]Eyre Peninsula Natural Resources Management Board, [3]Rural Solutions SA, Streaky Bay

Survey

## Key messages

- **Low soil fertility (phosphorus, nitrogen) appears to be affecting a low input, long-term pasture grazing system.**
- **Herbicide resistance, root diseases, snails and insect pests are issues that must be carefully managed in a cropping system to maintain sustainability.**
- **Agricultural systems tend to improve the microbial biomass and activity of the soil.**

## Why do the analysis?

The aim of this exercise was to analyse paddocks within a similar rainfall zone and on similar soil types with different agricultural systems for their relative production-based sustainability status.

A previous survey (EPFS 2003 Summary, page 56) on the sustainability (as measured by current benchmarks) of farms around Ceduna and Penong showed that no single system was any more sustainable than another, especially if good agronomic practices and management were conducted within each system.

## How was it done?

Four paddocks with a history of major farming system differences were sampled in the Streaky Bay district, namely long-term pasture, continuous crop, district practice rotations and native scrub. These paddocks are also part of the Biodiversity in Grain & Graze (BiGG) survey.

The farmers provided information during personal interviews about their paddocks, and their perceptions on sustainable indices were also recorded.

***Measurements***

Soil nutrients, soil compaction, root disease DNA, plant-available water, plant species population and density, soil microbial activity and potential disease suppression, soil surface invertebrates and bird species richness were measured in all four paddocks.

Economic data were not gathered as it was considered that this indicator is very much up to individual's attitude to risk, lifestyle and how much money they want to make.

## What paddocks were analysed?

All paddocks are close to Streaky Bay on the Gibson Peninsula. The average annual rainfall is 378 mm and average growing season rainfall is 306 mm.

The soil type is a highly alkaline grey calcareous sandy loam with a rooting depth of 60 cm where a class III carbonate layer restricts further root development.

***Scrub***

This is native scrub that has never been cleared and consists of an open Mallee and Tea-tree overstorey, with mixed chenopod (e.g. saltbush) shrubby understorey. There are few, if any, grasses in this scrub and over the years there may have been a slight build up of soil due to deposition of sand from wind erosion. The area has been fenced off from grazing for the past 30 years, though stock currently have access through an old fence. This paddock represents the natural state of the soil, plant diversity, compaction and root disease levels of the Gibson Peninsula. It provides us with a 'control' against which to assess the sustainability parameters of our farming systems.

***Long-term pasture***

The paddock is set stocked with sheep for an eight-month period each year. It was only cropped once in the last 15 years (1998) when barley was sown as feed with approximately 7 kg P/ha. At this time the paddock had only received two tillage operations.

The land was cleared relatively recently (1970s) and it has not been burnt for at least 25 years.

The system is based on annual pasture regeneration with low inputs and no pasture improvement, no herbicides used and no fertilisers added (except in 1998).

**Best practice**

*Farmer comment:*
'I have noticed pasture production and ground cover declining which is creating an erosion risk especially on the tops of sand hills, but inputs are all relative to outputs in terms of sustainability. The sampling area chosen is probably not typical of my light sandy country'.

***Crop–pasture***

This is a no-till system based on three years of crop followed by two years of pasture. It was last burnt in 1995 and medic was spread in 1990 to increase the legume component. Livestock are part of this system, with strategic grazing prior to cropping. The land has been cleared for at least 70 years, and in recent times 12–14 kg P/ha and 5–10 kg N/ha has been applied with the crop. Zinc has been applied as a foliar spray.

*Farmer comment:*
'This paddock has a good medic history, always yields well and has a dark colour to the soil'.

***Intensively cropped***

This is a minimal tillage system based on intensive cropping with six crops in the last eight years. It was last burnt in 1995 and a prickle chain may be used at sowing or three days post-sowing. Stubble is grazed over the summer period. The land has been cleared for at least 70 years, and in recent times 12–14 kg P/ha and 5–10 kg N/ha have

Farming Systems

been applied with the crop. Zinc has been applied to the system as a soil spray and regularly as a foliar spray.

*Farmer comment:*
'A very productive paddock with no erosion risk since minimum tillage. It wets up easily but there is an issue with snails and herbicide resistance'.

# What did we find?

## Weeds and plant diversity

***Scrub***

No environmental weeds were recorded in this system and the diversity of species, structure (overstorey, midstorey, understorey) and age classes indicate that this system, without excess grazing pressure, is maintaining viability.

***Long-term pasture***

Plants classified as a weed in a cropping system may be identified as an important pasture plant in this system. Lincoln weed, wild oats and barley grass are examples of this. The plant range here is predominantly barley grass, wild oats, medic, Guilford grass, Lincoln weed and brome grass. There is evidence of native spear grass becoming the dominant pasture plant, a beneficial summer-dominant species that can be linked to the low input regime of this paddock.

Pasture production is diminishing especially on the heavier soil type where medics are declining and Guilford grass is dominating. In comparison to the other paddocks, there appears to be much less brome grass and Lincoln weed in this paddock, and certainly no melon issues.

***Crop–pasture***

Herbicides play an important role in this system with pastures spray topped for two years before cropping and with a knock down used at sowing. Lincoln weed resistance to SU herbicides meant the use of these herbicides stopped in 2004. In crop, there are no grass weed issues and the pasture phase can be up to 95% medic dominant.

***Intensively cropped***

Herbicides play a far more important role in this system compared to the crop–pasture paddock. There is an issue with rye grass and brome grass in crop, which is why a double knock herbicide program has been adopted prior to sowing. Lincoln weed developed resistance to SUs and these herbicides have not been used since 2004. Melons have become a problem in this paddock.

## Ground cover and erosion risk

Ground cover and erosion risk was assessed in each paddock in autumn and spring (Figure 1) to identify any variation between farming systems. No erosion was sighted on any of the paddocks during the assessment.

***Scrub***

Erosion risk = 2 (low)

This paddock exhibited the highest average vegetation cover and conversely, the lowest percentage of bare area of all paddocks. Accordingly, the erosion risk has been scored as low, with any possible risk being attributed to overgrazing the sandy soils in the future. Such a result is to be expected from an uncleared and fenced site.

***Long-term pasture***

Erosion risk = 4 (moderate)

The long-term pasture site had significant bare areas during the autumn assessment with contrasting high vegetation and litter cover in spring, reflected in the moderate erosion risk score. There is an increasing risk of erosion with cover diminishing from sheep camping on hills and deep ruts from sheep tracks. Typically, in paddocks like this it has been difficult to achieve an even sowing pattern in the first year of crop.

***Crop–pasture***

Erosion risk = 5 (high)

This paddock has a higher risk of erosion due to the exposure period of soils following cultivation and also during the initial pasture phase due to lower starting cover from cropping. The cover in this paddock was consistently low, with bare areas dominant during autumn and litter ground cover only exceeding bare ground in spring. Management strategies such as no burning and minimal tillage have generally reduced the erosion risk, but the higher ground is still prone to soil movement. Harvesting as low as possible with a full header width straw spreader is believed to benefit the system by achieving even cover and organic matter breakdown.

***Intensively cropped***

Erosion risk = 5 (high)

This paddock has a high risk of erosion due to the frequent cropping regime and the risk of erosion during each seeding. This paddock maintained good levels of vegetation and litter cover through spring and autumn. There is a concern that the removal of grasses with continuous cropping will be a production barrier if a pasture phase was introduced into the system.

## Pests and invertebrates

Since burning stopped, snails have become a problem in all paddocks, but it is the cropping systems that bear the cost due to baiting and harvest downgrading. Over the last few years there has been an increase in pests damaging newly emerging cereal crops up to eight weeks post-seeding. This has mainly been the native weevil (*Polyphrades laetus*) and has created a reliance on insecticides.

The soil surface invertebrate trapping program undertaken for this project is still under analysis, with further samples to be collected in 2007.

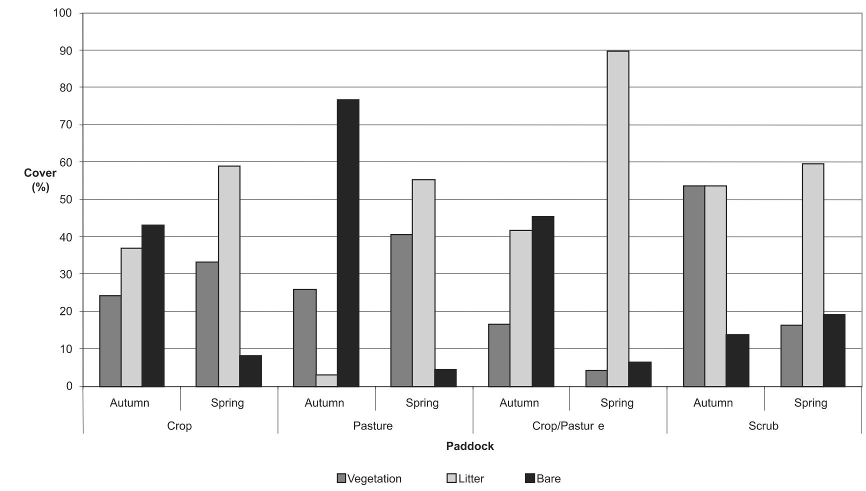


***Figure 1 Cover assessment across four paddocks at Streaky Bay, 2006.***

## Root disease

#### *Scrub*

This soil has low levels of all root diseases, which can probably be attributed to lack of grass or host type weeds (Table 1).

#### *Long-term pasture*

Shows high levels of *Rhizoctonia* and low levels of all other diseases. The wild oats and ryegrass-based pasture with no soil disturbance and no zinc addition would have increased *Rhizoctonia* risk.

#### *Cropped paddocks*

Both of these paddocks have a greater range of root disease in what could be called a trend of higher risks. It seems that cereal farming on this soil type and in this environment increases disease risk, which requires careful management to reduce its impact on productivity and profitability.

The farmer's perception was that both paddocks had *Rhizoctonia*, with crop–pasture having less than intensively cropped.

## Potential disease suppression bioassay

Disease suppression is the ability of the soil microbial population to compete with and inhibit plant pathogens such as *Rhizoctonia* and Take-all. The disease suppressive activity of a soil depends on the microbial community structure, the populations of microbes and their activities. A bioassay was undertaken to give an indication of the potential of the microbial population in the soil to respond to added carbon and compete with the pathogen, therefore lowering the level of *Rhizoctonia* disease on the seedlings (see 'Eyre Peninsula Disease Suppression Research Update' in the Disease section of this manual; Table 2).

These results suggest that the crop–pasture paddock shows the greatest potential to suppress *Rhizoctonia*, whereas the intensively cropped paddock has a very poor suppressive ability and would suffer from Rhizoctonia damage provided that sufficient inoculum was present. The scrub and long-term pasture paddocks both exhibited some potential suppressive ability.

## Soil compaction

All paddocks were checked for the presence of soil compaction using a penetrometer (an instrument which estimates the strength of the soil; Figure 2).

The strength of all soils increased with depth but it was only in those under agricultural production that strength increased to levels that would restrict root growth (Figure 2). Within the soils under agricultural production, both paddocks with frequent cropping had soil strengths that increased to restrictive levels by 10 cm below the surface. In the permanent pasture paddock, this level of soil strength was not reached until 25 cm below the surface.

There was no evidence of surface compaction (0–10 cm) in any of the farming systems even though some people have the perception that livestock will cause this to occur. Confirmed compaction by livestock has generally been on heavier, higher rainfall soils. On light, sandy soils, a single tillage pass will alleviate any compaction caused by livestock (Peter Walsh, Agricultural Engineer, pers. comm., EPARF Tillage Day, 2004).

The cropped paddock showed a profile of soil strength typical for soils that have had to bear repeated passes of heavy machinery. Wheels with high load will often cause compacted layers approximately 20 cm below the soil surface.

These results suggest that the physical condition of highly alkaline grey calcareous sandy loams is reduced under agriculture and that this effect has been most pronounced in systems with a history of frequent cropping. However, it is still uncertain whether these decreases in soil physical condition are causing declines in plant productivity.

These compaction measurements support the outcomes of the 2004 Upper Eyre Peninsula soil compaction survey (EPFS Summary 2005, page 117), where 18 out of 19 properties surveyed had more compacted soil under their cropping land than under adjacent uncropped land.

## Grain quality

The crop–pasture paddock had good grain protein and quality, and grain yield averaged 0.91 t/ha. The intensively cropped paddock averaged 1.0 t/ha with good grain quality but has a trend of decreasing protein. The protein level has never been less than 10%.

## Soil fertility

Soil fertility is a good indication of the sustainability of a system and the comparisons between the paddocks are very interesting (Table 3 and 4).

#### *Phosphorus*

The levels fit the application histories of the various paddocks, with the intensively cropped paddock having the highest P level and the long-term pasture paddock having the lowest (Table 3). If comparing the long-term pasture and the scrub (22 mg/kg), which has had no phosphorous, it suggests that phosphorus levels are decreasing in the crop–pasture paddock. The pasture production would be seriously affected, putting the sustainability of the system at risk.

It is interesting to see that total phosphorus levels are high in the scrub area, which suggests that this soil type has high background levels of phosphorus, much of which is unavailable.

#### *Calcium carbonate*

Levels are high throughout the profile and it is the 'nature of the beast' that limits production in this district. Soil carbonate levels are inherent and cannot be altered.

#### *Trace elements*

The history of zinc fertilisers (soil and foliar) has resulted in the highest DTPA zinc levels in the intensively cropped paddock. Other paddocks have low zinc levels for wheat (DTPA Zn <0.8). The crop–pasture paddock, which has only had foliar sprays of zinc, is marginal for barley (DTPA Zn 0.4–0.9).

#### *Soil salinity*

Using the indicator of conductivity, the highest salinity levels are in scrub and long-term pasture (Table 4). The long-term pasture paddock has higher salt levels than the cropped paddocks. It has been observed that there are more magnesia patches on this paddock now, particularly on the heavier ground.

The scrub has very high soil salt levels throughout the profile and this may be due to the trapping of salts from sea spray, and salt bulges under native vegetation through lower leaching and draining.

***Soil boron***

Boron levels were consistently low throughout the profile on all paddocks however there was a trend for higher levels in the scrub and long-term pasture, which also had higher soil salinity.

***Organic carbon***

All levels are good for this soil type but those for the cropping and grazing systems are substantially lower than the scrub area. Comparisons between the paddocks would suggest that current farming practices have decreased the organic carbon status but it is unknown if that trend is continuing or has stabilised under agriculture.

***Nitrate nitrogen***

This is the nitrogen pool immediately available for plant growth, and levels vary from 41 to 183 kg N/ha in the profile (Table 4). The crop–pasture system is the highest (183 kg/ha) and indicates a good sustainable system from a nitrogen–organic carbon viewpoint. The lack of medic in the scrub and the long-term pasture paddocks is reflected by lower levels of available nitrogen (Table 4).

## What does this mean?

For the interpretation of this study we need to assume that the scrub area is the benchmark.

The cropped paddocks require careful management due to herbicide resistance, snails and insect pests which, if ignored, may lead to the system becoming less sustainable. These issues have increased since no tillage and no burning has been adopted, but those practices are required to minimise any further erosion risk especially at autumn time.

The long-term pasture paddock has different plant species with less Lincoln weed and brome grass than the two cropping paddocks, which suggests that set stocking (during winter months) reduces the influence of those

***Table 1 Comparison of DNA root disease risk levels at Streaky Bay, 2006.***

| | CCN | Take-all | Rhizoctonia | *Pratylenchus neglectus* | *Pratylenchus thornei* | Crown Rot | Common Root Rot |
|---|---|---|---|---|---|---|---|
| **Scrub** | BDL | BDL | BDL | Low | BDL | BDL | Low |
| **Long-term pasture** | BDL | BDL | High | Low | BDL | BDL | BDL |
| **Crop–pasture** | BDL | Low | Med | Med | Low | Low | Low |
| **Intensively cropped** | BDL | Low | High | Low | BDL | Med | Low |

*(BDL = Below detection level)*

***Table 2 'Potential' disease suppression of Rhizoctonia at Streaky Bay, 2006.***

| | Scrub | Long-term pasture | Crop–pasture | Intensively cropped |
|---|---|---|---|---|
| **Potential disease suppression** | 0.82 | 0.66 | 1.05 | -0.21 |

***Table 3 Comparisons of soil nutrient levels at 0–10 cm, Streaky Bay, 2006.***

| Nutrient | Scrub | Long-term pasture | Crop–pasture | Crop |
|---|---|---|---|---|
| **Extractable P (mg/kg)** | 22 | 11 | 28 | 56 |
| **Total P (mg/kg)** | 499 | 419 | 516 | 614 |
| **Extractable S (mg/kg)** | 18 | 46 | 15 | 22 |
| **Extractable K (mg/kg)** | 293 | 177 | 304 | 198 |
| **pH (water)** | 8.4 | 8.6 | 8.6 | 8.5 |
| **Organic carbon (%)** | 3.5 | 2.2 | 1.6 | 1.9 |
| **Total nitrogen (%)** | 0.27 | 0.16 | 0.16 | 0.16 |
| **Carbon:nitrogen ratio** | 12.8 | 13.5 | 10.3 | 11.6 |
| **DTPA zinc (mg/kg)** | 0.21 | 0.23 | 0.46 | 1.81 |
| **DTPA copper (mg/kg)** | 0.16 | 0.27 | 0.21 | 0.17 |
| **DTPA manganese (mg/kg)** | 1.83 | 1.04 | 1.97 | 2.54 |

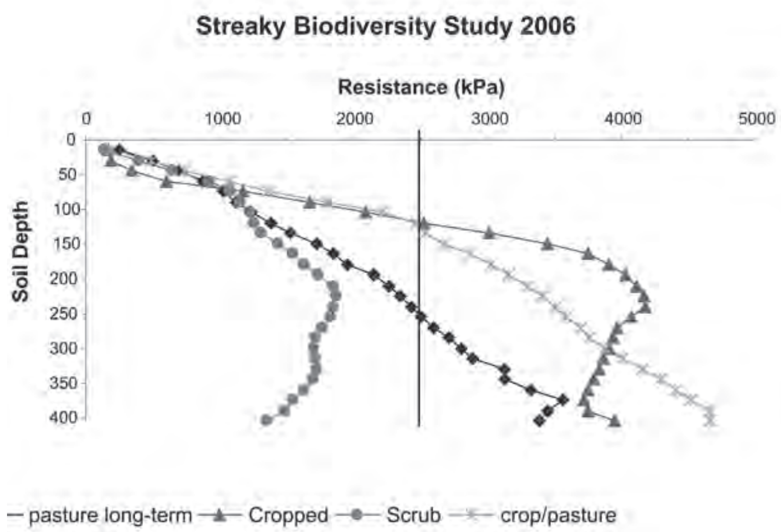


***Figure 2 Penetrometer resistance in the top 400 mm of soil in each of the four paddocks. Resistances greater than 2500 kPa will normally restrict root growth.***

weeds. However, the long-term pasture has issues with increasing prominence of less productive species such as spear grass and Guilford grass. This may be symptomatic of low soil fertility and high soil salinity, which is negatively affecting pasture production, pasture composition and inevitably carrying capacity. This may lead to less vegetative cover and create a soil erosion problem in the future. The farmer has already identified this and is instigating a program of sowing cereals to 'freshen up' these paddocks and improve pasture quality and quantity.

The crop–pasture paddock has the greatest potential for suppression of root diseases. Agriculture appears to have increased disease risk when compared to the scrub area. The farmer commented that the root disease *Rhizoctonia* is his major yield-limiting factor after rainfall in his cropping program.

Soil compaction has developed with agriculture to a stage where it is slowing root growth, but its effect on sustainability is unknown.

Unlike the scrub and long-term pasture, the crop–pasture and intensively cropped paddocks appear to have no major soil fertility issues and they have improved compared to the scrub area.

***Table 4*** ***Comparisons of soil salinity, nitrogen, boron and calcium carbonate in the soil profile to 60 cm, Streaky Bay, 2006.***

| Soil depth (cm) | Nitrogen (kg N/ha) | $CaCO_3$ (%) | Boron (mg/kg) | Chloride (mg/kg) | Conductivity (dS/m) |
|---|---|---|---|---|---|
| **Scrub** | | | | | |
| 0–10 | 31 | 77 | 2.3 | 833 | 0.61 |
| 10–20 | 6 | 85 | 2.6 | 3056 | 2.13 |
| 20–40 | 5 | 87 | 2.7 | 2943 | 2.17 |
| 40–60 | 2 | 92 | 3.6 | 2330 | 1.74 |
| **Long-term pasture** | | | | | |
| 0–10 | 28 | 76 | 2.2 | 3 | 0.45 |
| 10–20 | 6 | 80 | 2.9 | 118 | 0.23 |
| 20–40 | 5 | 86 | 4.2 | 164 | 0.21 |
| 40–60 | 2 | 85 | 5.5 | 293 | 0.32 |
| **Crop–pasture** | | | | | |
| 0–10 | 47 | 75 | 1.4 | 63 | 0.23 |
| 10–20 | 47 | 84 | 1.5 | 97 | 0.24 |
| 20–40 | 48 | 86 | 1.4 | 86 | 0.20 |
| 40–60 | 41 | 85 | 1.6 | 122 | 0.20 |
| **Intensively cropped** | | | | | |
| 0–10 | 49 | 77 | 1.6 | 101 | 0.25 |
| 10–20 | 23 | 84 | 1.6 | 43 | 0.16 |
| 20–40 | 10 | 84 | 1.8 | 28 | 0.14 |
| 40–60 | 7 | 86 | 2.0 | 33 | 0.15 |

## Acknowledgements

The Streaky Bay farmer cooperators are thanked for their support and patience when we have been sampling and monitoring their paddocks. Thanks to Ben Ward and Wade Shepperd for conducting the fieldwork, and the funding bodies who provided the resources to enable this study to happen. The national Biodiversity in Grain & Graze (BiGG) project is thanked for sample analysis. EPFS funded the research.

Government of South Australia
Eyre Peninsula Natural Resources Management Board

# Minnipa Farming Systems Competition — Proudly sponsored by AWB

**Michael Bennet[1], Neil Cordon[1] and Bruce Heddle[2]**

[1]SARDI Minnipa Agricultural Centre, [2]Farmer, Minnipa

Demo

**Best practice**

**Location:**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 1.01 t/ha (wheat)
Actual: 0.81 t/ha

**Plot size**
2.5 ha

**Soil type**
Red calcareous sandy clay loam

## Key messages

- **Consultants grew the best wheat crop in 2006.**
- **Researchers unsuccessfully apply for EC (Exceptional Commiserations).**
- **District practice continues as a quiet achiever.**

## Why do the trial?

The farming systems competition started in 2000 to compare the impact of four management styles on production, profitability and sustainability at the MAC.

## How was it done?

The competition is divided into four separate teams, each with a 2.5 ha paddock to manage. The teams are the local researchers, 'Starship Enterprise'; local farmers, 'Not Too Cocky Cockies'; local consultants 'De$parately $eeking $olutions'; and district practice.

## What happened?

What happened? That's exactly what the researchers are asking themselves while scratching their heads in dismay. What do we need to say about 2006, except that it started exceptionally wet and finished exceptionally dry. With optimism in the air, the various teams formulated their strategies for the season.

Having learnt a lesson from the farmers in 2005, the researchers followed their lead by planting medic pasture. A low risk strategy you might think, but no. Our enterprising researchers were on track to take advantage of what was looking like an exceptional season, by planting certified Angel medic, quite a bold move by our humble researchers.

The less adventurous members of the competition took a somewhat more boring approach to the season by planting wheat. They planted their paddocks early, which was the greatest driver of yield in 2006. The previous season offered the consultants, district practice and farmers the opportunity to clean up a few weeds (with peas and pasture) and get back into some profitable cereal production.

Comments from Dr Margaret Evans regarding how crown rot levels have changed under each system from 2005 to 2006 are provided in Section 8 — Disease.

## What did we learn last year?

### Team 1
### The Farmers (Not Too Cocky Cockies)

***Team motto: To farm profitably today, while giving our kids the chance to do the same tomorrow.***

Murphy once again visited the farmers of Australia, and the 'Not Too Cocky Cockies' were not spared. All we can say is that our conservative inputs and moderately successful crop at least minimised our losses! The returns of the livestock enterprise, which we have stuck with over the last six seasons, have contributed to our accumulated profits. We just don't have the stomach for a major exposure to 'broke' crops in the current environment, and are pretty sure the running gross margins justify our severe risk aversion.

***2007 plans***

Now for the question at the front of most grower's minds at the moment — How do we regroup and make the most of the next growing season?

For a start, we graze the stubble to ensure that a livestock component continues to exist on 'the farm', remove the few summer weeds that may show up and get rid of as much mouse food as possible, generally adding a bit of diversity to the system.

The plan is to sow another cereal crop, probably Wyalkatchem wheat, with conservative inputs and one pass crop establishment. A little grass remains in our system, and we will need to keep this in mind, given the pathetic competitive ability of Wyalkatchem.

From then on, it will be a matter of monitor the crop and hope nothing goes wrong; then panic as efficiently as possible when it does! This is supposed to be as much like a real farm as possible.

## Team 2<br>The Consultants<br>(De$parately $eeking $olutions)

***Team motto: If we get trounced, please blame Ed Hunt.***

When we sat down to make a decision on our paddock, we all agreed that wheat should follow our profitable field pea crop of 2005. Next decision was to select a variety, with a choice between Yitpi and Wyalkatchem. We chose Wyalkatchem since it has a seven-year yield advantage over Yitpi, and again in 2006 it came through with a 14% yield advantage over Yitpi. The area was sprayed with a Logran–Trifluralin–Powermax mix mainly in response to the knowledge of a caltrop issue and wanting to show that we are responsible managers.

Our decision to treat the seed only for smut protection was made based on Wyalkatchem's traits of short coleoptile length and low susceptibility to stem rust. A foliar spray could be used as a fall back for stripe rust. As advisers we were concerned about the sowing machine used, as the early emerging crop was slow, poor and patchy and as a result could have affected our dry matter production, weed competition and final yield. We would advise the farmer to spend some time prior to seeding in 2007 to improve the seed placement of the machine. For the second year in a row we feel our advice has been around the mark on production with financial figures to back us up!

***2007 plans***

Our initial thought is to sow wheat again with consideration given to the residual herbicide available to us, and the forecast wheat price for the 2007 harvest. We will take a pre-sowing deep nitrogen test to fine tune our nitrogen inputs.

***Table 1 MAC Farming Systems Competition Summary, 2001–06.***

| Year | Date | Farmers | Consultants | Researchers | District practice |
|---|---|---|---|---|---|
| 2001 | | Yitpi wheat<br>Yield: 2.75 t/ha, Prot: 13.6%,<br>Scrn: 5.6%, TW: 75.4,<br>GM = $600/ha | Yitpi wheat<br>Yield: 2.77 t/ha, Prot: 11.6%,<br>Scrn: 4.6%, TW: 75.4,<br>GM = $572/ha | Frame wheat<br>Cut for hay<br><br>GM = $207/ha | Yitpi wheat<br>Yield: 2.79 t/ha, Prot: 12.3%,<br>Scrn: 4.9%, TW: 75.6,<br>GM = $575/ha |
| 2002 | | Krichauff wheat<br>Yield: 1.48 t/ha, Prot: 12.4%,<br>Scrn: 1%, TW: 77.2,<br>GM = $316/ha | Krichauff wheat<br>Yield: 1.25 t/ha, Prot: 11.8%,<br>Scrn: 3.3%, TW: 74.4,<br>GM = $231/ha | Barque barley<br>Yield: 1.36 t/ha, Prot: 11.4%,<br>Scrn: 34.8%, TW: 72.6,<br>GM = $195/ha | Grazed pasture<br><br><br>GM = -$4/ha |
| 2003 | | Krichauff wheat<br>Yield: 1.21 t/ha, Prot: 13%,<br>Scrn: 4.1%, TW: 76,<br>GM = $163/ha | Krichauff wheat<br>Yield: 0.99 t/ha, Prot: 12.1%,<br>Scrn: 5.6%, TW: 77.2,<br>GM = $118/ha | Rivette canola<br>Yield: 0.50 t/ha, Oil: 40.7%,<br>Foreign: 5.7%, TW: 64.2,<br>GM = $90/ha | Yitpi wheat<br>Yield: 0.85 t/ha, Prot: 14.3%,<br>Scrn: 5.9%, TW: 78.6,<br>GM = $117/ha |
| 2004 | | Wyalkatchem wheat<br>Yield: 1.01 t/ha, Prot: 13.3%,<br>Scrn: 7.8%, TW: 74,<br>GM = $84/ha | Keel barley<br>Yield: 1.35 t/ha, Prot: 12.4%,<br>Scrn: 32.8%, TW: 58.4,<br>GM = $67/ha | Yitpi wheat<br>Yield: 1.25 t/ha, Prot: 11.7%,<br>Scrn: 6.6%, TW: 77.2,<br>GM = $132/ha | Krichauff wheat<br>Yield: 0.82 t/ha, Prot: 16.3%,<br>Scrn: 26.9%, TW: 68.2,<br>GM = $41/ha |
| 2005 | | Toreador medic<br>793 grazing days<br><br>GM = $11/ha | 319 grazing days<br>Kaspa peas<br>Yield: 1.57t/ha,<br>GM = $83/ha | Wyalkatchem wheat<br>Yield: 1.98 t/ha, Prot: 9.8%,<br>Scrn: 3.2%,<br>GM = $108/ha | Regenerated pasture<br>764 grazing days<br><br>GM = $53/ha |
| Running gross margin after 2005 | | $1117 ☺ | $1049 ☺ | $720 ☹ | $772 ☺ |
| 2006 | 3 April | Cultivated | Ploughed | Roundup Powermax @ 800 ml/ha + ammonium sulphate + Striker @ 75 mL/ha | Ploughed |
| | 11 May | Logran @ 30 g/ha + LI700 @ 50 mL/ha + wetspray @ 50 mL/ha | Roundup Powermax @ 800 mL/ha + TriflurX @ 800 mL/ha + Logran @ 30 g/ha | Roundup Powermax @ 800 mL/ha + ammonium sulphate + Oxen @ 70 mL/ha + Ally @ 5 g/ha | |
| | 11 May | Yitpi @ 50 kg/ha + 18:20:01 @ 40 kg/ha + Triad | Wyalkatchem @ 70 kg/ha + 18:20:0:1 @ 40 kg/ha + urea @ 22 kg/ha | Angel medic @ 10 kg/ha + 18:20:01 @ 50 kg/ha | Yitpi @ 50 kg/ha + 18:20:01 @ 45 kg/ha |
| | 5 July | 1.25 kg/ha zinc sulphate | 1 kg/ha zinc sulphate | Tigrex @ 50 mL/ha + Targa @ 150 mL/ha + ammonium sulphate + BS1000 | Tigrex @ 500 mL/ha + wetspray @ 125 mL/ha + 2 L/ha Zincsol |
| | | | | Targa @ 350 mL/ha + ammonium sulphate + BS1000 | |
| | | Wyalkatchem wheat<br>Yield: 0.71 t/ha, Prot: 15.5%,<br>Scrn: 3.8%, TW: 79.2,<br>GM = $26/ha | Wyalkatchem wheat<br>Yield: 0.81 t/ha, Prot: 14.4%,<br>Scrn: 2.1%, TW: 80,<br>GM = $22/ha | No harvest!<br><br><br>GM = -$166/ha | Wyalkatchem wheat<br>Yield: 0.60 t/ha, Prot: 17.4%,<br>Scrn: 7.4%, TW: 77,<br>GM = $1/ha |
| Running gross margin after 2006 | | $ 1143 ☺ | $ 1071 ☺ | $ 553 ☹ | $773 ☹ |

### Team 3
### The Researchers (Starship Enterprise)

***Team motto: Boldly going where no man has gone before.***

Applying a high-risk farming operation in a season with almost the lowest growing season rainfall on record was quite an outstanding piece of risk management. Prior to ANZAC day, the researchers were discussing how to claw their way back to victory. Several options were put on the table, including canola, hay, another wheat and certified medic. Certified medic was settled on as it offered the greatest upside in terms of gross margin (if the season was conducive to medic production).

Currently the researchers are considering what to do with their disaster paddock. The neighbours have offered quite reasonable money for the land and we are considering all options. We may however hold out for another season yet, but clawing back the gross margin will be quite a challenge.

Not to be outdone, other agronomy problems plagued the humble researchers. A sensor falling off the spray unit helped the researchers apply half the rate of grass herbicide to the paddock, which unsurprisingly didn't result in a weed kill. A second application was made to the weeds already stressed from the initial treatment, which by that stage were suffering from moisture stress. Needless to say, the weeds managed to come through both applications and still set some viable seed!

***2007 plans***

Keep the creditors at bay! The first job is to ascertain wether the Angel seed out in the paddock is viable and could produce a medic stand for the coming season. If so, we'll need to order up some good early rain to get the medic mobile and produce a bumper crop of medic to harvest in 2007. If the seed is unviable, then who knows what we'll do? One suggestion included planting a certain herbicide tolerant wheat along with a modest rate of bananas, then applying a cheap herbicide to control the weeds in our banana plantation. We however, will not resort to bending the rules to gain victory in the competition; instead we would rather keep the competition going for another 50 years or more until we are finally in front!


## Acknowledgements

AWB is thanked for its continued support with the competition. Brendan Frischke, Brett McEvoy and Shane Moroney are thanked for coordinating the paddock operations.

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Agricultural Research Foundation Inc.


*Rolling the 'Starship Enterprise's' promising medic crop earlier in the season.*

# Mouse Damage in Eyre Peninsula Farming Systems

## Greg Mutze

DWLBC Animal and Plant Control Group

Information

## Key messages

- **Mouse damage to crops on Eyre Peninsula is increasingly common due to changes in farming systems, such as increased cropping, reduced tillage, trash retention and reduced livestock numbers.**
- **Any factors that increase the supply of seed available in paddocks after harvest will increase mouse numbers and damage in the following year.**
- **Zinc phosphide wheat bait (MouseOff) can be used to control damage effectively in most mouse-infested crops.**
- **Farming systems should be evaluated by including the economic impact that mouse populations and mouse damage has in the following year.**

## Historical perspective

Like it or not, mouse plagues are part of farming on Eyre Peninsula. Mouse plagues are not a new phenomenon — they have occurred throughout the cereal-growing areas of southern Australia about once every four years since the late 1800s; in South Australia about once every 5–6 years; and on Eyre Peninsula about once every 10 years. The earliest plague recorded on Eyre Peninsula was in 1904, with affected areas around Tumby Bay and from Bairds Bay to Penong (earlier events may have gone unrecorded). However, mouse problems have become much more frequent in recent times, with seven significant outbreaks on Eyre Peninsula in the last 30 years and substantial damage in several other years.

## Biology of mice in cropping areas

Mouse plagues on Eyre Peninsula are caused by the house mouse that was introduced as a stowaway by the first European colonists. However, mice originated in the arid steppes of central Asia — they are desert rodents that are very well adapted to survival in dryland cereal production. They usually commence breeding after the first early weeds set seed in September and increase in numbers until the last of the grain spilled at harvest germinates or rots after autumn rains. The main population increase in spring–summer often goes unnoticed, but it is important to recognise that mouse problems in autumn–winter usually have their genesis 6–9 months earlier.

Mouse numbers are usually limited by low survival during winter, the limited length of the breeding season and low breeding success and juvenile survival in cereal paddocks during extreme summer heat. However, any factors that increase the supply of food will increase population density at the end of the breeding season. Unseasonable seed production can also improve or extend the breeding season for mice, and hence increase peak numbers. In particular, early autumn rains can germinate weeds and volunteer crops that set seed in winter and allow mice to breed early (e.g. 1983, leading up to the 1984 plague), and late spring rains can reduce harvest efficiency and produce a flush of crop regrowth and summer weeds that provide both moisture and fresh seeds (e.g. 1992, leading up to the 1993 plague). Sometimes, just the sheer weight of crops means that there is a massive food supply irrespective of unseasonable events (e.g. 1978–79, leading up to the 1980 plague).

## Why are mouse problems getting worse?

Mouse plagues have become more frequent primarily due to changes in farming systems. Tighter crop rotations (more frequently cropping of each paddock and a greater total area cropped), less tillage, stubble and trash retention, more diverse crop types, summer legume pastures and fewer livestock all help to provide mice with better cover, undisturbed burrows, a more continuous and greater quantity of food, and more diverse food resources. Consequently, higher numbers of mice are now likely for the same given seasonal conditions, and the timing of population increase and decline has become less predictable.

In addition, more damage to crops is likely for a given number of mice. Historically, cultivation was used to control weeds. Mice reached peak numbers in autumn then had to endure a period of cultivation lasting weeks or sometimes months during which the remaining seed germinated and they suffered declining food supply, which in turn caused mouse numbers to crash. Reduced tillage delays the timing of population decline, often until after crops are sown. In addition, increased crop variety gives a prolonged period of crops at vulnerable stages. Mouse plagues are now affecting crops at stages that historically had few problems (e.g. tillering wheat, before flowering), affecting new crop types in traditional problem areas (e.g. lupins, canola), and affecting areas that have historically had few problems (e.g. the Mid North and Kangaroo Island).

The timing of population decline can vary from late autumn to spring and that has a great bearing on the type of damage that occurs. Sometimes it is quite variable across short distances. For example, crops sown early in 1993 following localised autumn storms around Parrakie (Murraylands) received little damage during crop establishment, but the mice were still there and began chewing off tillers and flowering heads. Areas that missed the autumn storms had entirely different patterns of damage (Figure 1), a difference that was observed in some properties only a few kilometres apart.

The signs of mice digging out seed grain from drill rows are obvious but damage during the vegetative growth stages prior to flowering is less easy to identify. Mice cannot digest cellulose, so they will primarily eat the parts of growing plants where nutrients are concentrated — at the growing point inside the developing cereal tillers, or at the growing tip of pulses or canola. A small hole in the side of a tiller with the top of the plant fallen over may be

Farming Systems

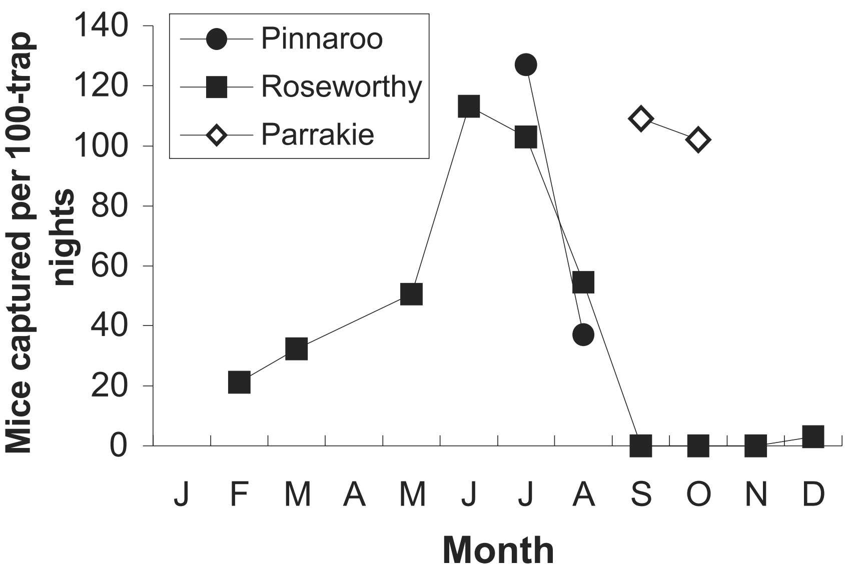



***Figure 1***
***Changes in mouse numbers during the 1993 plague at three sites. Crop establishment was severely compromised at Pinnaroo and Roseworthy but mouse numbers declined and damage ceased before flowering. Crop establishment at Parrakie was excellent but flowering heads were severely damaged. These sites were not baited during the periods shown. Trapping systems differed slightly but peak populations varied from ~500 to 1000 mice/ha at each site.***

mistaken for insect damage or disease at first glance. The level of damage can escalate dramatically at flowering so growers should check crops for evidence of ongoing damage or mouse activity and be prepared to act.

## Managing mouse damage

### Short-term control

A registered zinc phosphide sterilised-wheat bait (MouseOff, a registered trademark of Animal Control Technologies Pty Ltd) is now available to control mice in crops. The product is a major advance on previous decades when no product was registered for use. It can be purchased from S7 chemical resellers and has proven to be highly effective in most cropping circumstances. Bait can be applied at 1 kg/ha by landholders using small seed spreaders or by air-ag contractors. Technical information on how to monitor mouse numbers and use the bait has been developed by state government agencies and the bait manufacturer with GRDC support, and is readily available from the manufacturer.

The cost of baiting varies from about \$8 to \$15/ha depending on the size of the treated area and application costs. The benefit will vary depending on the level of infestation, but mouse damage can require complete reseeding, or reduce yields by >50% in a few weeks around flowering, so it is clearly economic in many circumstances. But how do growers decide when they need to use it? It is always hard to judge how many mice are in a crop and even harder to tell whether-or-not they are about to decline in the next few weeks. Nevertheless, alarm bells should be ringing wherever harvest was inefficient or lots of mice or mouse holes are visible. Various techniques can be used to monitor mouse numbers, including transect counts of mouse holes, bait cards and trapping. Each is useful but has its particular shortcomings (e.g. hole counts tend to underestimate numbers in harder versus softer soils, bait cards are ineffective after crop flowering, traps are time-consuming). Nevertheless, any technique will provide useful information that will assist farmers to judge the risk of significant damage.

### Long-term strategies

There can be no thought of abandoning minimum tillage practices but other means will have to be developed that don't rely on crisis control to manage mouse numbers. The inescapable fact is that any farming system which leaves grain for mice will promote mouse damage. This must be factored into cost comparisons of various farm management options. For example, various factors affect harvesting efficiency (e.g. harvesting speed, windrowing barley to prevent head loss in wind, collecting screenings, etc.). It is quite possible that screenings or fallen heads left behind during harvest in a year with a difficult finish could reduce yield in the following season by 0.5 t/ha, due to more mouse damage at seeding. Although modern harvesters often lack the capacity to collect screenings or have that as an expensive option, it may be a factor of far greater importance than the commercial value of the screenings themselves. One slightly contentious issue is the extent to which livestock reduce damage in the following year. Livestock-free systems are increasingly common on Eyre Peninsula but anecdotal evidence suggests that these systems are subject to more frequent and severe mouse damage and increased baiting costs. The sporadic nature of mouse damage makes it difficult to assess its economic impact with great precision, but eventually all farming systems will be evaluated by criteria that include their effect on mouse populations and mouse damage in the following season.

One further risk is that growing international sentiment against the use of acute mammalian poisons could eventually see zinc phosphide bait lost as a management option for mice, and it is unlikely to be replaced by another rodenticide. It is critical that landholders using zinc phosphide do so responsibly to protect non-target species and limit the risk of public opposition to its registration.

Government of South Australia
Department of Water, Land and Biodiversity Conservation

# Field Testing New Microbial Inoculants on Eyre Peninsula in 2006

**Nigel Wilhelm**[1] **and Sandy Gleddie**[2]
[1]SARDI Minnipa Agricultural Centre, [2]Philom Bios Australia, Waite Research Precinct

Research

## Key messages

- **The drought in 2006 constrained crop growth in the trials and restricted potential for growth and yield responses to the various treatments.**
- **Results from the two disease biocontrol trials were inconclusive as root disease levels were low and moisture stress was likely the greatest yield-limiting factor.**
- **Phosphorus (P) fertiliser improved wheat growth in two trials, but P solubilising inoculants had no impact on wheat growth.**
- **Neither P fertiliser nor P solubilising inoculants affected pulse growth in any of the three pulse trials.**
- **Granular rhizobial products show promise as an alternative to current peat-based formulations.**
- **The field-testing program will continue in 2007.**

## Why do the trials?

New microbial inoculant technologies have the potential to increase the availability of nutrients to crops, control soil-borne plant diseases, and enhance crop yields and profitability. These technologies are at various stages of research and development in Australia; however, farmers in North America have extensively used new microbial technologies such as P solubilising inoculants and granular rhizobial inoculants for a number of years.

GRDC has recently entered into joint venture arrangements with a Canadian company, which has developed and markets a wide range of microbial inoculants for North American agriculture. The new joint venture company, Philom Bios Australia, will develop and market a range of inoculant technologies from improved rhizobial inoculants to P solubilising inoculants and soil-borne disease biocontrols from research partners in Australia and abroad.

The new microbial inoculant trials established on Eyre Peninsula in 2006 were part of an extensive Australia-wide field research program assessing a number of different microbial actives and formulations across a range of soil and climatic conditions.

## How were they done?

**Biocontrol inoculants:** Two disease biocontrol trials were conducted on wheat on Eyre Peninsula in 2006 — one at Minnipa for Take-all and the other at Courela for *Rhizoctonia*. Both trials tested a number of different seed-applied biocontrol inoculants against an untreated control and a fungicide seed dressing. The *Rhizoctonia* trial was sown on 25 July into a barley crop, with many severe *Rhizoctonia* patches, which was sprayed out immediately prior to seeding. This approach was used because it is a reliable technique for producing *Rhizoctonia* in field trials. The Take-all trial was sown on 5 July (seeding delayed by late arrival of some microbial inoculants) with a low rate of artificial disease inoculum applied with the seed in all plots. Supplementary irrigation was provided for this trial to encourage development of Take-all. The plan was that irrigation would be used early in the season to create wet soils if necessary (which will promote colonisation of wheat roots by the Take-all fungus) and in early spring to promote extensive growth of the fungus into the crown of the plant. Supplementary irrigation was set up because development of Take-all is very sensitive to the pattern of rainfall in the growing season; irrigation should remove some of this uncertainty. Crop performance was monitored during the season with establishment counts post-seeding, disease infection in untreated controls at tillering, DM cuts at late tillering, and grain yield at maturity.

**P solubilising inoculants:** Two P solubilising trials were conducted on wheat on Eyre Peninsula in 2006, with both sites located on grey highly calcareous sandy loams — one at

**Searching for answers**

**Location: Wanilla**
**Rainfall**
2006 total: 402 mm
2006 GSR: 223 mm
**Soil type**
Siliceous sand over clay

**Location: Coulta**
**Rainfall**
2006 total: 396 mm
2006 GSR: 232 mm
**Soil type**
Grey calcareous sandy loam

**Location: Edillilie**
**Rainfall**
2006 total: 402 mm
2006 GSR: 223 mm
**Soil type**
Siliceous sand over clay

**Location: Mount Greenly**
**Rainfall**
2006 total: 396 mm
2006 GSR: 232 mm
**Soil type**
Grey highly calcareous sandy loam

**Location: Port Kenny**
**Rainfall**
2006 total: 333 mm
2006 GSR: 158 mm
**Soil type**
Grey highly calcareous sandy loam

**Location: Courela**
**Rainfall**
2006 total: 235 mm
2006 GSR: 115 mm
**Soil type**
Grey highly calcareous sandy loam

**Location: Minnipa**
**Rainfall**
2006 total: 236 mm + 120 mm from irrigation
2006 GSR: 111 mm + 120 mm from irrigation
**Soil type**
Red calcareous sandy clay loam

Mount Greenly and the other at Port Kenny. Both trials tested an untreated control and two seed-applied P solubilising inoculants across a range of P fertiliser rates — seed-placed applications of 0, 5, 10 and 15 kg P/ha. Crop performance was monitored during the season with establishment counts post-seeding, DM cuts at late tillering, and grain yield at maturity.

**Rhizobial inoculants:** Three rhizobial inoculant trials were conducted on pulses on Eyre Peninsula in 2006 — one at Edillilie with lupins, the second at Wanilla with faba beans and the third at Coulta with peas. The sites were chosen to be free of compatible rhizobia for the target crop based on a pot bioassay developed and conducted by Ross Ballard (SARDI Waite Research Precinct). Seed-applied peat and in-furrow granular formulations of rhizobia were applied with either 0 or 10 kg P/ha of seed-placed P fertiliser. P solubilising inoculants were also included with some of the treatments. Nodulation was scored for all treatments in one replication of each trial two months after seeding. DM cuts were taken from all plots at early flowering, and grain yield was measured at maturity.

## What were the results?

**Biocontrol inoculants:** The disease biocontrol inoculants and commercial fungicide seed dressings tested in both wheat trials generally had no effect on wheat performance. However, growing conditions were very poor at both sites and, while the target disease was present at each site, disease levels were not high and probably had little impact on grain yields — moisture stress was probably the most yield-limiting factor.

**P solubilising inoculants:** Under the very trying conditions of 2006, when wheat in both trials struggled to develop and fill grain in spring, neither of the two P solubilising inoculants produced any benefit to wheat growth. However, there was a strong response in wheat growth to increasing rates of P fertiliser at both sites, despite the poor finishing spring. Conditions for microbial colonization at establishment were good, as the soil was wet at both sites at planting; however, dry conditions shortly after establishment may have restricted the growth and function of the P inoculants. In addition, both sites were on grey highly calcareous soils that were extreme in soil pH and P-fixing ability.

**Rhizobial inoculants:** These three rhizobial inoculant trials provided only limited screening of the effectiveness of the new rhizobial inoculants because nodulation was absent in the nil control in only one of the three trials. In the other two trials, compatible rhizobia were already present in sufficient numbers in the soil to produce initial nodulation in the nil controls, and dry conditions after establishment may have restricted potential for growth and yield responses to the rhizobial inoculants. However, in the trial that was an effective screen (beans at Wanilla), the new peat and granular products were equally effective to the current industry standard. Application of P fertiliser or adding P solubilising inoculant to some of the rhizobial inoculants had no impact on crop growth in these rhizobial inoculant trials.

## What does this mean?

The new microbial inoculant field-testing program will continue in 2007 and hopefully conditions will be gentler on the crops (and the microbes!), which may give these new inoculants more opportunity to exert a beneficial impact. Improved strains and formulations will be tested in 2007 on a wider range of soils to continue to determine the best fits for these new technologies in Australian broadacre cropping.

## Acknowledgements

Many thanks to Terry Blacker and Ian Richter for their expert management of the trials, and to Shane Kelsh (Courela), MAC staff (Minnipa), John Giddings (Mount Greenly), Simon Guerin (Port Kenny), Matt Nelligan (Edillilie), Brian Foster (Coulta) and Barry Lienert (Wanilla) for provision of land for the trials. Thanks also to Ross Ballard for conducting the rhizobial bioassays and for advice on scoring pulse roots for nodulation.

# Section 6

**Section editor:**
**Amanda Cook**
SARDI
Minnipa Agricultural Centre

# Risk Management

## 2006 — A Year to Leave Behind but Not to Forget

**Dr Nigel Wilhelm and Geoff Thomas**
Low Rainfall Collaboration Project

Extension

Nobody is going to argue that 2006 was a disastrous year for agriculture in southern Australia. After a dream start in most areas, many farmers were saying that 'the crop went in the best it had for years', but the absence of useful follow up rain, and in some cases damage due to frost, was a bitter pill to swallow.

The 2006 winter crop produced only about one-third of the tonnage produced in 2005 (which was not a spectacular year for the nation either), and the Australian Bureau of Agricultural and Resource Economics has warned that $6.2 billion will be wiped from the value of farm production, a 35% decrease. The bureau further predicted that the drought would cut the country's predicted economic growth by 0.7 percentage points this financial year.

Nevertheless, many of us were amazed at how well the crops hung on despite the lack of rain and plenty of hot winds in spring. So to dismiss this as a year to be forgotten as quickly as possible would do farmers a grave injustice and bury some very valuable lessons.

We suggest that if the 2006 season had been experienced 30 years ago for example, the impact on the economy and the environment would have been far more dire.

So why was production in 2006 relatively better?

There were climatic factors. Some farmers were lucky enough to have some stored soil moisture from summer rains; others believe that the heavy frosts in June slowed the crops so that they produced fewer tillers and less biomass which enabled them to cope better with the tough spring. In other cases, the lack of windy conditions in winter meant that crops were not cut nor did they lose as much moisture. All of these factors were probably important.

But they don't explain why current farming systems produced better crop yields than those of the 1970s, especially the impressive differences in crop performance on the lighter soils. (No doubt, important gains have also been made on heavy soils and these gains are setting up much larger yield potentials in these areas, but in a season like 2006, their realisation was probably little better than they would have been in the 1970s, especially in the lower rainfall areas, simply because they ran out of moisture altogether.)

Our conclusion is that production in 2006 was better, particularly on the lighter soils, mainly because of **early seeding and better use of soil moisture.**

The background to such a conclusion is quite complex, and there are several reasons for the dramatically improved performance:

- The first was the introduction of cereal cyst nematode (CCN)-resistant cereal cultivars. This gave farmers a low cost and easy to manage entry into controlling this scourge of the sandy soils of southern Australia. The improved production which followed these substantial reductions in CCN infections provided farmers with the cash flow to embark on reducing the second major bottleneck to productivity.
- Superior grassy weed control. Tools such as grass-selective herbicides and spray-topping pastures (especially important in low rainfall districts because of their lower cost and better fit in their systems) controlled another major bottleneck to increased productivity on these soils, namely grassy weeds. Although these techniques are also used on heavy soils, their impacts have been most dramatic on sandy soils which are the preferred environment for a range of particularly difficult to manage grassy weeds (e.g. the brome grasses).

**Best practice**

Although both of these developments have generated enormous direct benefits in productivity (and usually profitability), their indirect impact of increasing the opportunities for **earlier seeding** are probably even more important, and very obvious in 2006.

Research has clearly demonstrated that in the temperate and Mediterranean climates of southern Australia where crops are maturing under increasingly hotter and drier conditions, early seeded crops will generally outperform those sown later. However, in 2006 on light soils, the benefits of early seeding were spectacular. Every district has stories of paddocks that produced economically positive yields right next to ones which were written off, and the only apparent difference was the time of seeding.

Tools such as grass-selective herbicides, pasture and crop-topping, herbicide-tolerant crop cultivars and no-till have all had a major influence on crop productivity and profitability by increasing the opportunities for seeding crops on the opening rains. This increases the length of the effective growing season for the crop, regardless of how the rest of the season plays out, and means that the crop has every opportunity to access stored and in-season water before losses occur to weeds, evaporation and drainage.

Other tools such as wider seeders, more powerful tractors, guidance systems and auto-steer, more efficient boom spray units and better adapted crop cultivars have all added value to this fundamental change in farming systems since the 1970s. In the 1970s, there were very few situations where farmers could seed right on the opening rains because limited weed and disease control options meant that weed and disease control prior to seeding, often through cultivation, were essential for a productive crop. These days, even dry seeding of crops prior to the opening rains is a viable option for some situations. This gives the crop the entire growing season in which to grow and mature.

Another major benefit of the current farming systems, especially on the lighter soils, is the prevention of erosion. Even though the 2006 season was the driest on record for some districts in southern Australia (and in the bottom 10% for nearly all districts), most surveys of land condition suggest that land condition is remarkably good. This is the indirect spin-off from improved productivity (more biomass above and below the soil to protect the soil surface from wind and water erosion) and less 'disruptive' crop establishment techniques (e.g. direct seeding with narrow points or discs). These benefits are important not only for long-term sustainability, but also politically as those outside farming seek to regulate practices in the interests of the environment.

There have of course been other technical developments that have improved productivity.

Crop nutrition has improved with better understanding of plant demand at different growth stages, and improved soil and plant analysis which enables the farmer to better match fertiliser supply to plant demand.

There is a wider range of varieties to suit various situations, including improved drought tolerance. Farmers are now better able to match crop decisions to the season, as well as the soil type.

So in many respects, whilst farmers have every reason to feel disappointed with 2006, they should reflect on just what has been achieved since the 1970s.

However, there is still much to do.

Although these developments have produced major improvements in productivity and in most cases profitability, many have involved increased risk (because they require increased investment in plant and raise input costs). The balance between increased revenue and increased costs is a dynamic one but generally has tightened as costs have increased relative to prices received.

Yes, technology will continue to play a role with new varieties with greater drought tolerance, new ways to conserve and better use soil water, better marketing systems, and the more profitable integration of livestock into the system.

But there is a need for greater attention paid to the containment of costs as farmers seek to generate reasonable profits at an acceptable level of risk. There will be greater attention to the economic rather than the technical aspects of farming businesses.

It will be increasingly important to achieve the right balance for the given season and environment. There is no such thing as the best farm system, even in a given area. What is good for one farmer will not suit another because of a different ability, capital structure, borrowings, attitude to risk, family situation, or simply how hard they wish to work.

This is where farming systems research is playing a vital role. The partnership of researchers with farmers through farming systems groups has become a vital cog in the adaption of research results and their adoption into commercial practice, and they will continue this role into the future.

As climate change imposes more changes and pressures on agriculture, farmers will need to continue their evolution of current farming systems, particularly with respect to exposure to risk and optimising the conversion of water into a saleable commodity every year. Farming systems research with farmer groups will be in the vanguard developing these changes, not only in technology as such but particularly in the areas of business viability and natural resource management.

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

GRDC Grains Research & Development Corporation

# Coping During Drought

**Merrill Lymn**

Central Eyre Peninsula Centacare Counsellor

Information

You've probably finished harvest and had a few days off with the family. You have taken the advice of the bankers and agronomists with regard to your budget for next year and are managing the dwindling stubbles from last years crop. With a hundred and one other issues to think about for next year, it could be time to have a 'check up' of the stress levels of members of your family and yourself as well.

The local Rural Financial Counsellor, Tracey van Loon, has produced an excellent document to highlight the 'do's and don'ts' of managing the stress of a financial crisis.

**DON'T** bottle up feelings

**DON'T** say bad things about yourself

**DON'T** avoid talking about what's happening

**DON'T** isolate yourself from other individuals and groups.

**DO** express your feelings and let your children share in problems. They know anyway!

**DO** discuss the problem with others

**DO** accept support from people who care

**DO** look after yourself — diet, sleep, time out, exercise, relaxation

**DO** take time to be with your close family and friends

**DO** express your needs clearly and honestly to family, friends, and those in the helping professions

**DO** let your children talk to you and others about their emotions

**DO** encourage younger children to express themselves in games and drawings

**DO** explain to your children why expenditure is being cut — they will cope!

**DO** try to keep the rest of your lives as normal as possible during a period of stress and crisis

**DO** try to let your family keep up with their activities as much as possible

**DO** play sport

**DO** drive more carefully

**DO** be more careful working around the farm

**DO** be aware that accidents are more common during and after severe stress

**DO** remember laughter is as good as a dose of medicine!!!

Another useful resource is a book written by John Ashfield titled *'Taking care of yourself and your family'*. This book is like the family medical book we all had on our shelves when the kids were young to help us recognise simple symptoms of common illnesses. It explains the common things we might notice if we are becoming over stressed or even depressed about our situation, and offers useful strategies to manage better. The book has been made available in your community at no cost. Check with your district council, Wesfarmers and Elders.

Michael Wallis, one of the speakers at the *'Looking forward'* event held in Wudinna in December 2006, gave us an excellent insight into how our brain works when it is functioning normally and also what happens when it is over stressed. He has offered to talk to small groups of farmers and community members during 2007 about many topics including laughter, expressing yourself, staying healthy, thinking well, problem solving without worry, relaxation, communication, community contribution, friends and socialisation, and sleeping well. Invite him along to your AGM and have a good laugh! His contact number is 8683 2083.

Best practice

## Local services

**Rural Financial Counsellor**, Tracey van Loon (ph. 8680 2287, fax 8680 2914, email eprcs@iinet.net.au)

**Central Eyre Peninsula Care Service, Centacare Counsellor**, Merrill Lymn (ph. 8680 2511, fax 8680 2522, email mlymn@ppd.centacare.org.au).

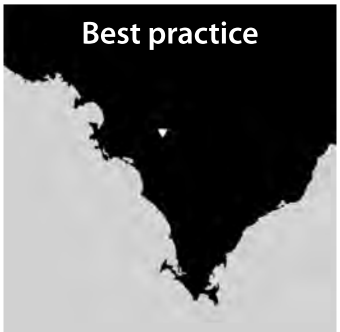
**Drought Hotline:** 180 2020
Clarify EC application details, etc.

**Centrelink Farmer Assistance Line:** 1800 050 585
Remember, don't self assess!!

# Eyre Peninsula Farm Profitability Workshops — is there a best cropping to livestock ratio?

**Ed Hunt[1] and Brenton Lynch[2]**
[1]Ed Hunt Consulting, Wharminda, [2]Lynch Farm Monitoring, Streaky Bay

Extension




## Key messages

- **How financial analysis is carried out is critical in obtaining an accurate result.**
- **Financial analysis needs to be standardised so that farming systems can be continuously analysed as new technology becomes available and commodity prices change.**
- **A well-run stock operation, when combined with cropping, reduces financial risk and improves profitability.**
- **The challenge for more intensive cropping systems is to reduce risks and improve profitability.**

## Why and how was it done?

The Eyre Peninsula Grain & Graze and the EP Farming Systems Project funded the development of workshops designed to enable farmers to determine 'What is the most profitable and most suitable enterprise mix over time for my farm?' Ed Hunt and Brenton Lynch, both Eyre Peninsula farm consultants, developed the workshops with assistance from Mike Krause (Applied Economic Solutions) and MAC staff.

The workshop aims to:

1. Determine the most profitable enterprise mix over time for individual farms (as case studies) in each of the three zones on Eyre Peninsula (Western, Eastern and Lower).
2. Measure changes in whole farm profitability as a result of changing the enterprise mix on these farms.
3. Identify any other advantages or disadvantages to the farming system offered by the various enterprise mixes in each zone.
4. Identify the key indicators for profitability in the different farming systems on Eyre Peninsula.

Day one of the first workshop at Minnipa has been run at the time of writing. Feedback from participants at the end of the day was very positive. Further workshops are planned to run in autumn 2007.

## What happened?

### Summary of Eastern and Lower Eyre Peninsula Case Studies — Ed Hunt Consulting

In farming, we are always striving for the ideal system, and yet it still appears to elude us. The parameters that affect profitability in farming are wide and varied, so what is profitable today may be less profitable tomorrow.

Our farming systems are also continually changing. Ryegrass resistance has become a major issue for more intensive cropping systems, with wide and varied approaches to its control being utilised. Our single biggest issue however is how we maintain profitability in farming with so much change around us.

In the last 10 years there has been a push to more intensive cropping systems for a number of reasons:

1. The system initially is relatively uncomplicated with low ryegrass levels and low disease levels, particularly in break crops.
2. Extension messages going to farmers have been to increase and intensify cropping.
3. The more crop-orientated systems with new technologies are more appealing to farmers, especially younger progressive farmers.

However, there has been an escalation in farm costs as weeds, diseases and machinery costs have increased.

These increasing costs, combined with a series of seasons that have been trying at best, has meant our current farm systems are not as financially robust as we had hoped.

Financial appraisals of farm systems are changing as our understanding of the real costs in farming are improving. What needs to be taken into account in more intensive cropping systems is the increasing cost for weed control and fertilisers, and the extra machinery required to cover the larger area cropped.

It is important to note that initially the high crop intensity systems work well where weed issues are low and the farmer has not 'geared' his machinery up to the larger hectares. Invariably weed issues increase, as does the gearing up of plant to suit the increased hectares.

#### *Machinery ownership costs*

Replacement of farm machinery has been one of the largest consumers of a farmer's available cash in the last 10 years. This cost is expressed as depreciation. In this analysis, 10% of current market value was used. A recent case study on an Eyre Peninsula property showed that machinery depreciation was 14%. With this analysis, the investment in plant is relative to the tonnes of grain produced. A figure of $250 investment in plant per tonne of grain has been used. This is a conservative estimate of current machinery investment on farm. Brenton Lynch (Lynch Farm Monitoring) found when benchmarking his clients in 2005 that the average investment was $270 of plant per tonne of grain produced.

It is very important to realise that there has been a major lift in machinery investment in the last five years and that this is now a major cost of farming. In 2001, 80 farmers benchmarked on Eyre Peninsula and the Mid North (E. Hunt and S. Roennfeldt, consultants, pers. comm., 2001) had an average investment of $165/t of grain produced. An example of the increase in machinery costs is that a 3 t/ha crop investment in plant has moved from $495/ha to $810/ha. The depreciation cost has increased from $49.50/ha to $81/ha.

***Study details***

Four farms on Eyre Peninsula were chosen in four different rainfall zones to assess the different crop intensities and their effects on profitability.

***Setting realistic yields***

When looking at financial analysis of farms, the plant-available water characteristics of the soil are important. Variation in yield is often most affected by this one characteristic. Variation in yield between neighbours could be significant based on different soil types and plant-available water. There is considerable interest in constructing whole farm plant-available water maps. Yield maps, biomass imagery and EM surveys are some of the tools being used. When completing financial analysis the 'real' yield potential is important as it has a major effect on the best enterprise mix on a farm.

Other factors that need to be taken into account are:

- frost risk relative to the crop grown
- reliability of malting barley.

In this study, average obtainable yields and 10-year average prices were used.

***Setting realistic stocking rates***

It was important to ensure that the stocking rates used in this study were reasonable so we were comparing good stock and crop operations that combined well.

Assumptions made:

1. A stock operation was standardised across all farms at their current stocking rate:
   - self-replacing Merino flock (2/3 ewes)
   - 1/3 ewes mated to cross-breds
   - all lambs not kept for replacement were sold across hooks at average values for last five years.
2. Wool values averaged over last 10 years.

The farms used in this analysis show a very good correlation of stocking rate with annual rainfall (Figure 1).

***Discussion***

Each farm has a different response to crop intensity, but in the study all farms had lower profit at 85% crop intensity.

Profit peaked at 50% cropping in case study 4 (450 mm annual rainfall zone) because:

1 Soil types have low plant-available water so it is difficult to achieve high yields.

2. The soil types leach nitrogen readily so nitrogen efficiency is poor. This has led to higher nitrogen costs at higher cropping intensities.

3. Ryegrass resistance has been a major problem on these soils, leading to higher costs with the more intensive cropping.

***Why is profit decreasing at high cropping intensities?***

1. Well-run stock enterprises have similar gross margins to break crops in all rainfall zones on Eyre Peninsula.

2. As cropping intensity increases, the percentage of break crops in the farming system increases (Note: break crops were not included in the 312 mm rainfall case study).

3. Plant investment increases with higher cropping intensities, which is reflected in an increase in machinery depreciation.

4. Higher crop intensities have increasing chemical and fertiliser costs.

***Understanding risk***

Risk in farming has always been very difficult to put a value on. Our most reliable indicator is return on our costs. Often this is expressed as a benefit to cost ratio.

Typical benefit:cost ratios:

| | |
|---|---|
| Sheep | 2.5 –3.5:1 |
| Good cereal | 1 –2:1 |
| Break crops | 1 –2:1 |

There is a wide range in benefit to cost ratios, and in some areas break crops are the most profitable (e.g. canola on Lower Eyre Peninsula).

**Benefit:cost ratios of case study 4 — 450 mm annual rainfall**

| Enterprise | Benefit:cost ratio | GM including depreciation |
|---|---|---|
| Sheep | 2.8 1 | $265 |
| Feed barley | 0.8:1 | $108 |
| Wheat | 1.1:1 | $166 |
| Lupins | 1:1 | $112 |
| Canola | 1.4:1 | $330 |

**Benefit:cost ratios of case study 3 (Good cropping property) — 400 mm annual rainfall**

| Enterprise | Benefit:cost ratio | GM including depreciation |
|---|---|---|
| Sheep | 3.6:1 | $200 |
| Malt barley | 2:1 | $277 |
| Feed barley | 1.5:1 | $178 |
| Wheat | 1.9:1 | $239 |
| Lupins | 1.3:1 | $134 |
| Peas | 1.2:1 | $152 |
| Canola | 1.3:1 | $248 |

If stock replace the lower GM crops, which often have the greater risk, the farm returns are more profitable. For example, if the farmer decides that 66% crop is more profitable he only needs to gear his plant up for this value, which is a major saving in plant replacement costs. Each farm in each district will have a different mix.

***Social and management skills***

On some continuous cropped farms the younger generation may never have run stock. The move into stock is a major learning process. If you hate sheep, don't run them — it's unlikely to be successful.

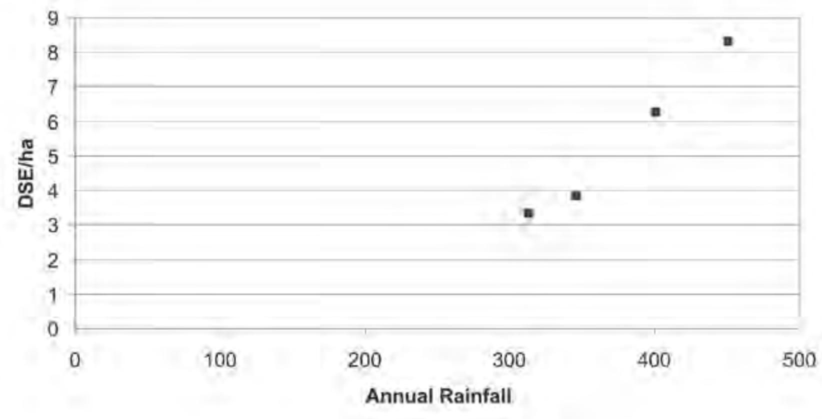



***Figure 1*** ***Stocking rates and annual rainfall of four farms in the Eyre Peninsula study.***

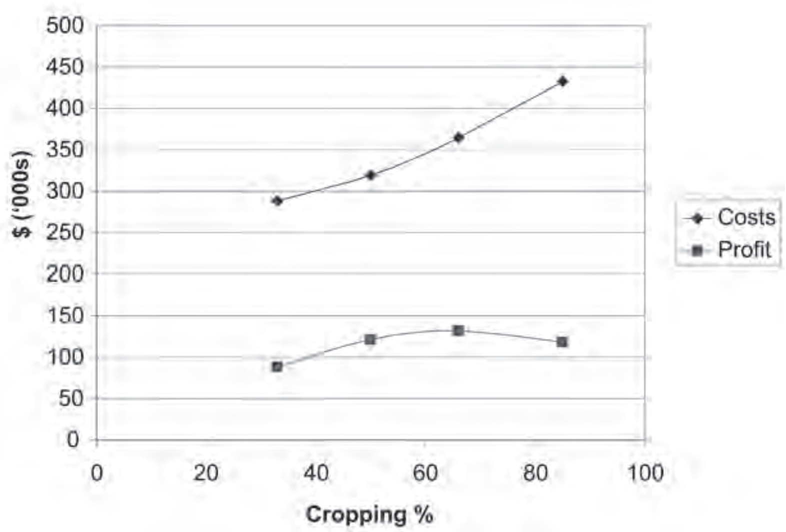



***Figure 2*** ***Case study 1 — Effect of differing cropping intensity on profitability in 312 mm annual rainfall.***

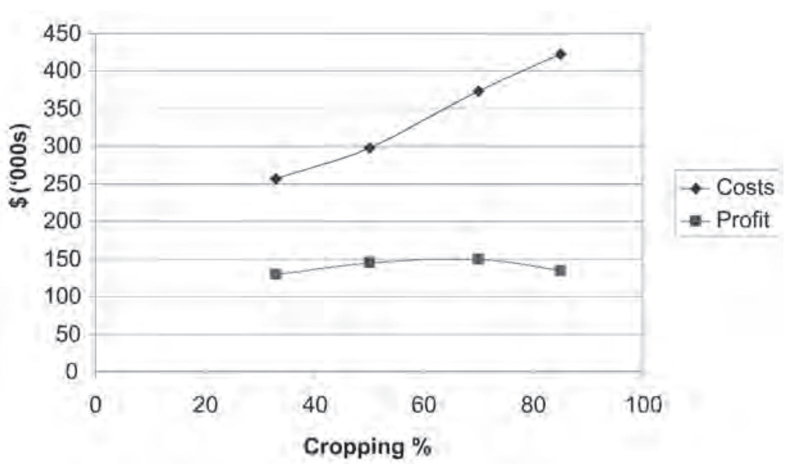



***Figure 3*** ***Case study 2 — Effect of differing cropping intensity on profitability in 350 mm annual rainfall.***

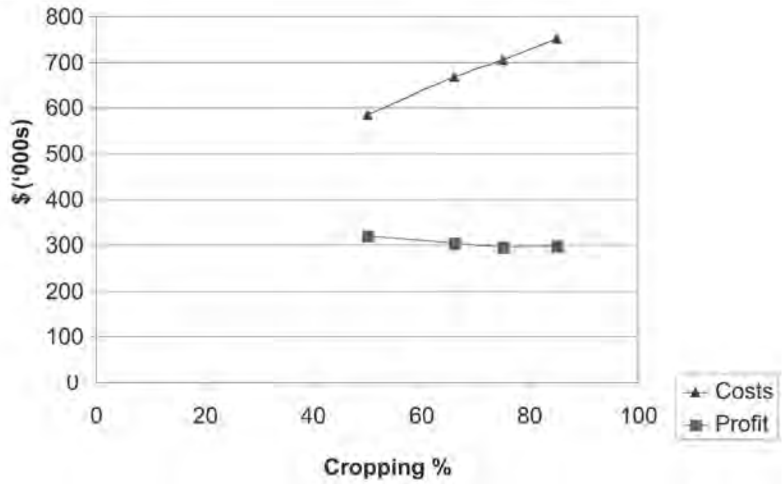



*Figure 4 Case study 3 — Effect of differing cropping intensity on profitability in 400 mm annual rainfall.*

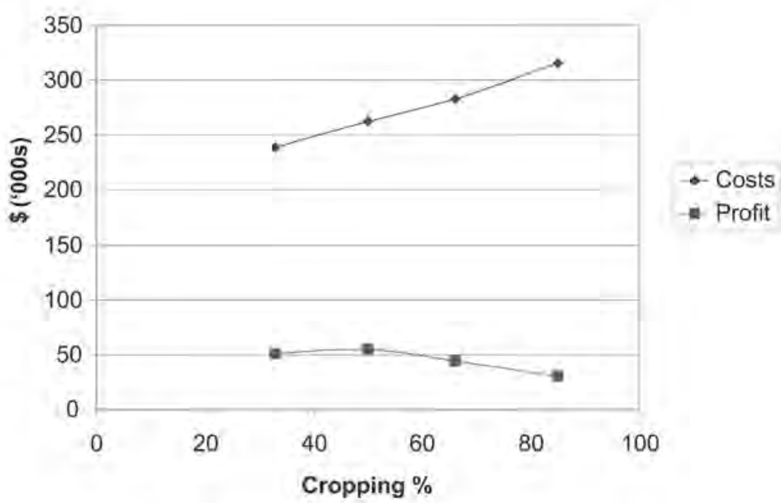



*Figure 5 Case study 4 — Effect of differing cropping intensity on profitability in 450 mm annual rainfall.*

***Commercial programs available for enterprise analysis***

At this stage there are two computer programs available for enterprise mix analysis. These are; 'Plan 2 Profit' (Applied Economic Solutions, Mike Krause) and 'Farming Systems for the Future'(Rural Solutions SA, Michael Wurst). Both have training courses available.

## Summary

A well-run stock operation, when combined with cropping, reduces financial risk and improves profits. How financial analysis is carried out is critical in obtaining an accurate result. Farming is forever changing. It is the way that we do analysis that is the important issue so that farming systems can be continuously analysed as new technology becomes available and commodity prices change. The challenge for more intensive cropping systems is to reduce risks and improve profitability.

## Acknowledgement

Eyre Peninsula Grain and Graze and EPFS funded development of the workshops.

Risk Mgmt

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# Farming Systems for the Future — a Tool to Develop Sustainable Farming Systems

**Michael Wurst**
Rural Solutions SA, Jamestown

Extension


The 'Farming systems for the future' program consists of two half-day workshops using a Microsoft Excel based computer program to assist farmers in developing and assessing a range of strategies that will provide a sustainable base for the future. The program has been developed by Rural Solutions SA in response to the need of UNFM farmers for a tool to evaluate the profitability and sustainability of their current or proposed farming system.

Growers in the Upper North have experienced seven below-average seasons in the last 10 years and have had to make drastic changes to their systems to remain viable, including increasing their reliance on livestock. Some are starting to question their long-term sustainability and this program should help them to fine tune their system to reduce risk, but still be able to maximise profitability when seasonal conditions are favourable. Although this program was initially developed for the lower rainfall districts, it has now been expanded to cater for the higher rainfall, more reliable districts as well.

In the more marginal cropping areas, intensive cropping has been seen as a high risk and most growers have continued with more traditional ley farming rotations.

This 'Farming systems for the future' program is aimed to help growers identify and develop profitable and sustainable farming rotations, taking into account soil type, rainfall variability and commodity price fluctuations.

## Features

- able to use local rainfall data and adjust yields, inputs and prices
- takes into account the impact of different soil types on production for different seasons
- includes a large range of cropping, pasture and livestock options with the ability to vary crop area and inputs for different rainfall deciles
- able to compare and assess the outcomes and risks of a range of strategy options for the future
- uses a computer program to make assessment easy and quick
- enables individuals to assess future farming system options depending on their risk comfort level.

## Benefits

Gives farmers the confidence to:

- make better decisions regarding farming system options
- be more innovative with known outcomes and risks
- identify management options to manage and minimise risk and its effect on the business
- better manage volatility in markets and rainfall, leading to better achievement of business goals.

## Where to now

Some workshops have already been held on Eyre Peninsula as part of the state government's Drought Response Strategy, with more planned in coming months. We are exploring ways to make the program more available and looking at the opportunity to build it into a farm planning framework. For further information contact Dave Davenport, Rural Solutions SA, Port Lincoln (ph. 8688 3404), or Michael Wurst, Rural Solutions SA, Jamestown (ph. 8664 1408).

# Climate Change on Eyre Peninsula

**Samantha Doudle[1] and Peter Hayman[2]**
[1]SARDI Minnipa Agricultural Centre, [2]SARDI Climate Risk Management Unit, Waite Campus

Survey




## Key messages

- **Once farmers on Eyre Peninsula accept that global climate change is real, the next questions are 'What does it mean for us?' and 'How should we include climate change in our planning?'**
- **Eyre Peninsula Agricultural Research Foundation (EPARF) has begun working with the Australian Greenhouse Office (AGO) to use the Minnipa Agricultural Centre (MAC) as a pilot to understand and reduce energy use and greenhouse gas emissions, and thereby increase efficiency through improvements in farming and office systems.**
- **EPARF will participate in a program to establish potential climate change scenarios and impacts for Eyre Peninsula and develop RDE programs to address these impacts.**
- **Due to the variable nature of our current climate, work in this area will be of immediate benefit, regardless of the outcomes of climate change in the future.**

## Why do the work?

Climate change is real and the scenario forecasts to date do not predict an improved environment for our current agricultural systems in the lower rainfall areas of South Australia. Seasonal climate variability has always been high in low rainfall areas, and farmers have either adapted over the generations and are still managing viable businesses or they have exited the industry.

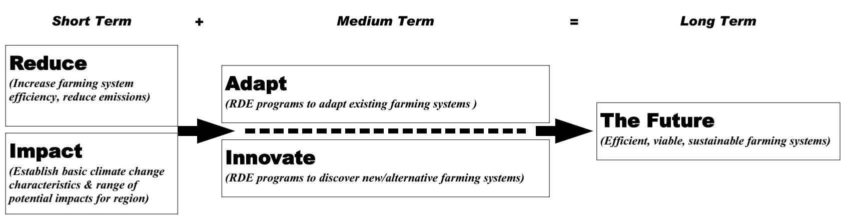
The opportunities and incentives exist now for teams of farmers, researchers and advisers to build on generations of climate variability adaptive skill and knowledge and prepare to respond to the impacts of impending global climate change.

MAC and EPARF have identified climate change as one of the major issues facing low rainfall agriculture in the medium to long term. MAC and EPARF recognise the potential synergies between improving farming efficiency, and therefore viability in low rainfall areas, and reducing greenhouse gas emissions on farm. As such, MAC and EPARF aim to begin work in this area now, with a view to increasing low rainfall farming efficiency (and also reducing emissions at the same time) and increasing public awareness of climate change and its potential impact on agriculture in the short term. In the medium term, EPARF aims to initiate and participate in RDE programs that will develop flexible farming systems having the capacity to adapt to climate change impacts and cope with climate variability.

## How will it be done?

The predicted nature of climate change and its potential impacts will see climate change work form part of the programs at MAC for the foreseeable future. Any work we do to improve our farming systems adaptation to lower rainfall, higher temperatures or increased climatic extremes is going to benefit us in the short term, not just the long term — that is the nature of the environment we live and farm in.

As such, we are developing a work plan looking at the short, medium and long term.



## Short term (2006–07)

### Greenhouse gas reduction — improve efficiency of energy and nitrogen use

***Aim:*** To use MAC as a pilot to understand and reduce energy use and greenhouse gas emissions, and thereby increase efficiency through improvements in farming and office systems.

***How:*** By working with the AGO through the Greenhouse Challenge Plus Program to:

- Audit the energy use of the office complex at MAC to identify ways to reduce resource use (electricity, fuel) and thereby save money and reduce greenhouse gas emissions.
- Assess the MAC farm to see how our farming practices and unique environmental characteristics (soil type, rainfall) combine to contribute to greenhouse gas emissions. Part of this process will involve MAC trialling the roll out of an on-farm manual being produced by the AGO. This manual identifies opportunities for production and economic benefits associated with implementing practices that reduce greenhouse gas emissions.

## Short to medium term (2007→)

### Impact–Adaptation–Innovation

***Aim:*** To develop solutions to future climate-related changes, whilst at the same time providing options that will increase farm business viability and sustainability in the short to medium term.

***How:*** By working with the AGO and relevant experts (including scientists, farmers and advisers) from around Australia to:

- Establish climate change impact scenarios for Upper Eyre Peninsula and the potential environmental, financial and social impacts on farming systems for each scenario. This will include an understanding of the key uncertainties in the projections.
- For each major impact identified, develop RDE programs to look at whether we can adapt components of our current farming systems or develop innovative new farming systems.

## What does this mean?

Over the next two years both the audits and the impact scenarios will be conducted. During this time I am happy to come out and talk to groups of people about this work and how you could potentially learn more about this issue or become involved. One of the strengths of the work on the Upper Eyre Peninsula has always been the close interaction between the farming community and the research community. It is hard to imagine a problem where this interaction is not more important.

For more information contact Sam Doudle, MAC (ph. 08 8680 5104).

## Acknowledgements

Thanks are extended to Angela Brungs and Anthony McGregor with the AGO Greenhouse Challenge Plus Program.

# A Summary of Latest CSIRO Projections for Climate Change on Eyre Peninsula

**Peter Hayman**

SARDI Climate Applications Unit, Waite Research Precinct

Research

## Key messages

- **The South Australian Government commissioned CSIRO to give an update on climate change projections. CSIRO used 13 of the latest climate models to project climate change for the eight NRM regions in South Australia.**
- **The projections for Eyre Peninsula confirm earlier modelling runs of a future that is warmer (high confidence) and probably drier (lower confidence but possibly more worrying).**
- **If greenhouse gases are reduced, the lower end of the projections doesn't change much, but the higher end, in terms of warming and drying, is significantly reduced.**

## Why do the work?

It is hard to go a week without the media covering some aspect of climate change. People are interested in global warming facts such as 2006 being the 6th warmest year on record (1st = 1998, 2nd = 2005, 3rd = 2002, 4th = 2003, 5th = 2004 and 7th = 2001). However, after watching the plight of polar bears and barrier reefs, it is not unreasonable to ask 'what does it mean on Upper Eyre Peninsula?' This is not an easy question to answer. The eminent climate scientist Stephen Schneider was the 'Adelaide Thinker in Residence' last year. When talking to farmer groups at Clare and Jamestown, Professor Schneider made the point that we know most about global energy balance and least about regional precipitation and that this is likely to always be the case. So we don't know exactly what is going to happen, but we can try and get the best indication and be clear about the uncertainty in that information.

In 2002, the South Australian Government commissioned CSIRO to provide a report on climate change projections for the state. In 2006 a group of South Australian Government departments commissioned an update. The 2002 report used 13 climate models that had been developed in the late 1990s. Since that time there has been an enormous effort in the science of climate change; much of the modelling effort has been leading up to the Fourth Assessment Round of the Intergovernmental Panel on Climate Change (IPCC) that will be due out later in 2007. The latest report from CSIRO can be found at the South Australian Greenhouse web site <www.climatechange.sa.gov.au>. This report uses 23 Global Climate Models and, after establishing the 13 models that performed reasonably well, applies them to the eight NRM regions in South Australia.

## What was found by the CSIRO projections?

About half the uncertainty in future climate is due to greenhouse gas emissions and half is due to differences in the model. This means that part of the future climate is 'path dependent', which means that as a global society we decide whether we continue on a high emission future or we significantly reduce greenhouse gas emissions. Obviously, if there are some major technological breakthroughs on alternative power sources or capturing carbon from fossil fuels, the lower emission future will be easier to achieve and hence more likely to occur. In the 18th century, the carbon dioxide concentration was about 265 parts per million (ppm). In the last 30 years carbon dioxide levels have increased from 340 ppm to over 380 ppm. In the 1990s the growth in carbon dioxide levels was less than 1 ppm/year but in recent years it has been up to 2.6 ppm/year.

One approach to the future emissions is the special report on emission scenarios (SRES) which looked at factors such as technology, population growth and economic growth, and came up with a range of alternative futures. Each future has a level of carbon dioxide in the atmosphere


measured in parts per million. The special report on emission scenarios gives a range between 540 and 970 ppm. An alternative approach for modelling is to ask the question 'If we were able to stabilise carbon dioxide at 450 ppm by 2100 or 550 ppm by 2100, what difference would that make to the projections for Eyre Peninsula?'

Using the wider SRES range of carbon dioxide concentrations, the findings from the CSIRO report are as follows…*'by 2030, the annual temperature increases between 0.4 and 1.2°C, summer and spring show increases between 0.4 and 1.3°C, autumn warms by 0.4 to 1.1°C and winter shows increases between 0.4 and 1.2°C. By 2070, the annual temperature increases between 0.9 and 3.5°C, summer warms by 0.8 to 4.0°C, spring warms by 0.9 to 3.8°C, autumn warms by 0.8 to 3.5°C and winter warms by 0.8 to 3.6°C. The annual rainfall shows changes of -10 to -1% by 2030 and -30 to -2% by 2070. Spring shows a strong decrease, while other seasons indicate moderate decreases.'*

Figure 1 shows the ranges of annual temperature increase and rainfall decrease for Eyre Peninsula. It is important to note that these graphs show a range, so it is clear that all models are suggesting a warming and drying, the extent of the warming or drying varies considerably. The range of possible outcomes is much greater for 2070 than 2030. If we were on a track that stabilised carbon dioxide concentrations at 450 or 550 ppm, this does not change the lower end of the projections; it does, however, greatly reduce the upper end. This means that we are likely to get some warming no matter what happens, but by reducing greenhouse gases the upper range of possible warming is greatly reduced.

Figure 2 shows the seasonal rainfall changes with the different carbon dioxide concentrations. There is a greater uncertainty with summer and autumn rainfall, and clearly the most worrying projection is for spring rainfall.

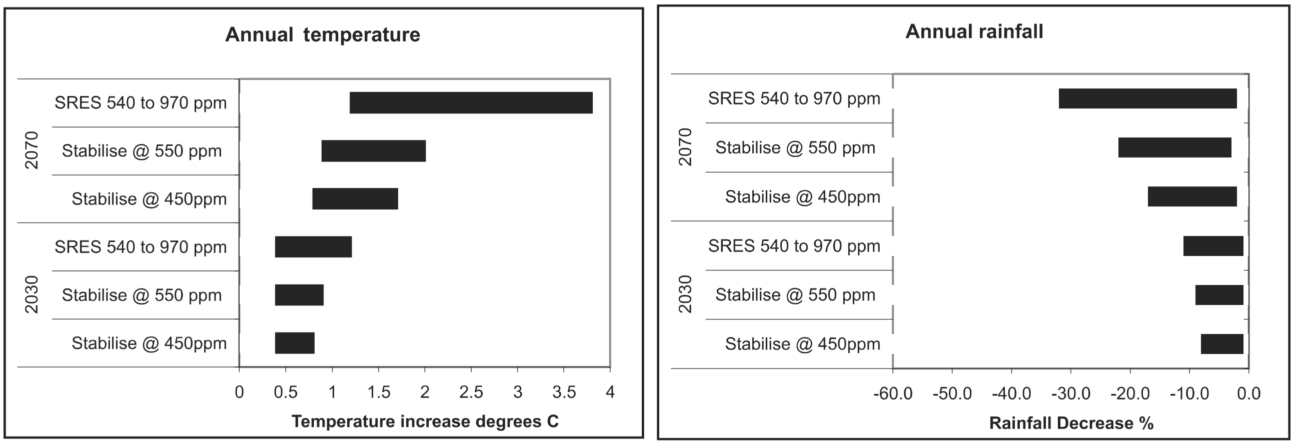



***Figure 1*** ***Projected range of changes in annual temperature (°C) and rainfall (%) in 2030 and 2070 for Eyre Peninsula if carbon dioxide concentration in 2100 was stabilised at 450 ppm, 550 ppm and the SRES range of 540–970 ppm (drawn from tables 6 to 10 of CSIRO report).***

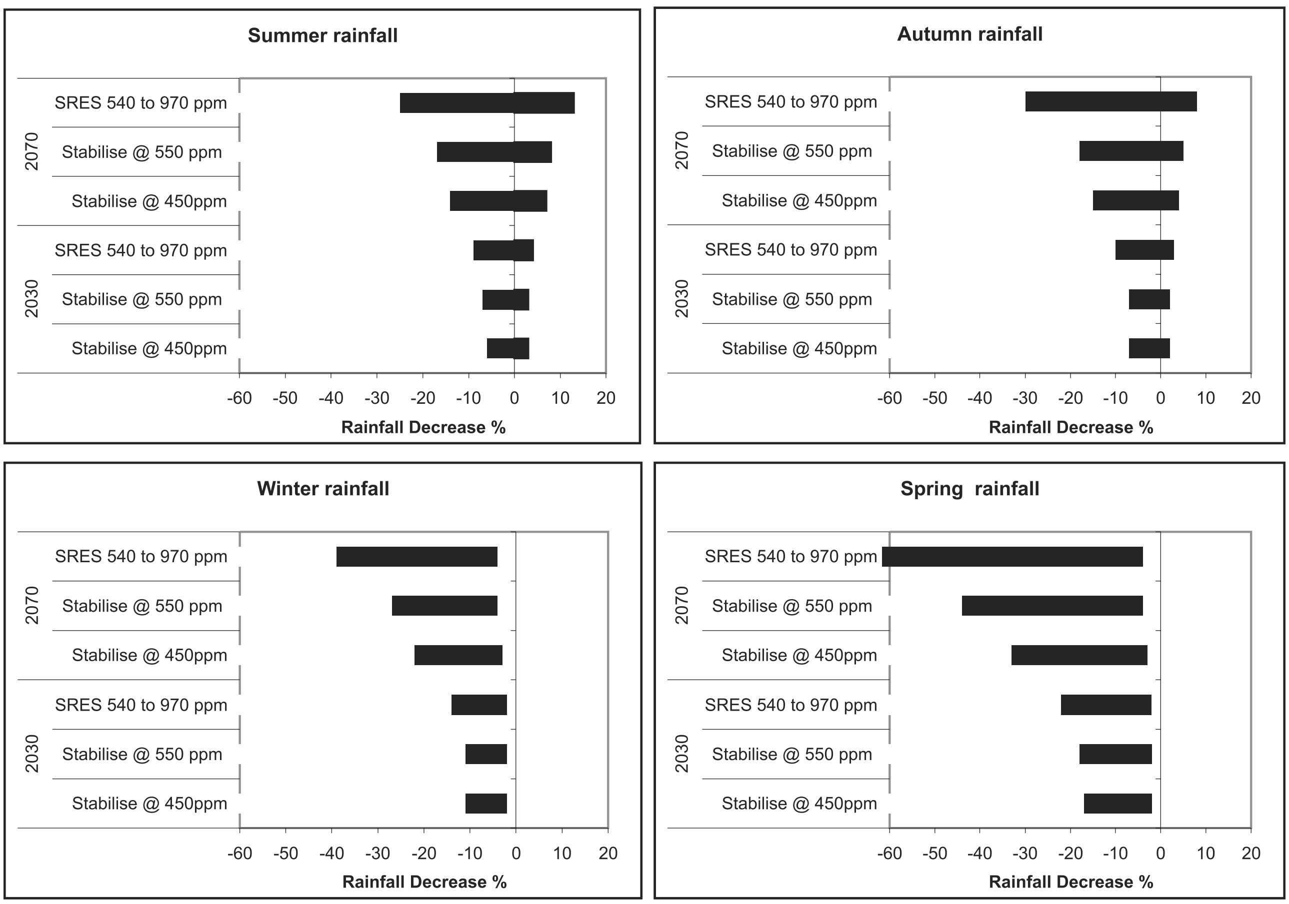



***Figure 2*** ***Projected range of changes in summer, autumn, winter and spring rainfall (%) in 2030 and 2070 for Eyre Peninsula if carbon dioxide concentration in 2100 was stabilised at 450 ppm, 550 ppm and the SRES range of 540–970 ppm (drawn from tables 6 to 10 of CSIRO report).***

## What does this mean?

The projections for Eyre Peninsula, as for most places on the planet, range from a change that would be within the coping range to extremes that would be almost impossible to adapt to. The range is much greater for 2070 and for the wider range of carbon dioxide concentrations. There is good reason to support a reduction in greenhouse gases to make it more likely to be within the coping range. Most experts would suggest that we would be very lucky to stabilise at 450 ppm. Furthermore, to stabilise at 550 ppm by 2100 is still fairly ambitious.

The next challenge is to work on what a temperature increase of say 1.5°C and a rainfall decline of say 10 or 20% means for farming on Eyre Peninsula. To do this we will be using a combination of modelling and expert opinion. The experts will be farmers, advisers and researchers who have worked with variability on Upper Eyre Peninsula.

## Acknowledgement

Ideas and direction for this work have come from Sam Doudle at Minnipa and Melissa Rebbeck as part of the SAGIT project 'Seasonal climate forecasts for South Australian grains — Looking forward'.

## Reference

Suppiah et al., 2006. *Climate change under enhanced greenhouse conditions in South Australia*. CSIRO report, available at <www.climatechange.sa.gov.au>.

Drs Ramasamy Suppiah and Penny Whetton provided invaluable interpretation of the science behind the report

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Risk Mgmt

# Section 7

Section editor:
**Alison Frischke**
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# Disease

## Eyre Peninsula Disease Suppression Research Update

Research

**Amanda Cook[1], Wade Shepperd[1], Sjaan Davey[2] and Nigel Wilhelm[1]**
[1]SARDI Minnipa Agricultural Centre, [2]University of Adelaide, Waite

Searching for answers

### Key messages

- **MAC paddock N12 continues to show good levels of disease suppression and will be used as a control soil for the Eyre Peninsula Potential Suppressive Soils bioassay.**
- **Further research into disease suppression is required.**

### Why do the trials?

Soil microbes play a very important role within our farming systems. They break down stubble, change nutrients into plant-available forms, compete with pathogens for resources, break down herbicides and pesticides, and improve soil structure through aggregate or glue formation. These glues hold soil together and improve soil stability and properties such as water infiltration.

Soil microbes can also help to control soil-borne diseases. Disease suppression is the ability of the soil microbial population to compete with and inhibit plant pathogens such as *Rhizoctonia* and *Gaeumannomyces graminis* (the Take-all fungus). The disease suppressive activity of a soil depends on the microbial community structure — the populations of microbes as well as their activities.

Trials by David Roget and V Gupta at Avon showed that the level of disease suppression can be altered by management practices (Roget and Gupta, 2005). Management practices that may increase disease suppression include full stubble retention, limited grazing and higher nutrient inputs to meet crop demand (which increases plant water use efficiency). These management practices increase carbon (C) inputs to the soil, which are the food sources for the microbes, creating a shift in the activity and composition of the microbial population.

Soil was collected from paddocks over Eyre Peninsula to assess the level of potential disease suppression in our soils as well as data on paddock history to see what aspects of management are related to the level of suppression present. Potential suppression was estimated in a pot bioassay developed by David Roget.

### How was it done?

In 2006, bioassays were run on 70 soils from Eyre Peninsula. The bioassays involved taking topsoil (0–10 cm) from paddocks and placing it into containers with three treatments (Nil, added *Rhizoctonia*, and added *Rhizoctonia* plus a C source (sugar)) that were watered and kept at 10–12°C, with a 12-hour light–dark regime, for two weeks (CSIRO Disease Potential Test for Suppressiveness of Soils). Five wheat seedlings were then planted in each pot and grown for four weeks, after which their roots were washed and scored for root disease. This bioassay gives an indication of the potential of the microbial population in the soil to respond to added C and compete with the pathogen, therefore lowering the level of *Rhizoctonia* disease on the seedlings.

### What happened?

Seven sets of bioassays were completed during the season, of which five were successful and many lessons were learnt along the way! N12 (a continuously cropped red loam on MAC) showed stable levels of disease suppression throughout the season, so will be used as the control or benchmark for all future bioassays. Figure 1 shows the results from N12 across successful bioassays 2, 4, 5 and 6. The soil has a low level of native *Rhizoctonia* which corresponds to a relatively low level of root disease. The level of root disease then increases with the addition of *Rhizoctonia* inoculum (more pathogen in the soil, thus more disease). When the *Rhizoctonia* inoculum and C source is added, the soil has the ability to reduce the level of disease on the seedling (compared to that without added C) by activating the soil microbes present — hence has potential disease suppression.

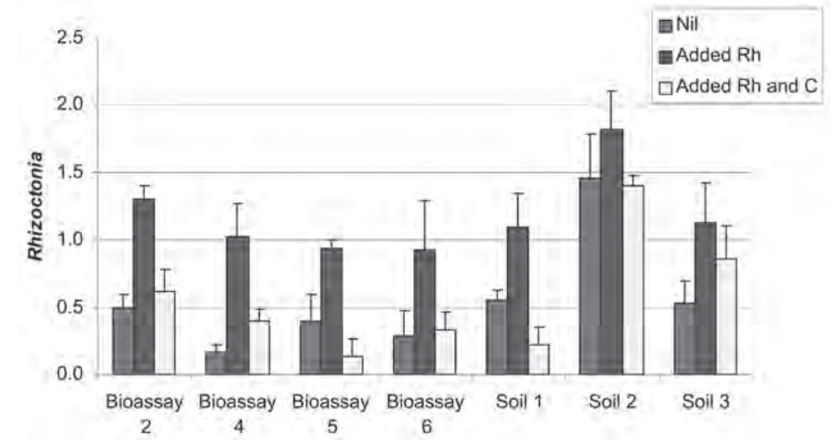


***Figure 1** Potential disease suppression bioassay results from N12 in bioassays 2–6 and three selected red loam soils.*

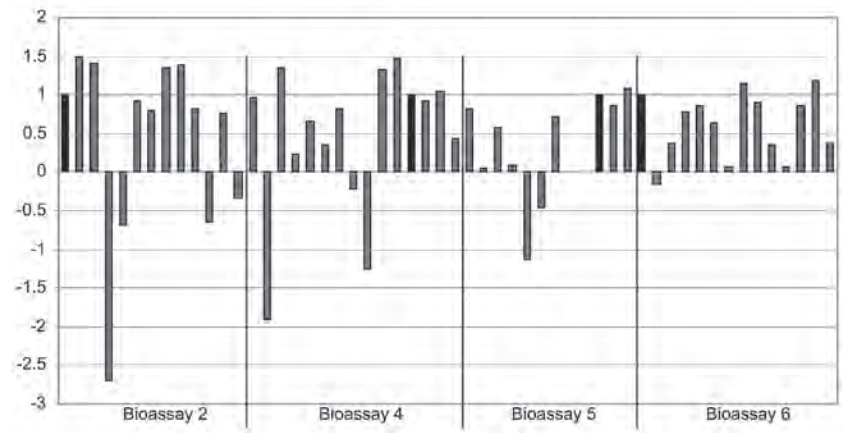


***Figure 2** Potential disease suppression of Upper Eyre Peninsula soils relative to N12 (black bars).*

Soils 1–3 are red loams from different properties. Soil 1, like N12, is showing an ability to respond to the added C and reduce the level of disease, so also has potential disease suppression. Soil 2 shows higher levels of disease present in the nil treatment, and a slight increase with added *Rhizoctonia*, but no decrease in disease levels with the added C source — therefore has little or no potential disease suppression. Soil 3 also has little or no potential disease suppression as the initial disease levels are lower and increase with added *Rhizoctonia*, but there isn't a large drop in disease with the added C source. See the 'Long term suppressive soils' article in this manual for other graphs showing 'potential' disease suppression.

Figure 2 shows all the soils that have been through the bioassay with 'potential suppression' expressed relative to N12. The potential suppression is calculated as the added *Rhizoctonia* treatment - added *Rhizoctonia*+C treatment)/added *Rhizoctonia*, as a percentage (i.e. the percentage reduction in *Rhizoctonia* rating when C is added). These reductions are then plotted relative to N12 (control=1) within each bioassay.

Figure 2 illustrates that we can achieve suppressive soil status on Eyre Peninsula soils, with several soil samples achieving as much, or greater, suppression than the known suppressive soil of N12 (i.e. greater than 1).

## What does this mean?

N12 showed stable levels of disease suppression throughout the season, so is used as the benchmark. Soil C and N values have been measured in all these soils and their values may help in the interpretation of the results. Some of the soils that have negative potential suppression have paddock histories of management practices, such as chemical applications, that may have affected the microbial population — but more data are needed before this can be properly investigated. This will be ongoing research in 2007.

## PhD study

The PhD being undertaken by Sjaan Davey will add value to the bioassay results, taking one or two soils from each group showing different characteristic responses (e.g. high, negative or nil 'potential suppression' relative to the N12 control). A replicated bioassay will be used to confirm the level of 'potential suppression'. These results and the detailed paddock histories will hopefully show some correlations in terms of management, soil characteristics and levels of 'potential disease suppression'. One possible avenue forward may then be an attempt to alter levels of 'potential suppression' by manipulating these soils (changing C, nutrient levels and microbial communities) under controlled experimental conditions. However, one must bear in mind that the development of a stable, disease suppressive system is a long-term process and manipulation of soil properties under laboratory conditions is relatively short term. Nevertheless, if these manipulations can be successfully achieved, monitoring of microbial community structure and activity as well as isolation of PEMs (*Pantoea agglomerans, Exiguobacterium acetylicum* and *Microbacteria*, the microbes believed to play an important role in the 'original' disease suppression discovered in Avon soil) are potential tools to explain the mechanisms behind changes in the suppressive abilities of different soils.

## Acknowledgements

Thank you to EPFS, SAGIT and GRDC for funding this project. Thank you to all farmers who directed us to paddocks to collect soil and for providing paddock history (and if you haven't sent yours in yet please do!). Thanks to Steve Barnett, David Roget, Alan McKay and Annie McNeill for support and input into the project.

## Reference

Roget, D.K. and Gupta, V.V.S.R., 2005. *Rhizoctonia control through management of disease suppressive activity in soils.* GRDC Research Update for Advisors — Southern Region.

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GRDC Grains Research & Development Corporation

# Brassicas and *Rhizoctonia* at Miltaburra

**Amanda Cook**[1]**, Wade Shepperd**[1] **and Sjaan Davey**[2]

[1]SARDI Minnipa Agricultural Centre, [2]University of Adelaide, Waite

Research

## Key messages

- **Results this season indicate that canola, vetch and chemical fallow can reduce *Rhizoctonia* inoculum levels, leading to an increase in cereal yield.**
- **There was no change in PEM microbes in Miltaburra soil under different management practices.**
- **Timing of grass control may be important in reducing disease inoculum levels.**

## Why do the trial?

This ongoing work is being conducted to investigate the role of *Brassica* species on the incidence of *Rhizoctonia* in an environment where root disease is a major constraint. Some very interesting results from Miltaburra in 2004 (EPFS Summary 2004, page 75) strongly suggested that canola or forage brassicas in the rotation markedly reduce *Rhizoctonia* inoculum levels. These results were supported by trial and paddock monitoring in 2005 (EPFS Summary 2005, pages 85 and 87). These observations are being investigated with field trials over a number of years to test the impact of *Brassica* options, varieties and management on root disease levels, especially *Rhizoctonia*, in the following cereal crop.

## How was it done?

### Brassica Variety and Management Trials — 2005 and 2006

A large selection of *Brassica* varieties were established in trials in 2005 and 2006. The treatments included high and low glucosinolate mustards, canola varieties (Stubby, Rivette and Eyre), vetch, wheat and chemical fallow.

The management options in canola (Atrazine and Triazine Resistant (ATR)-Stubby) included early and late removal of grasses, no grass control, Terrachlor, Apron and Maxim XL seed dressings. Granular and fluid fertiliser treatments were applied. All granular plots received 19:13 @ 70 kg/ha and urea at 15 kg/ha in 2005. The fluid fertiliser treatments were applied at the equivalent fertiliser rates as the granular with 9.1 kg P/ha as APP, 20.2 kg N/ha as UAN and 6.3 kg S/ha as ATS. The trace element treatment had granular 19:13 @ 70 kg/ha and urea at 15 kg/ha with 1 kg Zn/ha, 1.5 kg Mn/ha and 0.5 kg Cu/ha as fluid sulphates. An additional fluid fertiliser treatment at the same cost as the granular used equivalent rates of cheaper products — phosphoric acid (81%) and granular sulphate forms of the trace elements.

The ATR canola varieties and the management trial (all ATR-Stubby) received 0.8 L/ha Simazine @ 0.8 L/ha post-sowing, and the vetch plots had Lexone @ 180 g/ha.

The 2005 early grass control of Targa @ 375mL/ha was applied on 27 July, and late grass control on 26 September. The chemical fallow treatments were sprayed with 1 L/ha Roundup during the growing season to remove plant growth.

In 2006, the *Brassica* trial was sown on 29 May, but due to the dry seasonal conditions was not harvested. This trial will be sown with barley in 2007.

The Brassica Variety and Management trials from 2005 were sown to barley in 2006. The trials were sown on May 29 with Barque barley @ 50 kg/ha with 50 kg/ha of 18:20:00. Barley is very susceptible to *Rhizoctonia* hence will readily display *Rhizoctonia* patches. The site was sprayed with Sprayseed @ l L/ha and Treflan @ 1 L/ha pre-seeding. Hoegrass @ 1 L/ha and Tigrex @ 750 mL/ha were applied separately during August.

Root disease inoculum levels were estimated by DNA-based bioassay over the 2005–06 summer. *Rhizoctonia* infection was scored in the barley crop and total performance monitored.

**Searching for answers**

**Location:**
Closest town: Miltaburra
Cooperator: L, M, C and D Mudge

**Rainfall**
Av. annual: 306 mm
Av. GSR: 212 mm
2006 total: 239 mm
2006 GSR: 118 mm

**Yield**
Potential: 1.6 t/ha (barley)
Actual: 0.7 t/ha

**Paddock history**
2006: Barque barley
2005: safflower–canola trial
2004: wheat

**Soil**
Grey calcareous loam

**Plot size**
12 m x 5 replications

## What happened?

The initial root disease test score (RDTS) at the start of the 2006 season showed that there was little root disease inoculum present except for *Rhizoctonia*, which differed between treatments. *Rhizoctonia* inoculum at the start of the season was highest where wheat had been grown in 2005 (Table 1). Low *Rhizoctonia* inoculum levels were in the fallow, high glucosinolate and vetch treatments. The other treatments had low to medium levels although inoculum levels may also have been affected by poor plant growth (and increased weed growth) for the

***Table 1 Disease and barley results from the 2006 Miltaburra Brassica variety and management trials.***

| 2005 treatment | RDTS rating *Rhizoctonia* | *Rhizoctonia* Root Score (0–5) | Early DM (t/ha) | Late DM (t/ha) | Barley grain yield (t/ha) |
|---|---|---|---|---|---|
| **Variety** | | | | | |
| Cereal | High (83) | 1.94 | 0.08 | 1.64 | 0.38 |
| Chemical fallow | BDL (<19.5) | 1.52 | 0.11 | 2.20 | 0.52 |
| ATR–Eyre | Low (25) | 1.45 | 0.09 | 2.03 | 0.48 |
| ATR–Stubby | Low (35) | 1.67 | 0.09 | 1.99 | 0.50 |
| Rivette | Medium (42) | 1.38 | 0.10 | 1.70 | 0.46 |
| Juncea canola | Medium (42) | 1.89 | 0.10 | 1.95 | 0.50 |
| Low glucosinol | Medium (42) | 2.05 | 0.09 | 1.92 | 0.43 |
| High glucosinol — ATR variety | BDL (<19.5) | 1.56 | 0.10 | 2.21 | 0.50 |
| Biofumigant mustard | Medium (59) | 1.82 | 0.09 | 1.91 | 0.43 |
| Vetch | BDL (<19.5) | 1.54 | 0.10 | 2.30 | 0.56 |
| *LSD (P=0.05)* | *12.5* | *0.40* | *ns* | *ns* | *0.06* |
| **Management** | | | | | |
| Granular fertiliser — control | BDL (<19.5) | 1.60 | 0.14 | 2.44 | 0.69 |
| Chemical fallow | Low (27) | 1.45 | 0.14 | 2.60 | 0.67 |
| Cereal | High (103) | 2.38 | 0.11 | 1.50 | 0.44 |
| Early grass control | Low (24) | 1.63 | 0.13 | 2.64 | 0.66 |
| Late grass control | Medium (51) | 2.18 | 0.11 | 2.74 | 0.61 |
| No grass control | Medium (70) | 2.42 | 0.11 | 2.23 | 0.58 |
| Maxim XL | Low (29) | 1.80 | 0.12 | 2.53 | 0.65 |
| Terrachlor | Low (27) | 1.85 | 0.15 | 2.43 | 0.66 |
| Apron | Medium (43) | 1.66 | 0.13 | 2.80 | 0.64 |
| Fluids same cost granular | Low (34) | 1.06 | 0.16 | 3.00 | 0.69 |
| Fluids same rate granular | Medium (66) | 1.96 | 0.11 | 2.30 | 0.57 |
| Same rate gran + TE | BDL (<19.5) | 1.40 | 0.15 | 2.76 | 0.72 |
| *LSD (P=0.05)* | *12.5* | *0.68* | *0.03* | *0.64* | *0.07* |

*TE = trace elements*

biofumigant mustard and the low glucosinolate varieties. *Rhizoctonia* infection on barley roots was generally low (maximum of 2.4 in a 0–5 rating system) but were highest in those treatments with grasses in 2005 (including wheat).

Barley emergence in 2006 was the same regardless of treatments and it struggled all year due to the dry conditions. Plant growth was not affected by previous variety, but grain yields were slightly better after vetch than wheat. Barley performance on the management block was slightly better than in the variety block due to reduced weed numbers from the Simazine applied the previous year. Management options had little impact on barley yields in 2006. The phosphoric acid based fertiliser treatment looked promising; early it had the lowest *Rhizoctonia* infection levels and the best barley growth. The fluid fertiliser treatments increased DM but final yield was similar to the granular control. Delaying grass control increased the level of disease and also reduced yield.

Young barley plants and soil from the early grass control and chemical fallow plots were sent to Sjaan Davey (University of Adelaide, PhD). The barley roots were analysed for the presence of PEM microbes (*Pantoea agglomerans, Exiguobacterium acetylicum*, and *Microbacteria*) and *Trichoderma* spp. These microbes are believed to play an important and significant role in disease suppression within the Avon soil. However, no differences were detected in any of the PEMs or *Trichoderma* spp. between the two treatments.

## What does this mean?

There were differences in DNA *Rhizoctonia* inoculum levels at the beginning of the season, with the cereal stubble plots having high levels compared to the canola plots.

Within the variety trial, the plots that received early weed control in 2005 (fallow, ATR varieties and vetch) had reduced *Rhizoctonia* inoculum levels.

Within the management trial, all plots received Simazine after seeding in 2005, but the timing of grass control was important, with earlier grass control decreasing the level of disease and increasing the yield of the following barley crop.

The results of the experiment done by Sjaan indicated there was no short-term change in the soil microbes associated with disease suppression in the Avon soil, so the level of *Rhizoctonia* inoculum may be related to the amount of root mass as has been previously suggested. The decline in inoculum level in the fallow treatments and the increase in disease inoculum with the later grass control also support this, but further investigation is required.


## Acknowledgements

Thank you to EPFS, SAGIT and GRDC for funding this project. Thanks to Leon, Carolyn and Darren Mudge for allowing us to have trials on their property, and AGRICHEM for supplying fertiliser products. Thanks to Nigel Wilhelm and Alan McKay for their help this year.

Apron and Maxim XL seed dressings are registered products of Syngenta. Terrachlor seed dressing is a registered product of Crompto.


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# Long-Term Disease Suppression Trial at Streaky Bay

**Amanda Cook and Wade Shepperd**
SARDI Minnipa Agricultural Centre

Research

## Key messages

- **At the start of the 2006 season there were no differences in *Rhizoctonia* inoculum levels between rotations, supporting a one-year effect of canola on lowering *Rhizoctonia* inoculum levels.**
- **After three years there has not been an increase in the development of potential disease suppression in any of the rotations.**

## Why do the trial?

Management practices such as stubble retention, limited grazing and high nutrient inputs have influenced the development of disease suppression in soils at Avon (Roget and Gupta, 2005). Including Brassica species within the rotation has lowered *Rhizoctonia* disease inoculum levels at Miltaburra (EPFS 2005 Summary, page 87). A long-term trial was established at Streaky Bay to determine if disease suppression is achievable and whether soil microbial populations can be influenced by rotation and inputs in a grey highly calcareous soil.

## How was it done?

The trial was established in 2004 and was sown into a grassy pasture with 8 kg/ha zinc sulphate applied and worked in before seeding. In 2005, the trial was sown on 24 June with a knock-down of 1 L/ha of Roundup, 1 L/ha Treflan and 100 mL/ha Hammer pre-seeding, and 5 g/ha of Ally later in the season to control Lincoln weed. In 2006, the trial was sown on 30 May with l L/ha Sprayseed and 1 L/ha Treflan pre-seeding. Rotation treatments are described in Table 1. Triticale was selected for the cereal rotation as it has been shown to increase beneficial microbes in Avon soil (Steve Barnett, SARDI, pers. comm., 2006).

In 2006, root disease inoculum was measured using DNA-based bioassays at the start of the season, and yield data were collected for the triticale and canola at the end. Root disease scoring was not conducted as different crops were grown. Soil from the various treatments was included in a soil bioassay to assess if there were any differences in disease suppression between treatments.

## What happened?

In 2005, *Rhizoctonia* inoculum levels prior to seeding were lower after canola than after wheat, but by the start of the 2006 season these differences had diminished (Table 2). This supports previous research (EPFS Summary 2004, page 75, and EPFS Summary 2005, page 87). The DNA bioassay showed that *Pratylenchus neglectus* numbers remained higher in the canola rotation.

No rotation made a profit in the 2006 season (Table 3). The input costs were slightly higher this year due to high numbers of insects early in the season (at that stage we thought it was worth spraying). The high fluid fertiliser increased the yield of the triticale. High fertiliser inputs used in this trial are aimed to push the nutrition of the whole system rather than be economical, and this is reflected in the gross margins.

The results from the potential disease suppression soil bioassay conducted in December are shown in Figure 1. The soil taken from the continuously cropped Paddock N12 at MAC (bioassay control) shows low initial levels of *Rhizoctonia* (nil treatment), then a rise in disease level with added *Rhizoctonia* inoculum (Added Rh treatment), and then a decline in disease level when a carbon source is provided to activate the soil microbial population present (Added Rh and C). This decline in disease is indicative of the soils suppressive activity. Compared to N12, the grey calcareous soil at Streaky Bay supports higher levels of *Rhizoctonia* with the Added Rh treatment regardless of rotation (dark bars on Figure 1). The continuous cereal treatments did not show disease suppression and had less ability to suppress disease with added carbon compared to the other rotations. David Roget (CSIRO, pers. comm., 2006) indicated that it is not uncommon for a soil to become more prone to disease before disease suppression develops.

**Searching for answers**

**Location:**
Streaky Bay: K, D and K Williams
Streaky Bay Ag Bureau

**Rainfall**
Av. annual: 298 mm
Av. GSR: 243 mm
2006 total: 202 mm
2006 GSR: 113 mm

**Yield**
Potential: 0.78 t/ha
Actual: up to 0.42 t/ha (triticale)

**Soil**
Highly calcareous grey loamy sand

**Plot size**
60 m x 1.48 m

**Other factors**
Moisture stress, grass and Lincoln weed competition.

*Table 1 Rotations and treatments used in the Long-Term Disease Suppression Trial.*

| Rotation | Fertiliser | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| **District practice** | 14 kg P/ha and 16 kg N/ha applied as DAP @ 60 kg/ha | Excalibur wheat @ 55 kg/ha | Keel barley @ 60 kg/ha | Angel medic @ 5 kg/ha |
| **Intensive cereal — district practice inputs** | 16 kg P/ha applied as MAP @ 60 kg/ha | Excalibur wheat @ 55 kg/ha | Keel barley @ 60 kg/ha | Ticket triticale @ 60 kg/ha |
| **Intensive cereal — high inputs** | 20 kg P/ha applied as APP, 18 kg N/ha as UAN and TE (Zn, Mn, Cu) | Excalibur wheat @ 55 kg/ha | Keel barley @ 60 kg/ha | Ticket triticale @ 60 kg/ha |
| **Brassica break — district practice inputs** | MAP @ 60 kg/ha | Rivette canola @ 5 kg/ha | Keel barley @ 60 kg/ha | Stubby canola @ 5 kg/ha |
| **Brassica break — high inputs** | 20 kg P/ha applied as APP, 18 kg N/ha as UAN and TE (Zn, Mn, Cu) | Rivette canola @ 5 kg/ha | Keel barley @ 60 kg/ha | Stubby canola @ 5 kg/ha |

*Table 2 The RDTS rating of rotations at the start of the 2006 season.*

| Rotation | *Rhizoctonia* | Take-all | Common root rot | *Pratylenchus neglectus* | *Prat. thornei* | *Fusarium pseud.* | CCN |
|---|---|---|---|---|---|---|---|
| **District practice** | Medium (49) | Low (27.2) | Low (55) | Low (12) | Low (4) | Low (82) | BDL |
| **Intensive cereal — district practice inputs** | Medium (51) | Low (36) | Low (31) | Low (7) | Low (3) | Low (32) | BDL |
| **Intensive cereal — high inputs** | Medium (78) | Low (48) | Low (28) | Low (9) | Low (4) | Low (14) | BDL |
| **Brassica break — district practic e inputs** | Low (37) | Low (22) | Low (22) | Medium (25) | Low (2) | Low (90) | BDL |
| **Brassica break — high inputs** | Medium (69) | Low (21) | Low (36) | Medium (30) | Low (2) | Medium (176) | BDL |
| ***LSD (P=0.05)*** | *ns** | *ns* | *ns* | *6* | *ns* | *ns* | *ns* |

**ns = non-significant; BDL = below detection level*

*Table 3 Yield, input costs and gross margins of rotations at Streaky Bay.*

| Rotation | 2004 GM ($/ha) | 2005 yield (t/ha) | Input costs ($/ha) | 2005 GM ($/ha) | 2006 yield (t/ha) | Input costs ($/ha) | 2006 GM ($/ha) | Overall 2006 GM ($/ha) |
|---|---|---|---|---|---|---|---|---|
| **District practice** | 108 | 0.88 Keel barley | 60 | 51 | *Not harvested* Angel medic | 109 | -109 | 49 |
| **Intensive cereal — district practice inputs** | 116 | 0.81 Keel barley | 60 | 42 | 0.23 Ticket triticale | 66 | -15 | 143 |
| **Intensive cereal — high inputs** | 6.5 | 1.16 Keel barley | 230 | -84 | 0.42 Ticket triticale | 244 | -152 | -230 |
| **Brassica break — district practice inputs** | 9 | 2.08 Keel barley | 60 | 202 | 0.03 ART–Stubby canola | 121 | -106 | 105 |
| **Brassica break — high inputs** | -122 | 2.43 Keel barley | 230 | 76 | 0.05 ART–Stubby canola | 299 | -275 | -321 |
| ***LSD (P=0.05)*** | | *0.16* | | | *0.03* | | | |

*GM calculated using prices — wheat $140/t and canola $302/t for 2004 season, barley $126/t for Feed 1 in 2005, triticale $220/t and canola $480/t for 2006.*

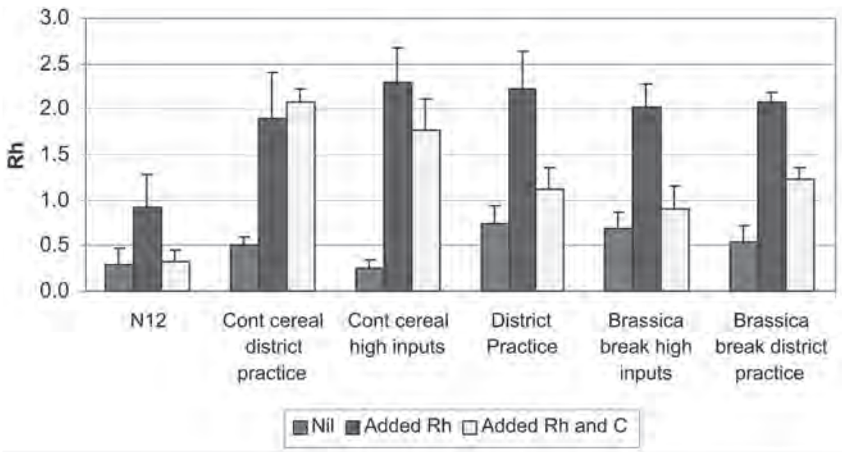


***Figure 1 The potential suppressive soil bioassay in December 2006 conducted on the various rotations at Streaky Bay.***

## What does this mean?

After growing barley last season, *Rhizoctonia* disease inoculum levels are not different between the rotations, even though they were lower after the canola rotation last season. This supports on-farm monitoring work at Miltaburra, where canola had a one-year benefit in reducing disease inoculum levels. Soil samples taken from the plots at Miltaburra showed there was not an increase in beneficial microbes (PEMs) associated with disease suppression in the Avon soil.

Bioassay results from the Streaky Bay trial show there has not been an increase in the development of disease suppression in any of the rotations, but the trial has only been established for three years. The cereal treatments are showing lower disease suppression than the district practice rotation at this stage.

This trial will be ongoing to monitor disease levels and the possible development of disease suppression in the future.

## Acknowledgements

Thank you to EPFS, SAGIT and GRDC for funding this project. Thanks to Ken, Dion and Kym Williams for allowing us to have trials on their property.

Hammer is a registered product of Crop Care. Ally is a registered product of Du Pont.

## Reference

Roget, D.K. and Gupta, V.V.S.R., 2005. *Rhizoctonia control through management of disease suppressive activity in soils.* GRDC Research Update for Advisors — Southern Region.

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Disease

# Fungicides in the Farming System

**Neil Cordon**
SARDI Minnipa Agricultural Centre

Research

## Key messages

- **Use fungicides in a farming system to control and protect field crops from diseases only according to label recommendations.**
- **There is no fungicide 'silver bullet' to control or protect cereal crops from *Rhizoctonia*.**
- **Be aware that some fungicides can affect crop emergence, which may influence early crop growth.**

## Why do the trials?

Since 2003, Eyre Peninsula farmers have faced severe outbreaks of stripe and stem rust in wheat, having to make decisions on what fungicide to use, when to apply fungicides, how much fungicide to apply and what is the best technique to use fungicides in the farming system. While our knowledge on fungicide use has developed through research and experience, the aim of these trials was to evaluate techniques of adding fungicides to a farming system. The main focus was to investigate claims (contrary to product labels) that some fungicides will reduce the impact of root diseases such as *Rhizoctonia*, Take-all, *Pratylenchus* and Common Root Rot on crop growth and yield.

## How was it done?

In consultation with farmer groups, three replicated trial sites were selected at Ceduna (K Trewartha), Elliston (T Henderson) and Lock (M Zacher) because they were likely to have a root disease problem. Management strategies to enhance root diseases were practiced such as no-tillage, maintaining green growth up to sowing and using SU herbicides pre-sowing.

Wyalkatchem wheat was sown at 60 kg/ha with 18:20:00 @ 60 kg/ha at all sites. Sowing dates for Ceduna, Elliston and Lock were 2, 1 and 8 June, respectively.

The control had no seed dressing and Raxil was applied to all other treatments except the Jockey (fluquinconazole) treatments.

Fungicides were applied to the seed or the fertiliser, or through a fluid delivery system. A foliar fungicide (propiconazole) was applied twice to ensure that we could identify where yield responses came from.

Two bio-control treatments from Dr Stephen Barnett's (SARDI, Waite Research Precinct) program were included in the trial design.

### Measurements

Pre-sowing and in-crop disease inoculum analysis, post-emergence root disease scores, emergence and vigour counts, YEB nutrient concentrations, grain yield and quality.

## What happened?

### Plant establishment and crop vigour

Crop establishment and growth at all sites was good but yields were depressed due to the dry seasonal conditions from August through to harvest. Mice damage at Ceduna reduced plant populations, with baiting required. Early visual observations (six weeks post-seeding) at all sites indicated better vigour for the nil and Jockey (300 mL/t) treatment, but this was not apparent mid-season. Only at Elliston were there differences in plant counts, the best establishment being obtained with the nil treatment (Table 1).

### Root diseases

Pre-sowing root disease analysis indicated little risk of any root disease. In-crop root scoring however, identified that *Rhizoctonia* was the predominant disease at all sites, which was consistent with in-crop RDTS analysis. Take-all was found at Lock and Ceduna. There was no difference in disease levels between treatments at Lock or Elliston, and at Ceduna the results were inconsistent.

**Searching for answers**

**Location**
Elliston: Tom Henderson
Elliston and district farmers

**Rainfall**
Av. annual: 410 mm
Av. GSR: 340 mm
2006 total: 318 mm
2006 GSR: 175 mm

**Yield**
Potential: 1.97 t/ha (wheat)
Actual: 1.1 t/ha

**Paddock history**
2005: pasture
2004: barley
2003: wheat

**Soil type**
Grey alkaline calcareous sand

**Plot size**
40 m x 1.5 m x 4 replications

**Location**
Ceduna: Kevin Trewartha
Goode and Charra Ag Bureaus

**Rainfall**
Av. annual: 300 mm
Av. GSR: 218 mm
2006 total: 244 mm
2006 GSR: 133 mm

**Yield**
Potential: 1.4 t/ha (wheat)
Actual: 0.5 t/ha

**Paddock history**
2005: pasture
2004: pasture
2003: pasture

**Soil type**
Reddish brown sandy loam

**Plot size**
40 m x 1.5 m x 4 replications

**Yield-limiting factors**
Mice

**Location**
Lock: Michael Zacher
Lock–Murdinga farmers group

**Rainfall**
Av. annual: 333 mm
Av. GSR: 254 mm
2006 total: 259 mm
2006 GSR: 111 mm

**Yield**
Potential: 0.9 t/ha (wheat)
Actual: 1.39 t/ha

**Paddock history**
2005: pasture
2004: barley
2003: wheat

**Soil type**
Non-wetting sand over clay

**Plot size**
40 m x 1.5 m x 4 replications

## Grain quality

Fungicide treatments had no effect on grain quality.

## Tissue nutrient levels

There were no trends at any site with any fungicide treatment.

## Grain yield

The only site to obtain a difference between treatments for grain yield was at Ceduna (Table 2), but no fungicide treatment outyielded the nil.

## Fungicide delivery

There was no influence in the various methods of fungicide delivery on yield and root disease levels.

## Bio-control agents

There was no influence by the bio-control agents on yield or root disease.

***Table 1*** ***Grain yield and treatment cost of Wyalkatchem wheat at Elliston with different fungicide treatments, 2006.***

| Treatment | Treatment cost ($/ha) | Plant/m$^2$ | Grain yield (t/ha) |
|---|---|---|---|
| Nil | – | 110 | 0.93 |
| Raxil @ 100 mL/100 kg of seed | 1.70 | 102 | 0.93 |
| Jockey @ 300 mL/100 kg of seed | 12.50 | 94 | 1.02 |
| Jockey @ 450 mL/100 kg of seed | 17.90 | 88 | 0.96 |
| Intake @ 200 mL/ha on fertiliser with seed | 10.25 | 88 | 0.94 |
| Intake @ 400 mL/ha on fertiliser with seed | 18.80 | 90 | 0.95 |
| Triadimefon @ 800 mL/ha on fertiliser with seed | 7.10 | 102 | 1.04 |
| Triadimefon @ 800 mL/ha with seed via fluid system | 7.10 | 80 | 0.91 |
| Triadimefon @ 800 mL/ha below seed via fluid system | 7.10 | 100 | 1.02 |
| Triadimefon @ 2.0 L/ha below seed via fluid system | 15.20 | 80 | 0.98 |
| Two foliar sprays with Bumper @ 500 mL/ha | 38.00 | 100 | 1.05 |
| Bio-control fungus | ? | 102 | 0.99 |
| Bio-control bacteria | ? | 102 | 0.96 |
| *LSD (P= 0.05)* | | *16* | *ns* |

***Table 2*** ***Grain yield and treatment cost of Wyalkatchem wheat at Ceduna with different fungicide treatments, 2006.***

| Treatment | Treatment cost ($/ha) | Grain yield (t/ha) |
|---|---|---|
| Nil | – | 0.45 |
| Raxil @ 100 mL/100 kg of seed | 1.70 | 0.40 |
| Jockey @ 300 mL/100 kg of seed | 12.50 | 0.45 |
| Jockey @ 450 mL/100 kg of seed | 17.90 | 0.46 |
| Intake @ 200 mL/ha on fertiliser with seed | 10.25 | 0.41 |
| Intake @ 400 mL/ha on fertiliser with seed | 18.80 | 0.40 |
| Triadimefon @ 800 mL/ha on fertiliser with seed | 7.10 | 0.47 |
| Triadimefon @ 800 mL/ha with seed via fluid system | 7.10 | 0.39 |
| Triadimefon @ 800 mL/ha below seed via fluid system | 7.10 | 0.45 |
| Triadimefon @ 2.0 L/ha below seed via fluid system | 15.20 | 0.41 |
| Two foliar sprays with Bumper @ 500 mL/ha | 38.00 | 0.43 |
| Bio-control fungus | ? | 0.42 |
| Bio-control bacteria | ? | 0.41 |
| *LSD (P=0.05)* | | *0.05* |

***Table 3*** ***Grain yield and treatment cost of Wyalkatchem wheat at Lock with different fungicide treatments, 2006.***

| Treatment | Treatment cost ($/ha) | Grain yield (t/ha) |
|---|---|---|
| Nil | – | 1.29 |
| Raxil @ 100 mL/100 kg of seed | 1.70 | 1.25 |
| Jockey @ 300 mL/100 kg of seed | 12.50 | 1.24 |
| Jockey @ 450 mL/100 kg of seed | 17.90 | 1.35 |
| Intake @ 200 mL/ha on fertiliser with seed | 10.25 | 1.33 |
| Intake @ 400 mL/ha on fertiliser with seed | 18.80 | 1.39 |
| Triadimefon @ 800 mL/ha on fertiliser with seed | 7.10 | 1.27 |
| Triadimefon @ 800 mL/ha with seed via fluid system | 7.10 | 1.34 |
| Triadimefon @ 800 mL/ha below seed via fluid system | 7.10 | 1.28 |
| Triadimefon @ 2.0 L/ha below seed via fluid system | 15.20 | 1.24 |
| Two foliar sprays with Bumper @ 500 mL/ha | 38.00 | 1.21 |
| Bio-control fungus | ? | 1.39 |
| Bio-control bacteria | ? | 1.16 |
| *LSD (P=0.05)* | | *ns* |

## What does this mean?

This work shows that, in the absence of rust, the fungicides and bio-control agents did not reduce Take-all or *Rhizoctonia*, or benefit crop growth, nutrient uptake, grain quality, crop vigour or grain yields in 2006. The fungicides with active ingredients flutriafol or fluquinconazole are registered to control Take-all; however, the low levels would lessen expected responses. Placing fungicide below the seed through a fluid system is possible but its effectiveness in early rust protection is still to be proven.

Good crop establishment and achieving early ground cover is important in any farming system especially for weed suppression and soil erosion. This work has indicated that farmers need to be aware that fungicide applied to the seed and fertiliser may affect plant numbers and early crop vigour.

The jury on bio-control agents in controlling root diseases is still out, and trials in 2007 will further investigate these techniques. Fungicides have a role in the farming system to control and protect field crops from a range of diseases but their use should be strictly according to label directions.

## Acknowledgements

Special thanks to Ben Ward for assisting in sowing and managing the trials, and Tom Henderson, Michael Zacher and Kevin Trewartha for provision of the trial sites. Steve Barnett is thanked for the for bio-control agents. EPFS funded the research.

Jockey and Raxil are registered to Bayer Crop Science, Intake in-Furrow is registered to Crop Care, and Bumper is registered to Nufarm.

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***Ben Ward, Jono Hancock and Neil Cordon at MAC washing and scoring plants from the fungicide trials.***

# Fungicide Experiences on Eyre Peninsula


## Neil Cordon and Brendan Frischke

SARDI Minnipa Agricultural Centre


Demo

## Key messages

- **Use fungicides in a farming system to control and protect field crops from diseases only according to label recommendations.**
- **Field demonstrations supported replicated research that showed no yield advantage from using fungicides to protect cereal crops from *Rhizoctonia* in 2006.**

## Why do the demos?

The use of fungicides in the farming system has increased since 2003 due to rust epidemics. Farmers have seen improved crop growth from the use of Triadimefon in the absence of rust, which suggests it has other positive effects in the farming system. These demonstrations were initiated by farmers to assess the impact of Triadimefon on crop growth and yield through the control of root disease such as *Rhizoctonia*, Take-all, *Pratylenchus*, Crown Rot and Common Root Rot.

## How was it done?

Single demonstration strips were sown with a fungicide (most often Triadimefon) to compare to a nil area. The two locations were at MAC and Lock (two sites). Site details are shown in Table 1. All the fungicide was applied to the fertiliser, which was then applied with the seed at sowing time.

### Measurements

Grain yield and quality, root disease tests prior to seeding.

## What happened?

Visual observations throughout the year showed little difference between the treatments in vegetative growth or disease patches.

### Root disease

Pre-sowing root disease testing showed that the largest risk was from *Rhizoctonia* at all sites, with *P. neglectus* an extra disease issue at one of the Lock sites (Table 2).

In-crop root disease scores (60 plants/treatment) supported initial testing that *Rhizoctonia* was the predominant disease at all sites. The sites at Lock were soil tested during the season for root diseases, which indicated significant risk levels of *Rhizoctonia* and *P. neglectus* across all treatments. Other root diseases were unable to be detected or were at low risk levels.

### Grain yield and quality

At all sites there was no trend to indicate that the fungicide treatment provided a grain yield or quality advantage over the nil (control) strip (Table 3)

Nutrient concentrations in the crop were evaluated at the Lock sites, and gave no indication that these fungicides had a secondary effect of enhancing trace element uptake.

## What does this mean?

This work supports the replicated trials (see article 'Fungicides in the farming system' in this manual) that show the fungicides evaluated here have no effect on reducing the impact of root diseases, especially *Rhizoctonia*. The fungicides had a role as a risk management strategy to control and protect cereal crops against a range of leaf diseases, especially rust, but label directions should be strictly adhered to.

Farmers have observed a prolonged greening effect of up to 14 days where they have used Triadimefon. If it did occur at these sites, then it did not transfer to any yield advantage over the normal farm practice.

**Best practice**

**Location**
MAC

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 Total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 1.0 t/ha (wheat)
Actual: 0.75 t/ha

**Paddock history**
2005: wheat
2004: Yitpi wheat
2003: pasture

**Soil type**
Red sandy loam

**Plot size**
1.1 ha

**Location**
Lock: Michael Zacher
Lock–Murdinga farmers group

**Rainfall**
Av. annual: 333 mm
Av. GSR: 254 mm
2006 total: 359 mm
2006 GSR: 111 mm

**Yield**
Potential: 0.9 t/ha (wheat)
Actual: 0.3 t/ha

**Paddock history**
2005: grass free pasture
2004: wheat
2003: grass free pasture

Soil type
Non-wetting sand over clay

**Location**
Lock: Michael Zerk
Lock–Murdinga farmers group

**Rainfall**
Av. annual: 315 mm
Av. GSR: 246 mm
2006 total: 294 mm
2006 GSR: 119 mm

**Yield**
Potential: 1.1 t/ha (wheat)
Actual: 0.2 t/ha

**Paddock history**
2005: wheat
2004: grass free pasture
2003: wheat

**Soil type**
Brown sandy loam

Disease

*Table 1 Demonstration details at Minnipa and Lock, 2006.*

| | Minnipa | Lock (Zerk) | Lock (Zacher) |
|---|---|---|---|
| Date sown | 16 May | 8 June | 4 July |
| Wheat variety | Scythe | Wyalkatchem | Wyalkatchem |
| Sowing rate (kg/ha) | 50 | 84 | 85 |
| Fertiliser | 18:20:00 | 27:12:00 Zn 1% | 17:19:00 Zn 1% |
| Fertiliser rate (kg/ha) | 40 | 100 | 85 |

*Table 2 Pre sowing root disease risk levels at Minnipa and Lock, 2006.*

| | Minnipa | Lock (Zerk) | Lock (Zacher) |
|---|---|---|---|
| CCN | BDL | BDL | BDL |
| Take-all | BDL | BDL | BDL |
| *Rhizoctonia* | High | Medium | Medium |
| *P. neglectus* | Low | Medium | Low |
| *P. thornei* | Low | BDL | Low |
| Crown rot | BDL | Low | BDL |
| Common root rot | Low | BDL | Low |

*BDL = below detection limit*

*Table 3 Grain quality and yield, and treatment cost for fungicides at Minnipa and Lock, 2006.*

| Treatment | Rate (mL/ha) | Protein (%) | Screenings (%) | Treatment cost ($/ha) | Grain yield (t/ha) |
|---|---|---|---|---|---|
| **Minnipa** | | | | | |
| Nil | – | 13.8 | 4.2 | – | 0.73 |
| Intake in Furrow | 200 | 13.6 | 4.1 | 8.55 | 0.75 |
| Intake in Furrow | 400 | 13.7 | 4.2 | 17.10 | 0.73 |
| Triadimefon | 800 | 13.7 | 4.3 | 5.40 | 0.74 |
| **Lock (Zerk)** | | | | | |
| Nil | – | 15.3 | 1.2 | – | 0.16 |
| Triadimefon | 1000 | 15.1 | 1.7 | 6.75 | 0.17 |
| Tebuconazole | 200 | 15.7 | 1.3 | 12.00 | 0.15 |
| **Lock (Zacher)** | | | | | |
| Nil | – | 17.2 | 1.1 | – | 0.3 |
| Triadimefon | 850 | 17.5 | 2.0 | 5.70 | 0.3 |

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Intake in Furrow is a registered trademark of Crop Care.

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THE UNIVERSITY OF ADELAIDE AUSTRALIA

GRDC Grains Research & Development Corporation

# Managing Crown Rot


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Extension

## Key messages

- **All cereals host crown rot, and concentrations of crown rot in 2006 stubbles are likely to be high.**
- **Where a cereal crop is infected with crown rot, the bulkier the crop the greater the risk of yield losses in the next cereal.**
- **Check levels of crown rot in your paddocks visually in-season or over summer using soil samples (Predicta-B).**
- **A break from cereal is the most effective management option for crown rot.**
- **Barley and bread wheat show smaller yield losses to crown rot than do triticale and durum wheat.**
- **Varietal resistance and tolerance to crown rot are limited.**
- **Fungicides will not protect crops from crown rot.**

## Why worry about crown rot on Eyre Peninsula?

Crown rot affects all cereals and is widespread on Eyre Peninsula, although often only present at low or medium levels. Intensive cereal cropping, limited break options and the frequent occurrence of moisture stress during grain fill all make Eyre Peninsula cereal crops vulnerable to crown rot.

Trial results show that crown rot has the potential to reduce bread wheat, barley and triticale yields by up to 25%. On average, bread wheat and barley losses are 7% and triticale losses are 17%. Durum wheat can lose up to 50% of yield, with average losses of 20%. Yield losses in oats are still being quantified.

This article draws on results reported in EPFS 2002 (page 74), EPFS 2003 (page 74), EPFS 2004 (page 81) and EPFS 2005 (page 80).

## How can you tell whether you have a crown rot problem?

Whiteheads scattered through wheat crops (not in well-defined patches) are the most obvious sign of crown rot. Typically one or two, but not all, tillers on a plant will exhibit whiteheads. Whiteheads will not always develop on infected plants, although yield losses may still occur.

You can check for crown rot by looking at plants during grain fill or around harvest. Note that oats do not show stem symptoms or whiteheads, and barley does not show whiteheads. Pull plants up and peel back the leaf sheaths. Infected stems will show a honey-brown to dark-brown discolouration at the base. Infected plants sometimes also have pink or white fungal growth at the base, around nodes or inside stems. If you are not sure whether stem browning is crown rot, you can place plant bases in a plastic bag with a damp paper towel for a few days in a cool place out of the sun. If fluffy pink growth occurs then it is crown rot; if the growth is white it may or may not be crown rot.

To get a feel for the problem in a paddock, you need to check a number of plants. I would suggest going to four spots in better-performing parts of the paddock and checking 10–15 plants in each. Categories for assessing disease risk to the following crop are not yet available, but I would suggest the following: low risk — less than 20% of plants infected; medium risk — 20–40% of plants infected; high risk — more than 40% of plants infected. Where a crop is infected, bulky crops mean a greater risk of yield losses to crown rot in the next cereal.

An alternative method of checking for crown rot problems is to take a soil sample over summer and send it in for DNA analysis (Predicta-B Root Disease Testing Service). This means you will have a risk assessment for your paddock well before seeding.


## What is crown rot?

Crown rot is a fungal disease mainly caused by *Fusarium pseudograminearum* in South Australia. The crown rot fungus can survive for many years on cereal and grass residues. This fungus does not grow through soil and to become infected individual stems or tillers must come into direct contact with infected plant residue. The highest concentrations of the fungus are found in the crown and lower stems.

All cereals host crown rot, although oats show no symptoms and barley does not show whiteheads. Grassy weeds also host crown rot and sampling on Eyre Peninsula has shown that brome grass, ryegrass, barley grass and wild oats (the only grasses present at the sites sampled) all carry significant levels of crown rot. Infected crops and plants do not always show disease symptoms, but will build up disease levels for subsequent cereal crops.

Crown rot grows in both living and dead plant material, and 'resistant' plants will only express that resistance while alive. Once the plant begins to die (e.g. as it moves toward harvest or when it is under moisture stress), resistance is lost and the fungus builds up in the stressed, dying and dead tissue.

## When is crown rot most likely to cause problems?

One cereal crop can build crown rot to high levels. Two or more years of break from cereals may be needed to reduce crown rot levels to the point of low risk. This means crown rot causes most problems where cereals are grown continuously and stubble retention is practiced.

The largest yield losses and quickest build up of crown rot are seen where good early crop growth is followed by moisture stress later in the season. Growing season rainfall on Eyre Peninsula often produces this situation naturally, but it can also be produced where excessive nitrogen is present, either applied early in the season as N fertiliser (an unlikely occurrence in Eyre Peninsula farming systems) or from a vigorous, medic-dominant pasture in the previous year.

## What should you do to manage crown rot?

The 'short and not-so-sweet' message is that infected plant material needs to be removed from the system as quickly as possible. This runs counter to the move into intensive cereal, stubble retention, no-till farming systems.

**Knowing the level of crown rot in your paddocks** is the key to long-term crown rot management. Select paddocks with low crown rot levels when sowing susceptible cereals and sow less susceptible cereals (or, preferably, have a break from cereal) in paddocks with medium crown rot levels. Avoid sowing cereals in paddocks with high crown rot levels — manage these paddocks to reduce crown rot levels.

**A break from cereal** is the most effective management tool for crown rot. Closed canopy breaks (e.g. peas, vetch, grass-free medic and canola) reduce crown rot levels most quickly. On Eyre Peninsula, where canopy development is often poor, breaks may be less effective. Limited data from the Minnipa competition paddocks suggest that heavily grazed grassy pastures with few volunteer cereals may also help reduce crown rot levels (Table 1). Where crown rot levels are high, a 2–3 year break may be needed to reduce risk levels to low. Assessing crown rot risk levels after a break from cereal is best done using a soil test.

**Burning** infected stubble over summer is unlikely to provide benefits for a cereal crop sown in the next season. Burning is most likely to be effective when used to remove heavily infected cereal stubble as part of a long-term management plan.

Choice of cereal type will influence yield losses and the time crown rot levels take to decrease. Barley is least likely to incur yield losses, followed by bread wheat. Triticale is more likely to have large yield losses and durum wheat will have the largest yield losses to crown rot. At present, we have no yield loss information for oats. All cereal types have similar concentrations of crown rot per gram of stubble, so it is crop bulk rather than crop type that will most influence build up of crown rot. If you do sow triticale, remember crown rot levels will take longer to reduce than after other cereal types.

**Cultivation in autumn** is unlikely to provide benefits for a cereal crop sown in the same season. Cultivation will help infected stubble to break down more quickly and may be useful as part of a long-term management plan.

**Fungicides** will not protect crops from crown rot.

**Hay making or baling cereal straw** is unlikely to provide benefits for a cereal crop sown in the next season but may be useful as part of a long-term management plan to keep crown rot levels low.

**Managing common root rot** (*Bipolaris sorokiniana*) may assist in reducing losses to crown rot. Where the root system is damaged by common root rot, moisture stress on the plant will be increased at the end of the season.

**Nutrition** plays a minor role in managing crown rot. Adequate trace element availability assists crops to cope with crown rot.

**Precision sowing** allows susceptible cereal crops to be sown between old cereal rows. Crown rot levels are usually lowest between old cereal rows. Sowing this way can reduce losses to crown rot, but in low rainfall situations it would be difficult to justify the expense of changing to precision farming simply for the purpose of managing crown rot.

**Variety choice** is not as important as for other diseases because the range of resistance or tolerance in commercial varieties is limited. Kukri is more resistant than other bread wheats but should only be grown in situations to which it is agronomically suited or it will yield poorly. Again, it is bulk rather than varietal resistance that will most influence build up of crown rot.

***Table 1** Crown rot (pg DNA/g soil) presence in MAC competition paddocks 2005–06 (note: limited data — one season and one site only).*

| | Researchers | District practice | Farmers | Consultants |
|---|---|---|---|---|
| **2004 crop** | Wheat | Wheat | Wheat | Barley |
| **2005 crown rot DNA pre-sowing and risk** | 21 (Low) | 2452 (High) | 453 (High) | 220 (Medium) |
| **2005 crop** | Wheat | Grassy pasture | Medic | Peas |
| **2006 crown Rot DNA pre-sowing and risk** | 115 (Medium) | 343 (High) | 89 (Low) | 22 (Low) |

## What research are we doing to find better management options for crown rot?

We are breeding and screening for resistant or tolerant varieties; developing improved methods for assessing paddock crown rot levels; quantifying yield losses in a range of cereals; checking the effectiveness of precision sowing; monitoring the effects of farm paddock management on crown rot levels; assessing the influence of nitrogen nutrition on yield losses; investigating whether microbial ameliorants will reduce crown rot levels in cereal stubble more quickly; and comparing the effects of different crop types and varieties on crown rot build up and reduction.


## Acknowledgements

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# CEREAL VARIETY DISEASE TABLES

## *Disease rating of current oat varieties*

| Oats | Rust | | *Septoria avenae* | BYDV | CCN | | Stem nematode | | Bacterial blight | *Pratylenchus neglectus* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | stem | leaf | | | Resistance | Tolerance | Resistance | Tolerance | | Resistance | Tolerance |
| **Bettong** | MS | R | MS | MR | R | VI | R | T | MR | MR | – |
| **Brusher** | MS | R | MR-MS | MS | R | MI | – | I | MS | MR-MS | – |
| **Echidna** | S | S | VS | MS | S | VI | R | T | S | MR | MI |
| **Eurabbie** | MS | S | MR | MS | MS | MI | MS | MI | S | – | – |
| **Euro** | VS | MS | S | MR | R | VI | VS | I | MS | MR | T |
| **Glider** | R | R | MR | S | MS | I | R | MT | R | – | – |
| **Kangaroo** | R | MR | MR | MS | R | MT | – | MI | MR | – | – |
| **Marloo** | S | S | MS | MR | R | MT | MS | MI | S | – | – |
| **Mitika** | R | MR | MS | MS | VS | I | – | MT | MR | – | – |
| **Mortlock** | MS | S | S | MS | MS | I | VS | VI | MS | MR | – |
| **Numbat** | S | MR | MS | R | S | I | – | I | S | MR | – |
| **Potoroo** | S-VS | MS | VS | MS | R | T | MR | MT | S | MR | T |
| **Possum** | MS | MS | MS | MS | VS | I | – | MI | S | MR | – |
| **Quoll** | R | R | MR | MS | S | I | R | T | MS | MR-MS | – |
| **Swan** | VS | S | MS | S | R | VI | VS | VI | MS | MR-MS | – |
| **Wallaroo** | S | S | S | MS | R | MT | MS | MT | MS | MR | MI |
| **Wintaroo** | S | S | MR | MR-MS | R | MT | MR-MS | T | MS | MR-MS | – |

*R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible, T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, – = uncertain*

Disease

## Disease rating of current wheat varieties

| Wheat | Rust | | | CCN | | *Septoria tritici* blotch | Yellow leaf spot | Powdery mildew | Root lesion nematodes | | | Crown rot | Common root rot | Flag smut | Black point |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stem | Stripe | Leaf | | | | | | *P. neglectus* | | *P. thornei* | | | | |
| | | | | Resistance | Tolerance | | | | Resistance | Tolerance | Resistance | | | | |
| **Wheat** | | | | | | | | | | | | | | | |
| **Annuello** | R | MS | MR | R | I | S | S | – | MS-S | MI | – | S | – | – | MS |
| **Barham** | MR | #/MR | MR-MS | MS | – | S | S | MR-MS | MR | – | MS | – | – | MR-MS | – |
| **Bowie** | S | #/MS | MR | MR-MS | MT | MS | S | – | MR | MT | MS | S | S | – | MR-MS |
| **Camm** | S | #/S | S | S | MI | S | S | – | MS | – | – | S | MS-S | MR | MS |
| **Carinya** | MR | #/MS | MR-MS | S | – | MS | S | MS | S | – | S | MS-S | MS-S | MS | S |
| **Catalina** | MR-MS | MR-MS | MR | R | – | S | S | MR-MS | S | – | MS | S | – | R-MR | – |
| **Chara** | MR-MS | MS | MR | R | MI | MS-S | MS-S | – | MS-S | MT | MR | S | S | – | MS |
| **Corell** | MR-MS | MR-MS | MS | MR | – | MR-MS | S-VS | R | S | – | MS | – | MS | R | MR-MS |
| **Derrimut** | R-MR | #/MR-MS | R | R | – | MS-S | S-VS | MS | S | – | MS-S | – | – | R | S |
| **Drysdale** | MR | MR-MS | MS | S | – | MS-S | MS-S | – | MS-S | – | – | – | – | MR | MS |
| **Frame** | MS | MR-MS | MS | MR | MT | MS | S-VS | R | MS-S | MT-T | S | S | S | MR | MS |
| **GBA Ruby** | MR-MS | R | MR | S | – | MR-MS | MR | MS | MS-S | – | MR-MS | – | – | S | MR-MS |
| **Gregory** | MR-MS | R-MR | MR | S | – | – | MS-S | R | S | – | S | – | – | R-MR | S |
| **Guardian** | MR | MS | MS | R | – | MS | S | MR-MS | MS-S | – | S | S | – | S | – |
| **H45** | MR-MS | VS | MR | S | I | VS | MR | – | MS | MT-T | – | S | S | – | MS |
| **H46** | MR-MS | #/VS | R | S | MI | VS | MR-MS | S-VS | MS | – | MS-S | – | – | R-MR | MR-MS |
| **Janz** | MR | MR-MS | MS | S | I | MS | S | MS | MS-S | MI | S | MS-S | MS-S | R | S |
| **Krichauff** | MR | S | S | S | MT | MS | MS | – | MR | MT | MS | S | MS | MR-MS | MR |
| **Kukri** | MR | MR | R* | S | I | MR | MS | – | MR-MS | MT | MS | MS | S | MS | MS |
| **Machete** | MR | MS-S | MS | S | I | S-VS | S-VS | – | S | I | S | S | VS | S-VS | MR |
| **Pugsley** | MS | #/S | MR | MS | MI | MS | S | MS | S | MT | – | S | MS | MR | MS |
| **Scythe** | MR | MS | MS-S | S | – | MS-S | S | R | – | MS | MS-S | – | MS | S-VS | MR |
| **Ventura** | R | #/MR-MS | MR | S | – | MS | MS-S | – | MS-S | – | MR | MS | MS-S | MR | MR |
| **Wentworth** | MR | MS-S | MS-S | S | – | – | S | MR | S | – | S | | MS-S | S | S |
| **Westonia** | S | VS | MS | S | – | S | MS | S | MS-S | MT | – | S | – | – | MS |
| **Wyalkatchem** | MS | MS-S | R | S | MI | MR-MS | MR | S | MR | MT-T | – | S | S | S | MS |
| **Yenda** | R | #/MR-MS | MR | MS | – | MS-S | MR | MS | MR | – | MS-S | – | – | MR | – |
| **Yitpi** | S | MR-MS | MS | MR | MT | MS | S-VS | – | MR-MS | MT-T | – | S | MS | MR | MS |
| **Young** | MR | #/MS | MR-MS | R | – | MS | MR-MS | R | S | – | MR-MS | – | MS-S | MS | MR |
| **Gladius** | MR | #/MR | MS | MS | – | S-VS | MS | MR-MS | MS | – | MS-S | – | MS | R-MR | MR |
| **Durum** | | | | | | | | | | | | | | | |
| **Kalka** | R | MR | MR | MS | MT | MS | MR | – | MR-MS | – | R | VS | MS | R | – |
| **Tamaroi** | R | MR | MR | MS | – | S | MR | – | MR-MS | MI | R | VS | MS | R | MR-MS† |
| **Triticale** | | | | | | | | | | | | | | | |
| **Kosciuszko** | – | MR-MS | – | S | T | – | – | – | – | – | – | – | – | – | – |
| **Rufus** | – | R | – | R | T | – | – | – | R-MR | MT | R-MR | – | – | – | – |
| **Speedee** | R | MS | R | – | T | – | – | – | – | – | – | S | – | – | – |
| **Tickit** | R | MR | R | R | T | – | R | – | MR | MT | MR | S | MS | R | – |
| **Tahara** | R | R | R | R | T | R | R | – | R-MR | MT | R | S | MS | R | – |
| **Treat** | R | MR | MR | MS | T | – | R | – | MR-MS | MT | – | S | MS | R | – |

*# These varieties carry the Yr17 (VPM) gene and are likely to be susceptible to some degree to a new rust strain identified in 2006.*
*†Tolerance levels are lower for durum receivals.*
*R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible, T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, – = uncertain*

## *Disease rating of current barley varieties*

| Barley | Scald | Net blotch | | CCN | | Powdery mildew | Leaf rust | Barley grass stripe rust | Root lesion nematodes | | Covered smut | BYDV | Common root rot | Black point |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Spot form | Net form | Resistance | Tolerance | | | | *P. neglectus* | *P. thornei* | | | | |
| Barque | S-VS | R-MR | MS | R | T | MR | MS | MR | R-MR | MR | – | S | S | S |
| Baudin | MS-S | MS-S | MR-MS | S | T | S-VS | VS | MR | – | – | – | MR | MS-S | MS |
| Buloke | MR | MS-S | MR | S | T | MR | MS-S | R | – | – | MR | S | – | S |
| Capstan | MR/S# | MS | MR-MS | R | T | MR | MS | MS | MR | – | MR | S | S-VS | MS |
| Fitzroy | MS-S | MS-S | MR-MS | S | T | MS-S | R | R | – | – | S | S | | – |
| Flagship | MS | MR-MS | MR-MS | R | T | MR | MS-S | MS | R | – | MR-MS | S | S | S |
| Fleet | MR-MS | MR-MS | MR | R | T | MS | MS | MR | – | – | MR | S | – | S |
| Gairdner | R/S# | S-VS | MR | S | T | MR | MS | R | MR | MR-MS | – | MR | MS-S | MR |
| Hindmarsh | MS | S-VS | MR | R | T | MS | MS-S | R | – | – | – | S | – | – |
| Keel | MR-MS | R-MR | MR | R | T | MR-MS | VS | MS | MR | MR | R | S | S | S-VS |
| Maritime | MS-S | MR-MS | R | R | T | S | MS | S | MR | – | MS | S | S | S |
| Mundah | S | S | MR | S | T | MS-S | S | R | MR-MS | – | – | S | S | MR |
| Schooner | MS-S | MS-S | MR | S | T | S | S/VS | R | MR-MS | R | MR | S | S | S |
| Sloop | S | S-VS | MR | S | T | S | S | MR | MS | MR | R | S | S | MS |
| Sloop SA | S | S-VS | MR | R | T | S | S | MR | MS | R | – | S | S | MS |
| Sloop Vic | S | S | MR | R | T | MR | MS-S | MR | MS | R | – | S | – | MS |
| Vlamingh | MR | MS-S | MR | S | T | S | MS-S | – | – | – | R | – | S | – |
| Yarra | S/VS | MS | MS | R | T | S | R | R | – | – | MS | S | S-VS | S-VS |
| WI3416/3572 | S | S | MS | R | T | MR | S | – | – | – | R | S | S | S |

*#These varieties may be susceptible if alternative strain is present.*
*R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible, T = tolerant, MT = moderately tolerant, MI = moderately intolerant, I = intolerant, VI = very intolerant, – = uncertain*

Disease

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# Nutrition

## The Potential for Reducing Fertiliser Costs in 2007

**Neil Cordon[1] and Chris McDonough[2]**
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Information

### Key messages

- **Use trace elements strategically as a foliar spray in your crop program.**
- **Use seed with high nutrient concentration and content for sowing.**
- **If your soils are manganese deficient, access your seed from a soil type with adequate manganese levels.**
- **Target higher fertility land with good production potential to reduce fertiliser inputs.**
- **Apply extra nitrogen strategically during the growing season rather than applying it all up front.**
- **Granulated urea and 18:20:00, or combinations of both, are the most cost-effective fertilisers to supply nitrogen and phosphorus to a farming system.**

Many farmers will have limited cash flow from the 2006 season, so finding cropping areas where you can reduce input costs with minimal impact will be a priority in 2007. Fertiliser is but one of those input costs but we need to remember that rates were reduced by up to 20% last season so the decision needs to be thought through.

The first thing to do is to sit down and plan paddock by paddock. Identify those good performing and usually more fertile paddocks to earmark them for sowing in 2007, regardless of whether they were cropped in 2006. Obviously, those poor performing paddocks (even in good years) would be more profitable to leave out as a pasture phase.

History and experience shows that a paddock with good fertility will perform in a good season even with reduced fertiliser rates!

A soil test is useful if there is a requirement to more accurately identify paddocks of higher fertility.

### Soil type

Considering soil type is part of the above process. Sandy soils have lower fertility, so greatly reducing inputs here could have a much larger impact than on the heavier soils. We also know that there is less risk of crop 'burn off' on sands with higher fertiliser and seeding rates. I would substitute any drop in fertiliser rate on sands with a corresponding increase in seeding rate.

### Rotation

Crop choice needs to be considered but it is probably more important to pay attention to agronomic factors such as herbicide residues, root and leaf disease carry over, build up or susceptibility, and herbicide management.

Given the dry end to the 2006 season, we can assume that lower than normal amounts of nutrients were removed in the grain. However, most of Eyre Peninsula did have reasonable vegetative crop growth up until mid-August 2006 so there was still nutrient removal from the soil, which was then deposited in the stubble. These nutrients (especially nitrogen) may not become available until the stubble breaks down and goes through a mineralisation process for availability.

In areas receiving little summer rain, then pasture, pulse, fallow or canola paddocks from 2006 should be targeted for cropping this year over cereal stubble paddocks.

### Summer rainfall

This needs to be evaluated in regard to nitrogen inputs as research by the Mallee Sustainable Farming Project has suggested that, for intensive cropping situations, about 100 mm of non-growing season rainfall is ideal for good stubble breakdown, nitrogen mineralisation, and nitrogen fixation from microbial activity, leading to good soil nitrogen levels at seeding time. In this summer rainfall situation, farming systems that use extra nitrogen at seeding over starter nitrogen may be able to reduce that extra early nitrogen input.

The Mallee work showed that summer rainfall less than 50 mm meant stubble paddock soils were still low in nitrogen and there was a likelihood of more nitrogen tie up during stubble breakdown at seeding time.

### Nitrogen

Crop growth during 2006 was such that little residual nitrogen was left in the system and there was less seasonal nitrogen mineralisation during the drought.

In paddocks where you are sowing cereal into cereal stubble, and there has been minimal summer rainfall, then starter nitrogen will be important for crop establishment. This is particularly important if there is a late opening to the season, and soil temperatures fall, as these conditions tend to work in favour of Rhizoctonia.

Other than starter nitrogen, use post-emergence nitrogen strategically during the season when we have more idea of yield potential and seasonal prospects.

For those who are growing crops with high nitrogen demands (e.g. canola), a deep soil nitrogen test this autumn could provide valuable information.

### Product selection

Granulated urea and 18:20:00 or combinations are the most cost-effective products to supply nitrogen and/or phosphorus to a farming system. If sulphur is required then ammonium sulphate can be substituted for the urea.

### Seed selection

Sowing large plump grain high in nutrient concentration and content will lead to improved early vigour, plant survival, number of early tillers, grains per plant and grain yields. This can be achieved by retaining the large plump grain at seed grading or sourcing 2007 seed from soils that are high in fertility, especially manganese.

### Trace elements

This is an area where real savings can be made if you have traditionally been adding trace elements with your fertiliser or a pre-sowing soil spray. Now is the time for that expenditure to help ease the burden of fertiliser costs this year by using an early tissue test for trace elements and then foliar spray if levels are deficient or spray when visual symptoms first appear.

### Phosphorus

There is likely to be some phosphorus carryover from failed crops last year. One year of reduced phosphorus is likely to have little impact on soils with good levels (greater than 20 mg/kg) or with a good phosphorus history. I suggest that the bare minimum should be enough to cover crop removal. A 1 t/ha wheat crop removes on average 3 kg P/ha so doing a crop removal phosphorus budget is a worthwhile exercise. As a last resort, if cash flow is desperate, then an extreme fallback position is to add nitrogen with little or no phosphorus.

### Cultivation

Whilst not advocating a return to widespread cultivation, it is well known that soil disturbance will improve the availability of nutrients at seeding, which is important for early growth. So in a year where nutrient inputs may be reduced, there should be consideration of getting some soil disturbance by using shares rather than narrow points, but this should not be at the risk of increased exposure to soil erosion.

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# Types of work in this publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad-scale nature, care should be taken when interpreting results from demonstrations.

| Type of work | Replication | Size | Work conducted by | How analysed |
|---|---|---|---|---|
| Demo | No | Normally large plots or paddock size | Farmers and agronomists | Not statistical, trend comparisons |
| Research | Yes, usually 4 | Generally small plot | Researchers | Statistics |
| Survey | Yes | Various | Various | Statistics or trend comparisons |
| Extension | N/A | N/A | Agronomists and researchers | Usually summary of research results |
| Information | N/A | N/A | N/A | N/A |

# Roles of Arbuscular Mycorrhizal (AM) Fungi in Yield Production and P Nutrition in Cereal Crops on Eyre Peninsula

**Huiying (Lisa) Li[1], Sally Smith[1], Dot Brace[2], Kathy Ophel-Keller[1,3], Bob Holloway[1,2] and Andrew Smith[1]**

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[3]SARDI Plant and Soil Health, Plant Research Centre

Research

## Key messages

- **Mycorrhizal infection of wheat was high in grey, highly calcareous soils of Upper Eyre Peninsula.**
- **AM fungi are involved in P uptake by wheat but the value to production is not clear.**

## Why do the trial?

Arbuscular mycorrhizal (AM) fungi exist in most natural and agricultural soils worldwide. They form symbiotic associations with the roots of many plants, including cereal crops such as wheat. After contacting roots, the hyphae grow along the root surface and penetrate the roots to form specialised structures (arbuscules, coils and vesicles; see photos). At the same time, hyphae in the soil grow, branch and form extensive networks that extend the root system. The hyphae are more efficient than roots at absorbing P and are able to transport it (and other nutrients like Zn) rapidly from soil to plants. AM fungi can also reduce impacts of root disease, drought and salinity on plants, and improve soil structure.

The relationships between AM fungi and plants are therefore usually mutually beneficial; the fungi supply mineral nutrients and other benefits to their hosts and in return the plants supply sugars to the fungi. However, plant growth responses to AM fungi differ considerably with different plant and fungal species and are also altered by soil P status. Some plants always show marked benefits from the symbiosis, but others, such as wheat, sometimes show no benefit or even have negative responses, especially at the early stages of plant growth. This is thought to be because plants 'lend' considerable amounts of sugar to the fungi as they spread in the roots and soil. It is unclear how plants barter sugar for P with their fungal partners and budget their investment in sugar over the whole plant lifespan. Better understanding of the behaviour and strategy of the symbiosis may help farmers to manage the AM fungi appropriately and maintain healthy soil environments for higher crop production. Projects supported by SAGIT and ARC-Linkage grants are investigating the multifunctional roles of AM fungi in P nutrition related to yield and disease development in cereal crops, particularly on the highly calcareous soils of Eyre Peninsula, over a wide range of experimental scales from molecular to glasshouse to field. This paper shows some of the results so far.

## How was it done?

Inoculum potential of native AM fungi was examined under both field and glasshouse conditions. Soil and wheat root samples were collected from trials at Cungena, Warramboo and Port Kenny. Spores in soils and colonisation in roots were measured. The soils from the three sites were brought to the glasshouse to test mycorrhizal growth responses of wheat, clover and medic. The soils were sterilised to eliminate native fungi and provide a non-mycorrhizal (NM) control. Mycorrhizal treatment was sterilised soil inoculated with 10% unsterilised soil to reintroduce native fungi. Plants were harvested at six weeks after planting.

We have also conducted glasshouse experiments by using sterilised soil from Cungena and single cultured fungus with different rates of P applications. The purpose of these experiments was to investigate the function of AM fungi in wheat growth and P uptake at different developmental stages and soil P status.

## What happened?

Up to ~20–40 spores of AM fungi are contained in one gram of soil (from Cungena). Three crops (wheat, clover and medic) were quickly and heavily colonised by both native and cultivated AM fungi at six weeks after planting. About 80% of root length was filled with hyphae, arbuscules, coils or vesicles (see photos). Each gram of soil contained up to 3 m of hyphae, capable of extending plant P uptake. Soils from Cungena, Port Kenny and Warramboo showed similar high potential of AM fungi to colonise roots. Many AM fungal species coexisted in field soils. DNA technologies have shown that three major groups of fungi are present, with the dominant ones being *Glomus* species. AM colonisation was very high in all Eyre Peninsula soils.

Clover and medic grew poorly or even died in NM soils, even when extra P was supplied. However, they grew large and healthy in the presence of AM fungi. These species of plants rely almost completely on AM fungi for P uptake in Eyre Peninsula soils. Wheat plants differ from clover and medic in AM response. During early growth (up to tillering), total dry weight was significantly decreased by AM fungi at all P levels (Figure 1A; $P<0.001$). At maturity, responses of

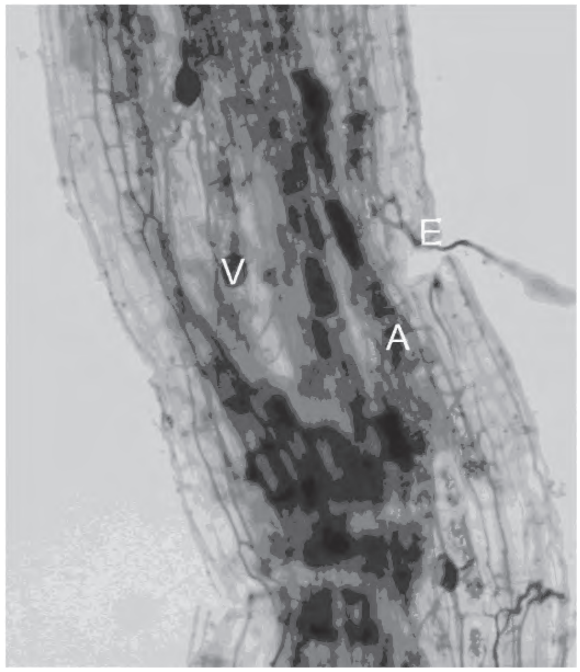
Nutrition

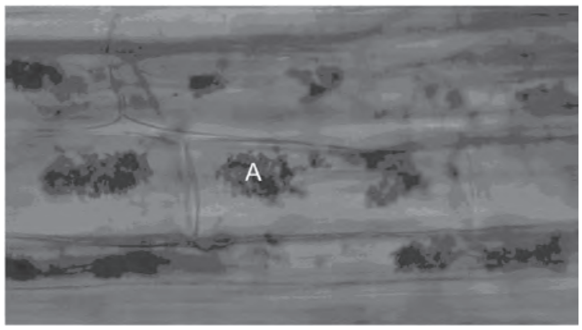
AM plants compared to NM plants varied depending on P levels. There was a significant interaction between AM fungi and P supply ($P<0.001$). AM plants had lower grain yield when no P was applied, but with higher P application yields were similar or higher in AM plants (Figure 1B). Results show that the effects of AM fungi on wheat are complex, change during plant development and can be modified by P fertilisation.

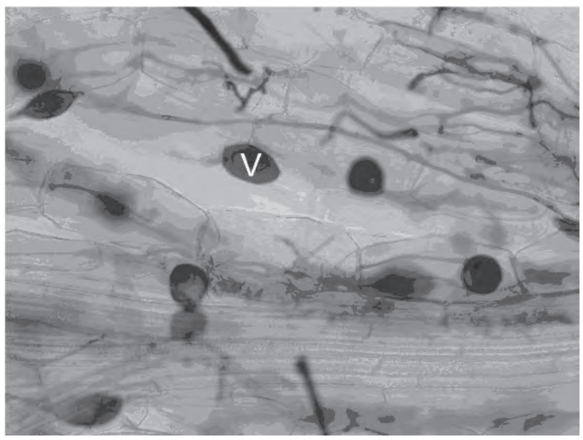
## What does this mean?

An important question is whether the AM fungi cheat young plants by taking sugar without supplying P when growth depressions occur. We have shown that this is not the case. Although AM fungi decreased early growth of plants in low P soil, plants with AM fungi produced larger individual seeds that contained much higher P and Zn than NM plants. This may be vital for ensuring success of the next generation. By supplying the hyphae with radioactive phosphate, we showed that the fungi delivered 50% of the P that the plants received from the soil. In other words, the fungi quietly took over half of the work of the roots and were not cheating the plants. But we do not know why plants seem to pay 'excessively' for hyphae to replace the P uptake job of the roots. Is it because the growth environment is too hard and complicated for roots so they have to find a confederate, or is it because other benefits (like disease or drought tolerance) actually outweigh the reductions in early growth? This is almost impossible to determine in the field because all soils have AM fungi. 'NM controls' can only be produced by drastic treatments like soil fumigation. As this will eliminate pathogens as well as AM fungi, the results of the experiments are confounded.

The next step of the project will be to reveal differences in the way both roots and fungi access the P from fluid fertiliser, in comparison to granular forms. Do roots and fungi grow differently in soil with granules or dispersed fluid P? The aim is to find out if the value of fluid fertiliser depends on the activities of the fungal partners. We will also address the potential effects of AM fungi on root disease. As it seems that AM fungal colonisation of wheat roots is normal in many field soils, we must learn how best to manage their effects on plant productivity and maximise their potential benefits. One of the tools that is now needed to do this effectively is




***Photos*** ***AM formation in roots of wheat at tillering stage grown in the trials at Cungena, 2005. Fungi (stained blue) penetrate the roots at the entry point (E) and spread rapidly, forming specialised structures that transfer nutrients (Arbuscules, A) and fungal lipids (Vesicles, V).***

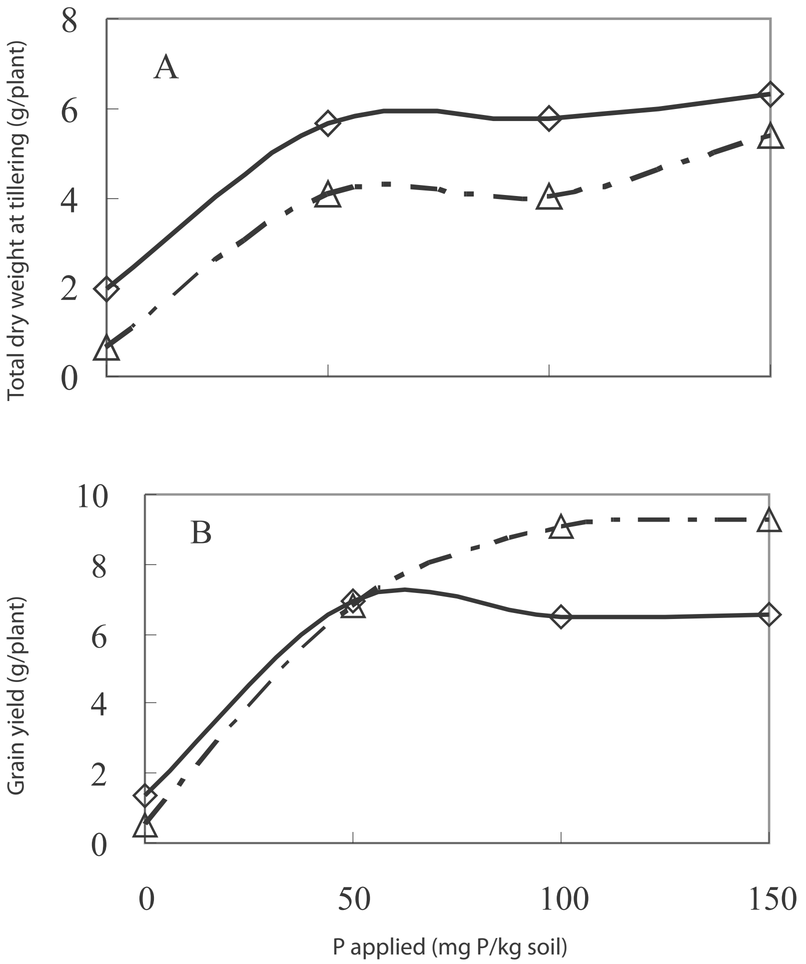



***Figure 1*** ***Total dry weight at tillering (A) and grain yield at maturity (B) of wheat (cv. Krichauff) grown in a sterilised calcareous soil from Cungena. The soil was uninoculated (NM; solid line) or inoculated (AM; dotted line) with a cultivated AM fungus (Glomus intraradices). Phosphorus was added as*** $CaHPO_4$ ***at 0, 50, 100 and 150 mg P/kg soil.***

DNA-based assessment of AM fungal populations and infectivity. A major aim is to develop DNA technologies to provide a test for AM fungal infectivity of soil and biomass in roots. Such a test would replace very time-consuming bioassays that are currently the only way of determining the potential activity of the fungi in field soils. Future work will also isolate, cultivate and test the different native fungi for their ability to colonise roots and provide benefits to the plants.


## Acknowledgements

We thank SAGIT (Project no. UA1/05) and ARC-Linkage (Project no. LP0669161) for funding the research. The SARDI Root Disease Testing Service (RDTS), with funding from Meat & Livestock Australia, have provided expertise for the initial stages of development of the DNA tests.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Nutrition

# Why We Think Fluid Trace Elements are More Effective than Granular Trace Elements

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[3]NRMRL, USEPA, Cincinnati, USA [4]GSECARS, University of Chicago, Chicago, USA


## Key message

- **Fluid forms of Cu, Mn and Zn, when supplied with fluid P, are more mobile in the soil compared to granular fertiliser.**

## Abbreviations

Cu: copper, Zn: zinc, Mn: manganese, P: phosphorus, N: nitrogen, MAP: monoammonium phosphate

## Why do the study?

Recent field studies conducted on Eyre Peninsula have shown an increased response to fluid Cu, Mn and Zn (concentration in grain and/or grain yield) compared to granular fertilisers in calcareous sandy loam soils (Holloway et al., 2002, 2006). Laboratory investigations using isotopic dilution techniques revealed that soil-applied micronutrients in fluid form diffuse more and remain in soil as potentially 'plant-available forms' longer compared to micronutrients applied in granular forms (reported in the EPFS 2005 Summary, Hettiarachchi et al., 2006, pages 106–107). Understanding the chemical reactions responsible for the differences between fluid and granular micronutrients will allow us to explain why some micronutrient fertilisers perform better than others in soil and to predict which is the best form of fertiliser to be used in a specific soil type. A series of laboratory experiments were therefore set up at the University of Adelaide and CSIRO Land and Water. We used advanced X-ray methods to study the different minerals forming after fertilisers were added to soil. The equipment to analyse these experiments is not yet available in Australia, so the experiments were done both in the USA and Japan at the large and powerful X-ray facilities there (synchrotrons).

## How was it done?

Grey calcareous soils from Eyre Peninsula (Mn and Zn, Warramboo; Cu and Zn, Cungena) were incubated with fertilisers in the centre of experimental cells for four weeks. Trace elements were supplied in the sulphate form for the liquid treatments and for Mn and Cu in the granular treatments. Zn was supplied in the oxide form for granular treatments. For all granular treatments, the trace elements were incorporated into the fertiliser granule. The treatments applied are shown in Table 1.

*Table 1 Fertiliser treatments applied to grey calcareous soils from Eyre Peninsula.*

| Granular | Liquid |
|---|---|
| Granular P and Mn | phosphoric acid+Mn |
| Granular MAP+Zn | liquid MAP+Mn+Zn |
| Granular MAP+Cu+Zn | liquid MAP+Cu+Zn |

After four weeks, X-ray data were collected to observe how far the micronutrients had moved away from the granule, or from the point of liquid injection. We also used the x-ray techniques to try to identify the types of micronutrient minerals forming in the soil around the fertilisers.

## What happened?

**Movement of Cu, Mn and Zn from the fertilisers into soil**

Figure 1 shows that most of the Mn in the granular P form moved out of the granule but was retained or precipitated in the soil just around the granule. Manganese supplied in fluid form with fluid MAP moved well away from the point of fertiliser application.

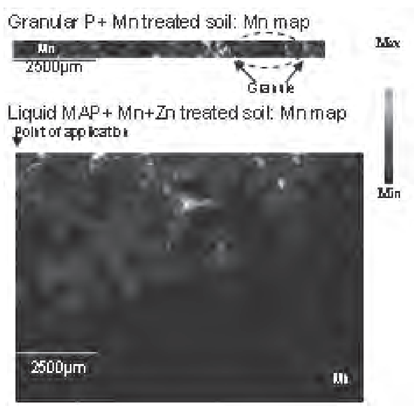


*Figure 1 Manganese distribution maps for soils fertilised with granular and fluid Mn fertilisers.*

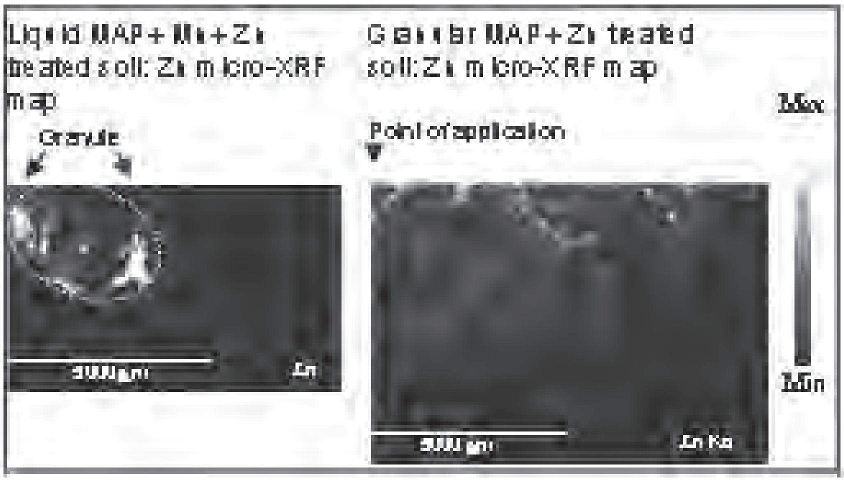


***Figure 2** Zinc distribution maps for soils fertilised with granular and fluid Zn fertilisers.*

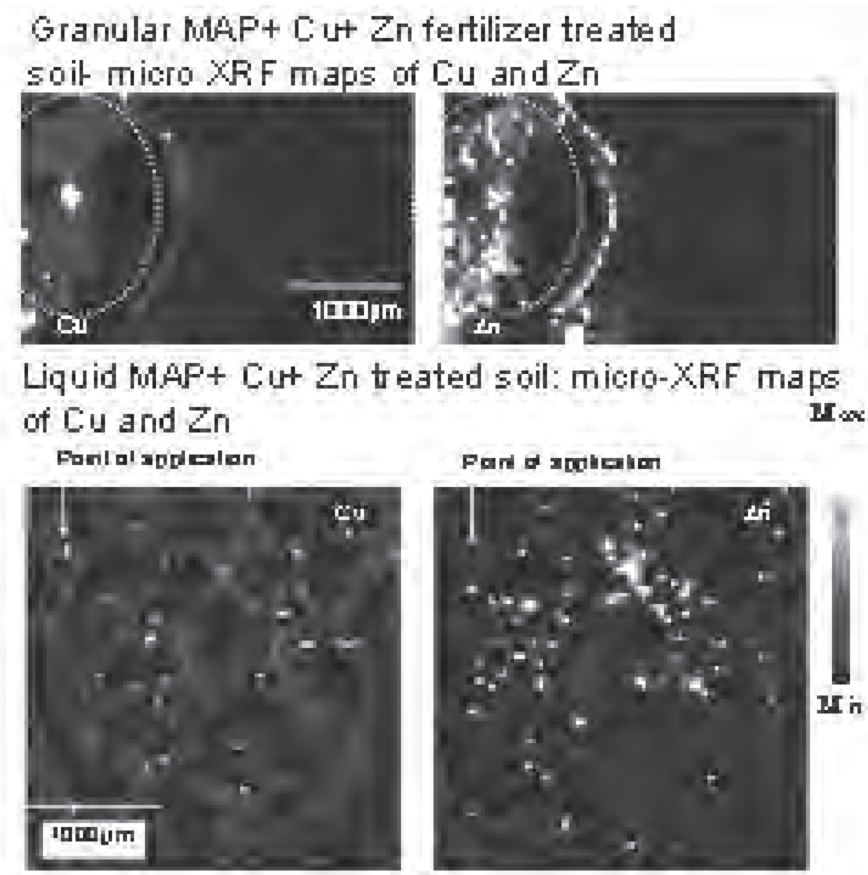


***Figure 3** Cu and Zn distribution maps for soils fertilised with granular and fluid fertilisers.*

In Figure 2, most of the Zn in the granular MAP stayed in the granule and did not move into the soil at all. Like Mn, Zn in fluid form supplied in fluid MAP moved easily away from the point of application.

When Cu and Zn were added to soil in granular MAP, the micronutrients also did not get out of the granule at all in the four weeks in which the fertiliser was incubated with the soil. Cu and Zn supplied in fluid form moved readily away from the point where the fertiliser was injected (Figure 3)

**Chemistry of Cu, Mn and Zn in soil around the fertilisers**

X-ray analysis showed that in soils where micronutrients were added in granular form the types of minerals formed in the soil were different to those in soils fertilised with fluid micronutrients. This is due to a different chemistry occurring in the soil around the granules compared to soil around fluid injection zones. Our previous work showed that the same results are true for P chemistry in soil fertilised with fluid P, where different P minerals formed compared to soils fertilised with granular P. We suggested this might be due to the movement of moisture in soil towards the granules after they are drilled into soil, compared to the movement of liquid away from fluid injection zones (reported in the EPFS 2005 Summary, Hettiarachchi et al., 2006, pages 106–107). These small changes in movement of moisture obviously have a big influence on the chemistry of the nutrients in the soil.

## What does this mean?

The solubility and movement of Mn in granular P+Mn fertilisers is good, but the Mn does not appear to get very far away from the granule, ending up in precipitated minerals in the soil just outside the granule. Cu and Zn in granular P fertilisers do not appear to get out of the granule very much at all, at least in four weeks.

Fluid forms of Cu, Mn and Zn when supplied with fluid P are more mobile, and move away from the point of fluid injection satisfactorily. The movement of fluid Mn was about 10 mm whereas fluid Cu and Zn moved 4–6 mm away from the point of application. This leads to better distribution of micronutrients through the soil and thereby increases the probability that a plant root might hit them. In addition, this enhanced distribution of micronutrients also leads to different minerals forming in the soil around the fertiliser placement point; these appear to be more soluble that those formed around granules.

Our results show that applying micronutrients in a fluid form helps to distribute micronutrients in a greater soil volume and in a more plant-available form at the time the plants needs them the most. These combined factors should result in better fertiliser use efficiency, thus better yields. We think these results explain the superior agronomic effectiveness of fluid Cu, Mn and Zn fertilisers observed in field trials conducted by Dr Bob Holloway's team on Upper Eyre Peninsula and reported in previous EPFS Summaries.

## Acknowledgements

Our thanks to the Australian Synchrotron Research Program (ASRP), ARC (Project no. LPO454086), SAGIT and CSBP Ltd for the provision of funding. A part of this work was performed at GeoSoilEnviro CARS, Advanced Photon Source at Argonne National Laboratory.

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# Section 9

**Section editor:**
**Sam Doudle**
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# Soils

Research

## Update on Subsoil Amelioration Project


**Damien Adcock[1], Terry Blacker[2], Ian Richter[3] and Nigel Wilhelm[3]**

[1]University of Adelaide, Roseworthy, [2]SARDI Port Lincoln,
[3]SARDI Minnipa Agricultural Centre


### Key messages

- **Not all subsoil amelioration treatments confer residual benefits in the years after application.**
- **Deep-placed fluid fertiliser continues to provide a residual yield benefit for wheat.**
- **Cheap, granular sources of N and P may be as effective as fluid N and P when deep placed with liquid TE.**

### Why do the trial?

The GRDC-funded project 'Improving the profitability of cropping on hostile subsoils' has conducted two field trials from 2004 on sand over clay soils to test the residual value of ameliorating subsoil constraints. This work follows up the initial studies by Sam Doudle, who showed substantial benefits to deep-placed nutrients on Wharminda (and other) sands on Upper Eyre Peninsula. These benefits occurred in the year of application and a priority for this project was to test the residual benefits of this technique. Reports of progressive results from Sam's work and this project can be found in all previous editions of the EPFS Summaries.

### How was it done?

A replicated three-phase rotation of wheat, barley and lupins was established on a siliceous sand over sodic yellow clay subsoil with a series of subsoil amelioration treatments (Table 1) at Darke Peak and Stansbury (Yorke Peninsula, canola was used instead of barley). These treatments were applied in 2004 only and are compared to the district 'best' practice in terms of DM production, grain yield and harvest index.

All crops received 50 kg/ha DAP+Zn (5%) banded below the seed, with a further 25 kg/ha as a starter with the seed (75 kg/ha of DAP+Zn with the seed at Stansbury).

### What happened?

Below average rainfall for August, September and October in 2006 resulted in a growing season rainfall of only 120 mm, the second lowest ever recorded at Darke Peak. The trial was sown under very marginal moisture conditions into the water repellent sand and with no immediate follow up rains; establishment was extremely poor and uneven. Insufficient crop developed to harvest.

The Stansbury site on Yorke Peninsula provided some very promising results, which are summarised in Table 2. Generally, the highest wheat grain yields have been achieved by either 'The works' treatment or the deep ripping + nutrient treatment, which have consistently produced more wheat grain than the control, reinforcing the earlier work of Sam Doudle and Nigel Wilhelm with deep-placed nutrients (refer to previous EPFS Summaries).

**Searching for answers**

**Location**
Closest town: Darke Peak
Cooperator: Alan and Mark Edwards
Group: Darke Peak No-Till Group

**Rainfall**
Av. annual: 377 mm
Av. GSR: 285 mm
Actual 2006: 235 mm
Actual 2006 GSR: 120 mm

**Yield**
Potential: 0.74 t/ha (wheat), 1.14 t/ha (barley)
Actual: crops failed due to poor establishment

**Paddock history**
2005: see EPFS 2005 Summary (page 124)
2004: see EPFS 2004 Summary (page 113)
2003: pasture

**Soil**
Land system: dune–swale
Major soil type: Siliceous sand over sodic yellow clay

**Yield-limiting factors**
Severe drought, water repellency reducing establishment

*Table 1 2004 subsoil amelioration treatment details.*

| Treatment | Description |
|---|---|
| 1 | District practice as described in the paragraph above |
| 2 | DR + injection of liquid nutrients* to 0.4 m |
| 3 | DR + organic matter (2 t/ha lupin pellets) at 0.4 m |
| 4 | DR + calcium (equivalent of 4 t/ha of gypsum) at 0.4 m |
| 5 | Surface application of approx. 20 t/ha of composted piggery bedding straw |
| 6 | 'The works', a combination of treatments 2–5 |

**Liquid nutrients contained 60 kg N/ha, 20 kg P/ha, 2 kg Zn/ha, 4 kg Mn/ha and 2 kg Cu/ha.*
*DR = deep ripping*

*Table 2 Stansbury wheat grain yields (2004–06).*

| Treatment | Grain yield (t/ha) | | |
|---|---|---|---|
| | 2004 | 2005 | 2006 |
| 1. District practice | 1.42 | 2.76 | 0.88 |
| 2. DR + nutrient | 3.56 | 3.67 | 1.51 |
| 3. DR + organic matter | 2.63 | 3.19 | 1.41 |
| 4. DR + gypsum | 2.77 | 3.23 | 1.21 |
| 5. Surface organic matter | 1.67 | 2.99 | 1.13 |
| 6. The 'Works' | 2.41 | 3.34 | 1.73 |
| *LSD (P=0.05)* | *1.08* | *0.69* | *0.31* |

*DR = deep ripping*

## What does this mean?

Three consecutive years of grain yield benefits have been achieved from deep-ripped subsoil amelioration treatments applied in 2004 at the Stansbury trial site, which is a duplicate of the Darke Peak site. At Darke Peak, yield benefits were not realised in one of the years since application, so prolonged residual benefits will have to be measured, or substantial cost savings in the technique developed, for subsoil amelioration to be financially viable.

Now it has been demonstrated at Stansbury that consecutive residual grain yield benefits are achievable, especially for wheat and to a lesser degree for canola, the economic feasibility of subsoil amelioration needs to be determined.

Currently, the cost of the fluid fertiliser component of the deep ripping plus nutrients and 'The works' treatments is considerable, and methods of reducing the cost of this component are currently being trialled. Initial results from a trial conducted at Stansbury in 2006 appear to indicate that some components of the fluid fertiliser blend, namely nitrogen and phosphorus, may be applied in a granular form with fluid trace elements without losing the yield benefits achieved from an all-fluid blend. Further research is required to substantiate these initial results.

## Acknowledgements

We would like to thank Alan and Mark Edwards for their support and hospitality, and all the staff at SARDI Port Lincoln and MAC who assisted with sampling.

This project is funded by GRDC as part of the 'Improving the profitability of cropping on hostile subsoils' project (DAV00049), a collaborative effort between SARDI, University of Adelaide, DPI Victoria (Horsham) and the Birchip Cropping Group.

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BCG shared solutions

GRDC Grains Research & Development Corporation

# Buckleboo 'Subsoil Enhancer' Demonstration (3rd year)

**Buckleboo Farm Improvement Group (BIG FIG), Jon Hancock**[1]

[1]SARDI Minnipa Agricultural Centre

Research

## Key messages

- **Gypsum increased grain yield on the sand over clay soil.**
- **Gypsum was essential to prevent yield losses from subsoil treatments on the loamy soil.**

## Why do the demonstrations?

These demonstrations, initiated by the Buckleboo Farm Improvement Group (BIG FIG), are testing whether ripping, nutrition and/or gypsum applications can increase the depth of soil profile accessed by crops and thus increase grain yield. They aim to answer the following questions over a number of years and soil types:

- Is there a benefit with deep ripping?
- Are fluid fertilisers more effective than granular fertilisers?
- Is deep-placed fertiliser (40 cm) better than conventionally placed fertiliser (5 cm)?
- Are higher rates of deep-placed fertiliser better than standard rates?
- Does the application of gypsum improve yield and/or access to subsoil moisture by improving soil structure?

Previous results were published in EPFS 2004 Summary (pages 115–118) and EPFS 2005 Summary (pages 122–123).

## How was it done?

BIG FIG gained sponsorship to build a precision seeder and set up long-term demonstrations on four different soil types (sand, heavy red, grey and loam) in 2004. The precision seeder, equipped with Primary Sales hydraulic tynes, is capable of delivering granular or fluid fertilisers to a depth of 40 cm. Different gypsum treatments (2 t/ha bi-annually or 5 t/ha once) were applied to a strip running the length of each demonstration, with control strips (no gypsum) on either side. The bi-annual treatments have now received a total of 4 t/ha of gypsum. The different nutrition and ripping treatments (Table 1) were applied perpendicular to the gypsum strips in the same location each year.

Soil samples taken in 2005 were used to determine the plant-available water capacity (PAWC) for the sand, red and loam sites. The shallow layer of calcrete prevented these measurements from being taken at the grey site. Field capacity (FC), the maximum amount of water that a soil can hold, and permanent wilting point (WP), the theoretical point at which plant roots can no longer extract water, were measured in the lab. The crop lower limit (CLL), the actual point at which plant roots could no longer extract water, was measured in the field at the three sites by having rain-out shelters

***Table 1** Nutrition and placement treatments for Buckleboo demonstrations*

| Treatment number | Name | Fertiliser rate and type | | Fertiliser placement |
|---|---|---|---|---|
| | | Granular @ seeding | Fluid @ seeding | |
| 1 | District practice | 65 kg/ha 18:20 (12N + 13P) | – | Shallow |
| 2 | Rip only | 65 kg/ha 18:20 (12N + 13P) | – | Shallow |
| 3 | Shallow fluids | | 11.7N + 13P + 1Zn + 1Mn + 0.5Cu | Shallow |
| 4 | Deep fluids | 25 kg/ha 18:20 placed shallow | 7.2N + 8P + 1Zn + 1Mn + 0.5Cu | Fluid placed deep |
| 5 | Deep fluids super brew | 25 kg/ha 18:20 placed shallow | 20N + 15P + 1Zn + 1Mn + 0.5Cu | Fluid placed deep |

**Almost there**

**Location**
Buckleboo sand: Tony Larwood
BIG FIG

**Rainfall**
Av. annual: 325 mm
Av. GSR: 230 mm
2006 total: 168 mm
2006 GSR: 123 mm

**Yield**
Potential: 0.77 t/ha (wheat)
Actual: up to 0.23 t/ha

**Paddock history**
2005: Clearfield STL wheat
2004: Mundah barley
2003: lupins
2002: barley

**Location**
Buckleboo red: Rowan Ramsey
BIG FIG

**Rainfall**
Av. annual: 300 mm
Av. GSR: 210 mm
2006 total: 171 mm
2006 GSR: 99 mm

**Yield**
Potential: 0.45 t/ha (wheat)
Actual: failed

**Paddock history**
2005: Clearfield STL wheat
2004: Mundah barley
2003: Yitpi wheat
2002: medic pasture

**Location**
Buckleboo grey and loam:
Bill Lienert
BIG FIG

**Rainfall**
Av. annual: 325 mm
Av. GSR: 250 mm
2006 total: 221 mm
2006 GSR: 114 mm

**Yield**
Potential: 0.69 t/ha (wheat)
Actual: up to 0.40 t/ha (loam site)

**Paddock history**
Grey and loam sites
2005: Clearfield STL wheat
2004: Mundah barley
2003: Carnamah wheat

over small areas of crop from anthesis, and then measurements were taken of the actual water remaining after crop maturity.

In 2006, the bi-annual application of 2 t/ha gypsum was broadcast over the appropriate strip within each demonstration prior to seeding (April). The demonstrations were sown to Clearfield Stiletto wheat (Clearfield STL) at 70 kg/ha on 8 June and sprayed with Tigrex on 17 August for broadleaf weed control. The district practice and rip-only treatments were also sprayed with a trace element brew that delivered 160, 400, 80 and 364 g/ha of Zn, Mn, Cu and S, respectively. Plots were harvested at maturity and grain samples were retained for protein analysis.

## What happened?

CLL, WP and FC for the sand, red and loam soils are shown in Figures 1 to 3. The red soil type has the greatest capacity for storing water but it also has the highest levels below which crops cannot extract water, so its PAWC is little better than the sandy profile (Table 2). The sandy soil on the other hand, while not being able to hold a lot of water, does not hold onto the water as 'tightly' and water is available to plants to lower water contents. For example, at 20 cm from the surface, the red soil has to reach a water content of nearly 20% before water becomes available to wheat. However, at the same point below the surface, water becomes available to wheat at less than 5% for the sandy soil. Loamy soils (mixtures of sand and clay) have very good water-holding characteristics because they have a reasonable capacity to store water, but they still 'release' the water easily to crops.

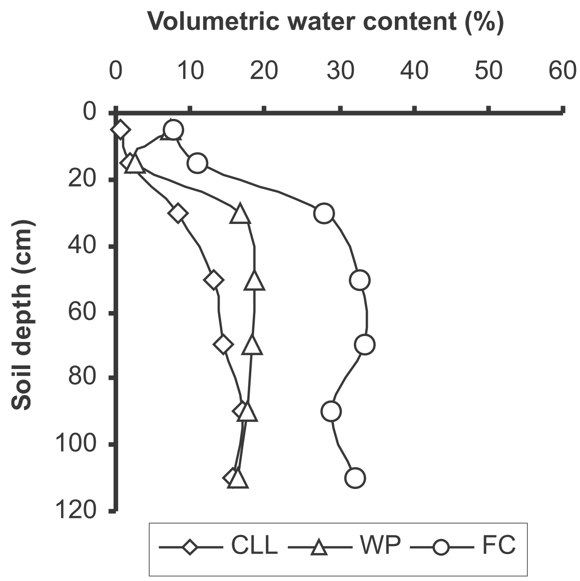



*Figure 1 Water-holding characteristics of the sand site at Buckleboo.*

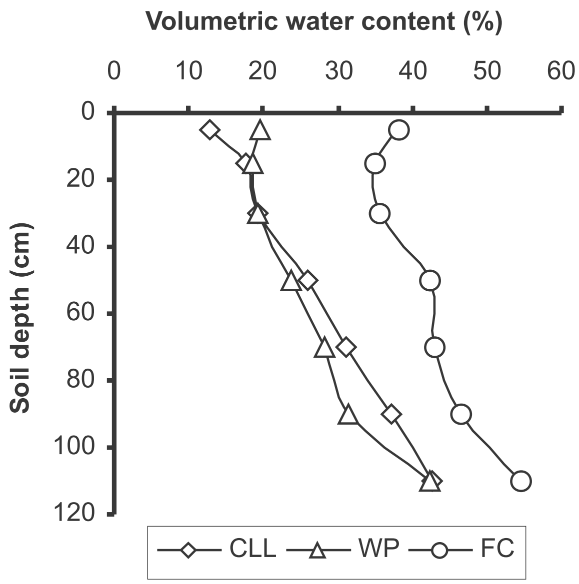



*Figure 2 Water-holding characteristics of the red soil site at Buckleboo.*

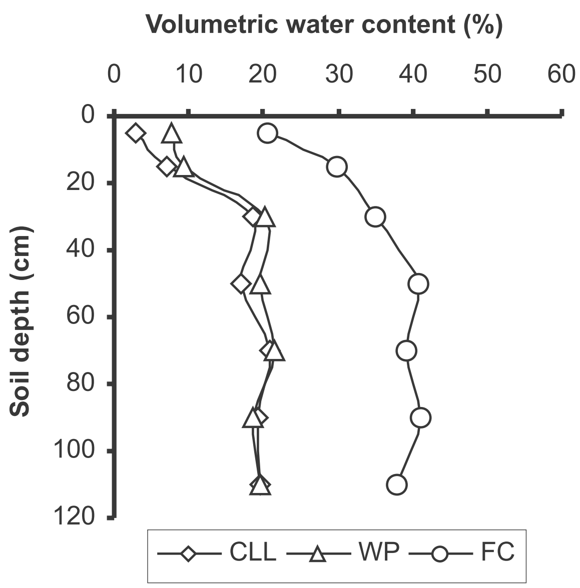



*Figure 3 Water-holding characteristics of the loam site at Buckleboo.*

*Table 2 Water-holding characteristics of sand, red and loam soils to 120 cm at Buckleboo.*

| Site | Maximum amount of water held (mm) | Water unavailable to plants (mm) | PAWC (mm) |
|---|---|---|---|
| Sand | 329 | 186 | 143 |
| Red | 517 | 351 | 166 |
| Loam | 438 | 217 | 221 |

*Table 3 Influence of gypsum on grain yield of wheat at the Buckleboo sand site in 2006.*

| Gypsum treatment | Grain yield (t/ha) |
|---|---|
| Nil | 0.17 |
| 2 t/ha biannually | 0.20 |
| 5 t/ha in 2004 | 0.23 |
| *LSD (P=0.05)* | *0.03* |

*Table 4 Effect of gypsum on grain protein (%) at the sand and loam sites.*

| Gypsum treatment | Sand site | Loam site |
|---|---|---|
| Nil | 18.3 | 16.7 |
| 2 t/ha biannually | 17.7 | 14.9 |
| 5 t/ha in 2004 | 18.0 | 16.3 |
| *LSD (P=0.05)* | *0.5* | *0.3* |

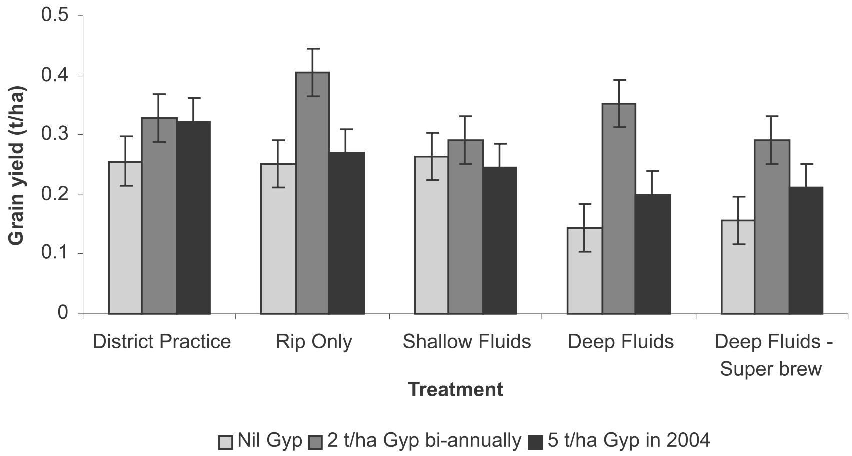



*Figure 4 Effect of nutrition, deep ripping and gypsum on grain yield of wheat at the Buckleboo loam site in 2006.*

The 2006 season was extremely dry at Buckleboo and crops failed at the heavy red and grey sites. Consequently, only the sand and loam sites were harvested. At the sand site, nutrition treatments did not have any effect on grain yield but, for the third consecutive year, grain yield increased with the application of 5 t gypsum/ha (Table 3). One reason that gypsum might increase crop yields is by correcting a sulphur (S) deficiency. Since S levels in grain are a sensitive indicator for S deficiency, selected grain samples from 2005 were analysed for nutrient composition. However, all samples had more than satisfactory sulphur levels for all treatments tested, which indicated that the yield responses to gypsum were not due to the correction of a S deficiency. This suggests that gypsum may be having an impact on the sodic clay which exists below 30 cm in this profile, allowing more root growth and water extraction. Follow-up soil sampling and root scoring work in 2007 is required to substantiate this.

At the loam site, for the treatments that only had shallow cultivation, gypsum did not cause any yield improvements; however, for the treatments that had deep cultivation (rip only, deep fluids and deep fluids super brew), grain yield was higher where 2 t gypsum/ha had been applied bi-annually (Figure 4).

Grain protein was reduced by the bi-annual 2 t/ha gypsum application at the sand and loam site. There were no differences in protein between nutrition treatments (Table 4).

## What does this mean?

At this stage, there appears to be no reason for farmers at Buckleboo to change from their typical practice of a low rate of NP fertiliser at seeding.

In 2006, a very dry season, none of the alternative nutrition techniques outperformed district practice and the deep-placed nutrients reduced yields in the loamy profile. Fluid fertilisers performed slightly better at the red and grey sites in 2004, and at the loam site in 2005, but with erratic and low (<15%) yield responses, it would not currently be worth pursuing these alternatives.

Gypsum produced yield responses at both sites harvested in 2006 and it will be interesting to monitor its effect on subsoil constraints in the future. The sand has had a significant response to the 5 t/ha rate of gypsum since the demonstration began. Grain yield was increased by 0.2, 0.15 and 0.06 t/ha in 2004, 2005 and 2006, respectively, which at current grain prices would be worth around $27/ha/year. The cost of applying 5 t/ha of gypsum, including product, freight and spreading costs, is approximately $155/ha, which would take about six years to recoup. So while gypsum does give reliable yield increases on the sand, unless cheap sources of gypsum are available, it is not a very profitable venture in the short term.

## Acknowledgements

Thanks to cooperators Tony Larwood, Rowan Ramsey and Bill Lienert for providing the demonstration sites. Clearfield is a registered trade mark of BASF Corporation. Tigrex is a registered trade mark of Bayer CropScience. EPFS funded this research.

GRDC Grains Research & Development Corporation

## BIG FIG Sponsors

***Major Sponsors*** — AWB Ltd, Rabobank, Primary Sales, KEE.

***Sponsors*** — Pringles Ag Plus, Hardi Australia, Fertisol, SARDI, Liquid Systems.

***Additional Sponsors*** — Mooses Metalworks, Landmark Kimba, Agsave, K&D Paul and Agrichem.

Special thanks to Fertisol and Agrichem for providing the fluid brews. Thanks to Sam Doudle for helping BIG FIG establish these demonstrations, and staff of MAC, particularly Wade Shepperd, for technical assistance.


***Sowing the BIG FIG trials, 2006.***

# EM38 Mapping on Upper Eyre Peninsula

**Tiffany Ottens**[1] **and Joshua Telfer**[2]

Rural Solutions SA, [1] Streaky Bay, [2] Cleve

Survey

## Key messages

- **EM38 technology can indicate changes in soil texture, salinity, ground water, and the presence of rock. When combined with careful soil sampling it can provide a detailed map of soil limitations under the soil surface.**
- **Understanding the nature and location of soil limitations may enable changes to be made to management practices that could increase yield and overall profitability.**
- **This technology is showing potential benefits for broadacre cropping systems, but more research is needed.**

## Why do the trial?

As input costs continue to increase, it is vital that farming systems are continually refined to ensure that every dollar spent is going to optimise profit in the long term. Although farmers generally recognise poor or better-yielding areas in their paddocks, they do not always know the reasons why.

The EM38 is a device that emits a pulsating electromagnetic wave, and measures the response reflected by the soil down to a selected depth of about 60 cm or 1 m, depending on the configuration. By towing an EM38 in transects across a paddock and recording the different reflections using a data logger, it is possible to generate a soil survey map, similar to the process used to generate yield maps. Because soil salinity levels, soil texture, rock and soil moisture can all affect the electromagnetic signal, some soil sampling is still required to link the map to the actual issues present in the paddock. When the EM38 data are in map form, it can be overlayed with yield data to determine if soil variation is driving yield differences across a paddock.

EM38 mapping have been more widely used in high rainfall and irrigation areas, but there is still a lot to learn about its potential use in low rainfall systems such as on Upper Eyre Peninsula.

## How was it done?

Support provided by farmers from Mount Damper, Wudinna and Streaky Bay allowed investigation of three sites representing a range of soil types and topography. Each landholder identified a repeatedly under-performing paddock that was then surveyed at the end of May using an EM38. A series of soil samples was taken down the soil profile at sites of interest as determined from the survey map. Samples were tested for salinity, pH and texture and then assessed in relation to zones on the EM map. Yield data were collected at the end of the year and these data compared to EM38 readings and soil analyses to estimate actual impacts of soil conditions on crop yield across the paddock.

The results from one of these sites, Dean and Nigel Oswald's paddock at Mount Damper, is discussed in this article.

## What happened?

The EM38 data are shown in Figure 1 (the red star symbols indicate the points where soil tests and yield cuts were taken). There is a relatively narrow range of conductivity (0.01–0.30 dS/m) over this paddock, compared to surveys we have conducted at other sites (up to 2.0 EC (dS/m) in some areas).

Conductivity levels from the EM38 probe of between 0.01 and 0.3 dS/m are not usually considered to be very damaging to wheat. However, when the yield data from the demonstration paddock were compared to the EM38 data, there is a reasonable and negative correlation between the two (Figure 2). This was most apparent at site 421, where soil testing confirmed high salinity levels (ECe of 3 dS/m at 60 cm) and about half the yield compared to high yielding (and low salinity) sample sites (Figure 3).

**Searching for answers**

**Location**
Mount Damper: Dean and Nigel Oswald

**Rainfall**
Av. annual: 328 mm
Av. GSR: 271 mm
2006 total: 277 mm
2006 GSR: 75 mm

**Yield**
Potential: 1.3 t/ha (wheat)
Actual in 2006: 1.1 t/ha

**Paddock history**
2005: canola
2004: wheat
2003: wheat

**Yield-limiting factor**
Dry season

Given the relatively low soil salinity, it is likely that a combination of other soil (texture, fertility) and agronomic (disease, weeds) factors also played a role in the yield differences, but more detailed monitoring is required to confirm the key soil or agronomic factors controlling yield.

## What does this mean?

- EM38 surveys provide maps of soil variability across paddocks that should not change appreciably over time as it is a stable layer of information; EM38 surveying should therefore only need to be undertaken once per paddock.

- EM38 technology can give a reliable indication of variations in soil texture and salinity that exist to about 1 m of depth within a paddock. When combined with several years worth of yield data (to increase our understanding of how paddock variation responds to various seasonal conditions), farmers can gain a greater understanding of the impact these soil variations are having on overall production.

We are only just beginning to explore the potential benefits of EM38 mapping on Upper Eyre Peninsula and the cost-benefit of using technology needs to be carefully scrutinised. However, it does appear to offer opportunities to help manage inputs to maximise economic production and can support systems promoting farming to land class such as 'zone cropping' and 'precision agriculture'. The results from these demonstrations should be considered in conjunction with other work done in the EPFS project on plant-available water and paddock variation (see relevant articles in this manual and previous EPFS volumes).

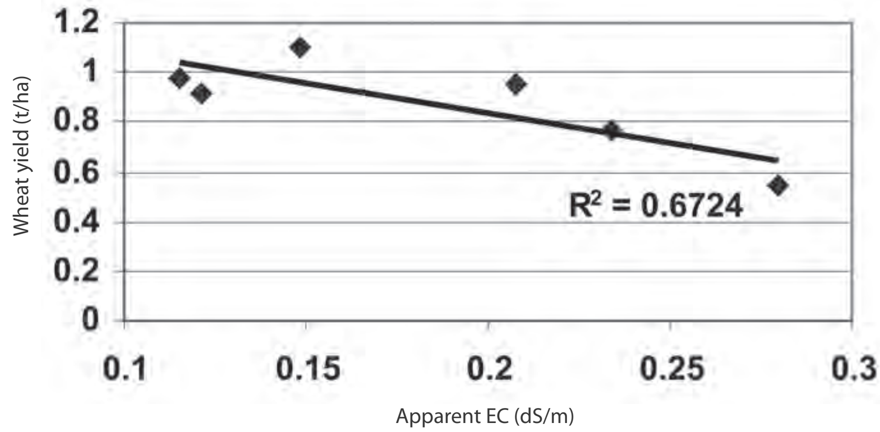



***Figure 2** Correlation between wheat yield (t/ha) in 2006 and apparent EC (dS/m) at Oswald's, Mount Damper.*

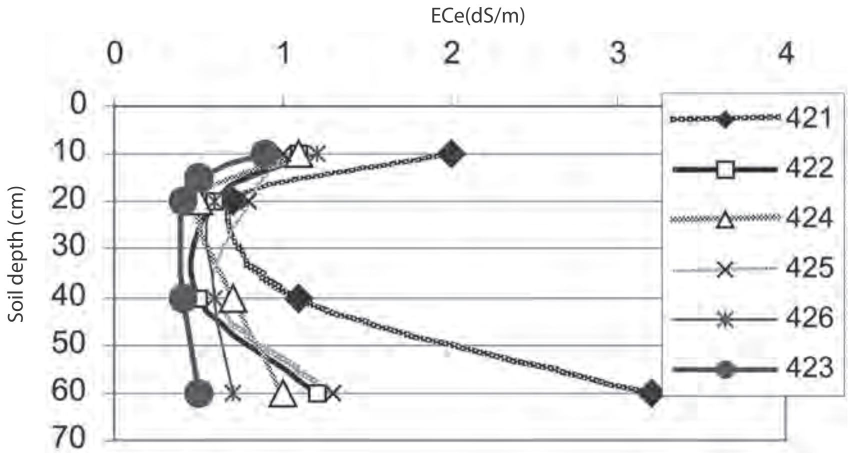



***Figure 3** ECe (dS/m) readings from soil testing conducted at all sampling locations at Oswald's, Mount Damper.*

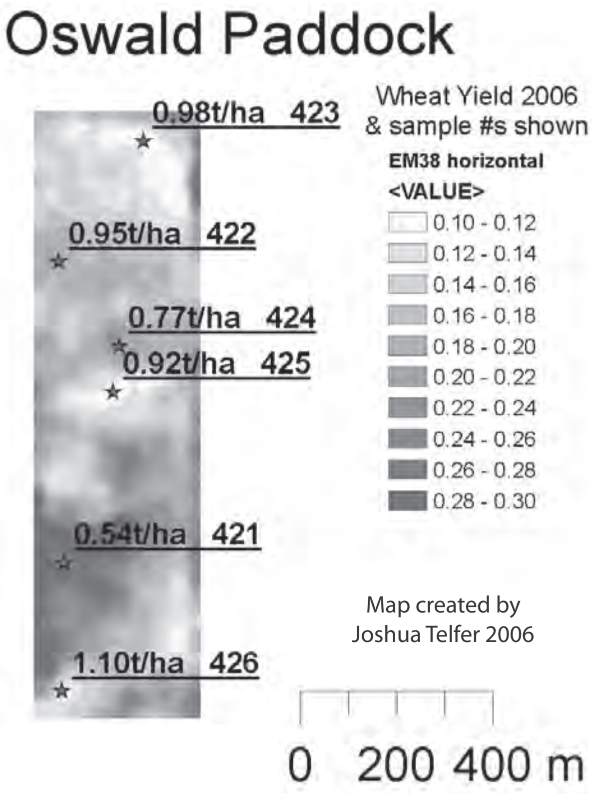



***Figure 1** EM 38 map of Oswald's paddock at Mount Damper, highlighting soil sampling locations and crop yield. The red stars are soil and crop yield sampling points.*

## Acknowledgements

These demonstrations were conducted with funding through the National Landcare program and coordinated by the Eyre Peninsula Natural Resource Management Board.

Many thanks go to the farmers involved — Dean and Nigel Oswald (Mount Damper), Daniel Foster (Wudinna), Simon Patterson (Piednippie) and all their families.

Thanks to Terry Evans for surveying the sites and producing the EM38 maps.

Finally, a big thank you to Liz Guerin for making everything work behind the scenes.

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Program

Government of South Australia
Eyre Peninsula Natural Resources Management Board

# LEADA Water Use Efficiency Demonstrations

**Kieran Wauchope, David Davenport, Nyssa Marshall**
Rural Solutions SA Consultants, Port Lincoln

Demo


## Key messages

- **Soil testing to depth is essential before undertaking any soil amelioration.**
- **Deep ripping can encourage greater root penetration which may give rise to increased yield.**
- **Address the most yield-limiting factor first.**
- **Low potassium levels found in some sandy soils may be affecting crop yields.**

## Why do the trial?

Subsoil constraints are the main factors identified by farmers and agronomists limiting water use efficiency and therefore farm productivity on Lower Eyre Peninsula. These demonstrations were designed to display management strategies to increase water use and productivity on problem soil types found in the region.

## How was it done?

Three sites were selected to represent important soil types on Lower Eyre Peninsula — an ironstone soil, a sandy loam over poorly structured clay and a non-wetting sand over sodic clay. The sites were mapped with an EM38 (electromagnetics) to determine site variability according to apparent electrical conductivity levels, then ground truthed to identify and measure subsoil constraints. Soil testing was undertaken to 50 cm to assess nutrient status, pH, and exchangeable cations.

Treatments applied were influenced by the subsoil constraints present (Table 1). Treatments were imposed in early May with a modified Yeomans plough, with five tines set at 60 cm spacings. Farmer cooperators treated demonstration sites like the rest of the paddock, employing their standard spraying, seeding and fertiliser practices. Establishment and grain yield were measured. Grain was analysed for protein and screenings.

## What happened?

The Koppio (McDonald) site is located on an ironstone soil with a poorly structured clay subsoil. Soil testing indicated that the surface soil was acidic so lime was applied across a number of treatments. There appears to be a yield response to surface-applied lime, but the limed plots were on the downhill side of the demonstration and may have benefited from movement of water downslope; further work is required to confirm the benefits of lime in this situation (Figure 1). There were no differences in protein between limed and non-limed treatments but screenings were higher in five out of the seven treatments without surface lime (Figure 1).

There were no visual crop growth differences during the growing season. Low rainfall was the overriding factor on this demonstration in 2006, which may have reduced treatment effects.

The Marble Range (Puckridge) site has a poorly structured subsoil, and in average rainfall years would often be affected by waterlogging and yield poorly. Treatments were designed specifically to address this issue, but there was insufficient rainfall in 2006 to cause typical waterlogging. There may have been a response to ripping as the average yield of the ripped treatments was 0.45 t/ha higher than the average of the non-ripped treatments, but variability across the site means that further work is required to substantiate this result (Figure 2). Lime had previously been applied to the paddock and, as pH was neutral, no yield response was seen on any of the limed treatments. Surprisingly, there does appear to be a response in grain protein to the lime application (Figure 2) but the reasons for this require further investigation.

***Table 1 Subsoil amelioration treatment details for three LEADA sites.***

| Marble Range and Koppio* | Ungarra** |
|---|---|
| Deep lime | Rip 40 cm |
| Shallow N&P TE 30 cm (surface lime @ Koppio) | Deep TE @ 23 kg/ha |
| Control | Control |
| Deep TE 24 kg/ha | Deep N&P @ 70 kg/ha |
| Deep N&P 70 kg/ha | Surface gypsum @ 5 t/ha, deep N&P TE |
| Deep rip 50 cm | |
| Deep N&P TE @ 70 kg/ha | |

**One half of each site spread with 2 t/ha lime*
*** One half of site spread with potassium sulphate @ 100 kg/ha*
*Note: N&P mixes varied at sites; Marble Range (28:13), Koppio (18:20), Ungarra (19:13:09), TE = trace elements*

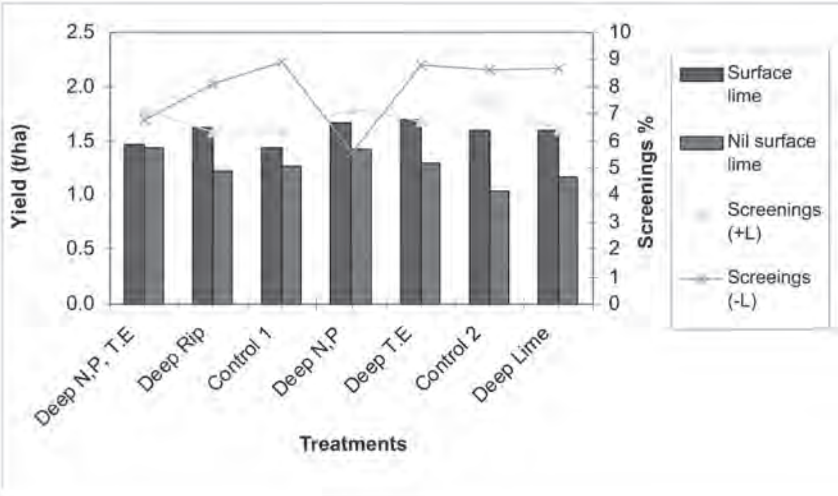



*Figure 1 Treatment effects on grain yield and quality a t Koppio.*

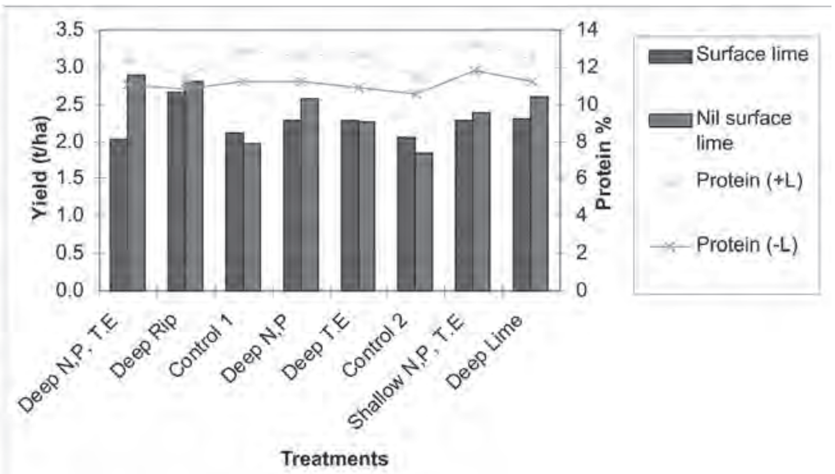



*Figure 2 Treatment effects on grain yield and quality at Marble Range.*

## *Site information*

| | Koppio | Marble Range | Ungarra |
|---|---|---|---|
| **Rainfall** | | | |
| **Av. annual** | 500 mm | 538 mm | 400 mm |
| **Av. GSR** | | 426 mm | 275 mm |
| **2006 total** | 374 mm | 446 mm | 266 mm |
| **2006 GSR** | 207 mm | 262 mm | 140 mm |
| **Paddock history** | | | |
| **2006** | Yitpi wheat | Wyalkatchem wheat | Wyalkatchem wheat |
| **2005** | canola | canola | lupins |
| **2004** | wheat | barley | barley |
| **2003** | canola | wheat | wheat |
| **Soil type** | Ironstone soil | Sandy loam over poorly structured clay | Non-wetting sand over sodic clay |
| **Soil test** | | | Low potassium |
| **Plot size** | 50 m x 12 m | 50 m x 12 m | 50 m x 12 m |
| **Yield-limiting factors** | Lack of moisture | Lack of moisture | Lack of moisture |

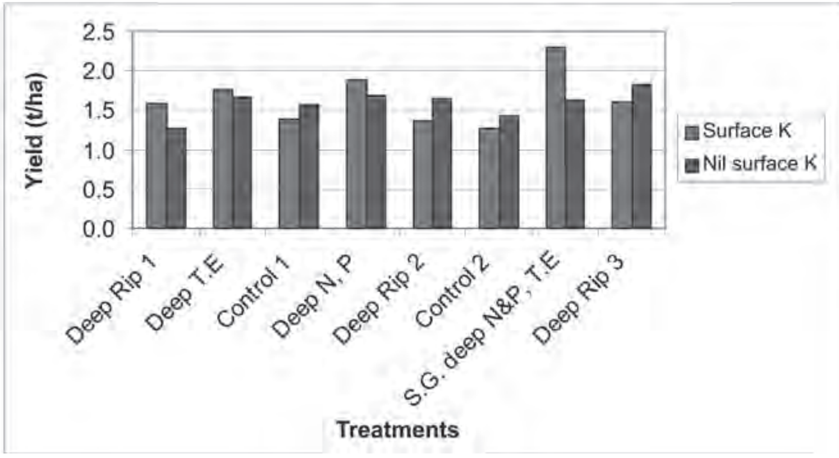



***Figure 3 Treatment effects on grain yield at Ungarra. SG = surface gypsum.***

The Ungarra (Fatchen) site is located on shallow sand over sodic clay and the depth to clay across the demonstration site was variable, making data interpretation difficult. Potassium levels in the sand were low. The combination of surface gypsum and deep nutrition provided the highest yield but, based on what we know of gypsum movement and its effect on subsoil sodicity, the gypsum we applied was not expected to have an effect in the first season (Figure 3). There may have been a response to potassium, particularly where extra nutrition was applied. This result is consistent with some previous work conducted by Hifert in the early 1990s on the same soil type in the Ungarra district (NB: the Hifert work did not always produce a potassium response; results were variable).

## What does this mean?

The demonstration sites will be monitored next year to re-examine the 2006 results and monitor the longer term impacts of:

- liming at Koppio
- deep ripping at Wangary
- potassium at Ungarra.

The investment required to undertake any of these soil amelioration options can be large. This demonstrates the need for thorough soil analysis and setting up some of your own demonstration strips over a number of seasons before undertaking any such work on a broad scale. The results from these treatments on your soil type, under your management regime, can be used to work out the costs and benefits of changing your paddock management. It helps to be confident of a positive yield and economic benefit before spending money.

## Acknowledgements

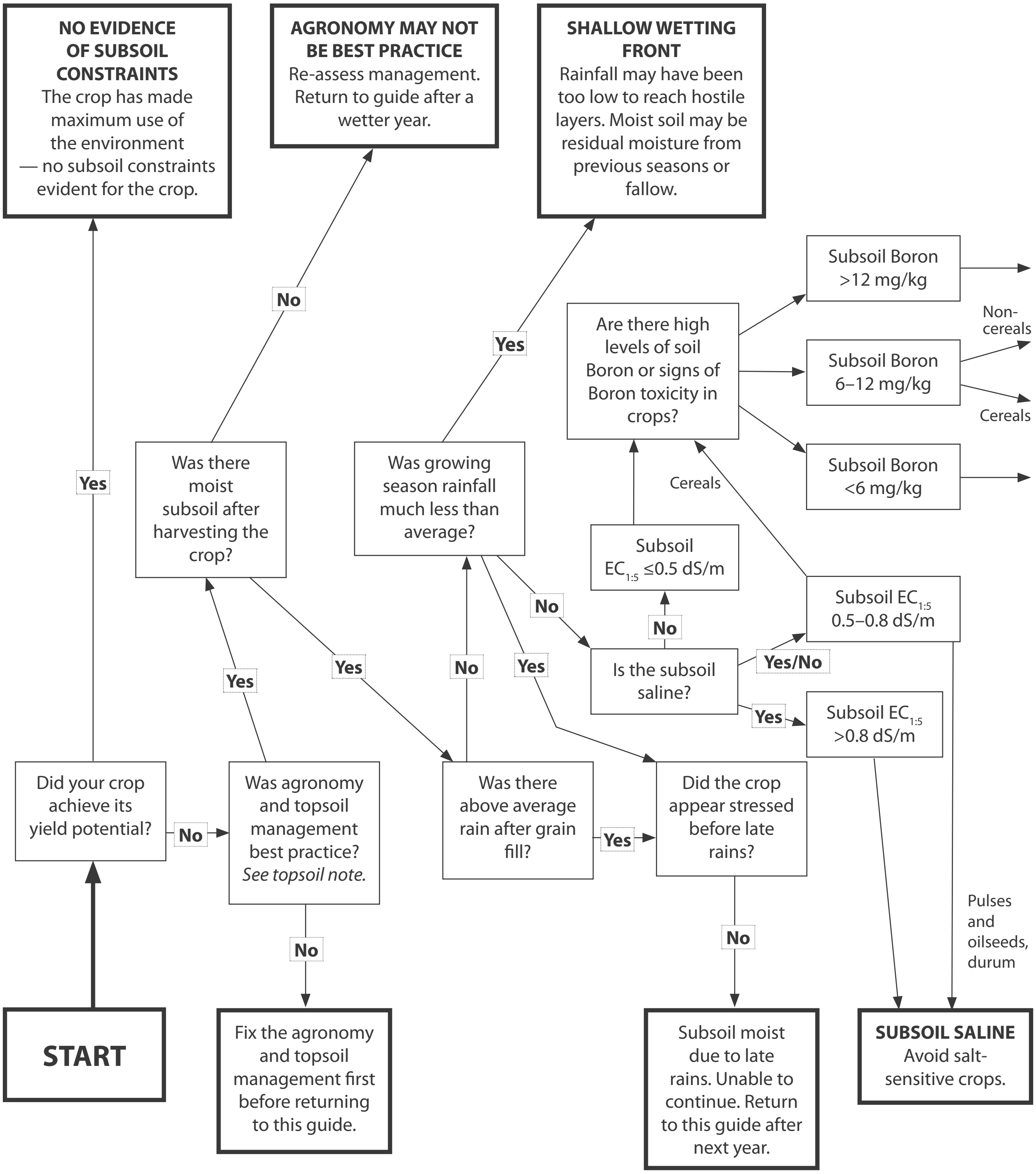
Thanks to the Fatchen, McDonald, and Puckridge families who allowed and supported the demonstrations on their properties. Thanks also to NLP for project funding and DWLBC for supporting the project coordination. Thanks are also extended to the LEADA committee members for their involvement in the demonstrations and general support for LEADA over the past 12 months.

Government of South Australia
Department of Water, Land and Biodiversity Conservation

LEADA Lower Eyre Agricultural Development Association

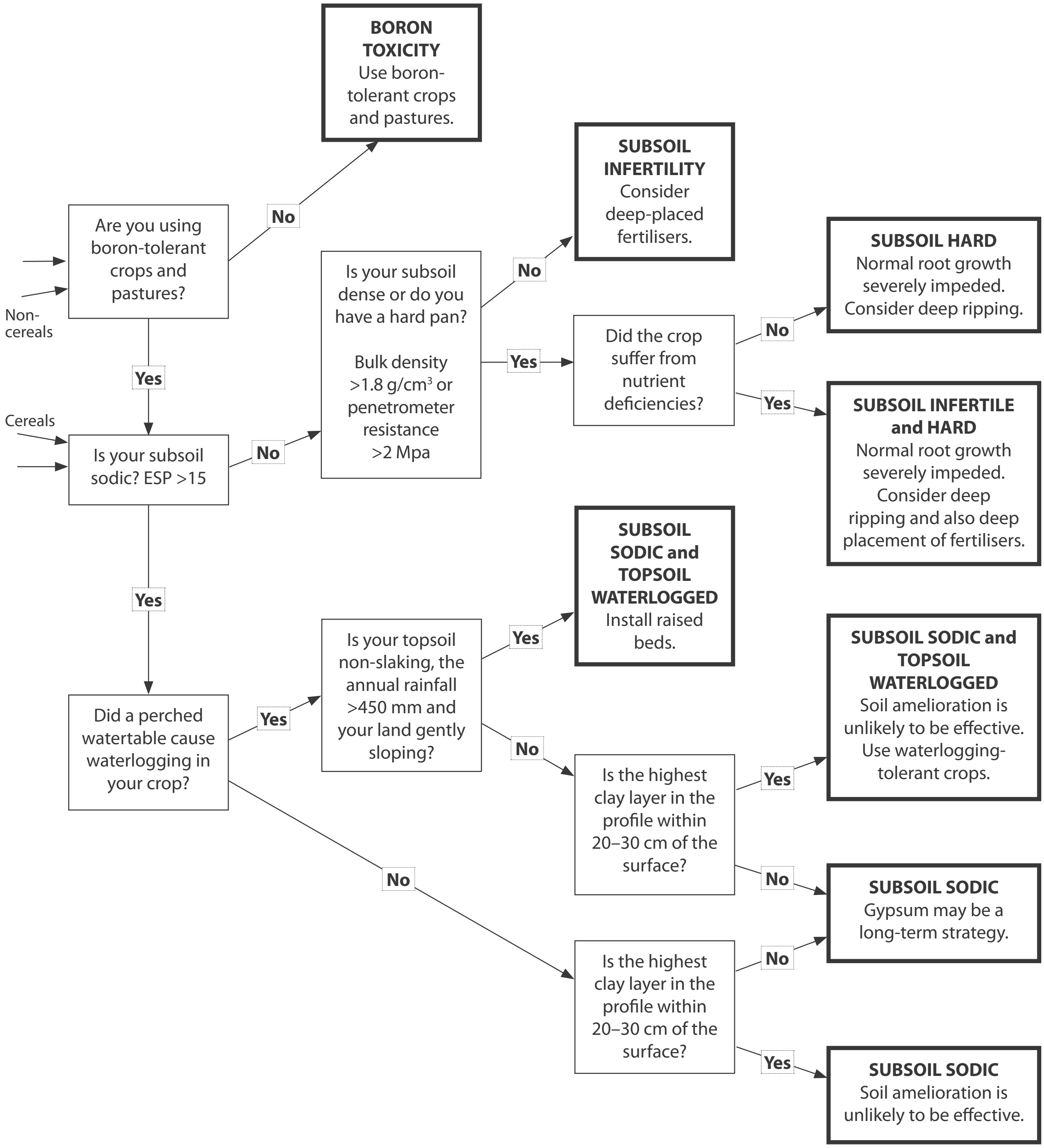
# Diagnostic guide to subsoil constraints

**Diagnostic guide to identify the primary subsoil constraint present in neutral to alkaline soil profiles of southeastern Australia and to suggest appropriate management responses.** This guide is designed such that the constraint in the uppermost subsoil layer is identified first, if that should be ameliorated, then the guide could be re-used to identify a constraint in the next lower subsoil layer (and so on). In order to use this guide, the user will require sound knowledge of crop performance on the soil profile being examined, the chemical characteristics of the subsoil in the profile, and whether the subsoil is moist after harvest of the crop. The logic of the guide flows from left to right. The subsoil has been defined as the soil below the cultivated layer.




### TOPSOIL NOTE

Topsoil management includes all aspects of crop establishment; weed, disease and pest control; variety choice; time of seeding; management of acidity and frost.


BORON TOXICITY Use boron-tolerant crops and pastures.
SUBSOIL INFERTILITY Consider deep-placed fertilisers.
SUBSOIL HARD Normal root growth severely impeded. Consider deep ripping.
Are you using boron-tolerant crops and pastures?
No
Yes
Non-cereals
Cereals
Is your subsoil dense or do you have a hard pan?
Bulk density >1.8 g/cm3 or penetrometer resistance >2 Mpa
Did the crop suffer from nutrient deficiencies?
SUBSOIL INFERTILE and HARD Normal root growth severely impeded. Consider deep ripping and also deep placement of fertilisers.
Is your subsoil sodic? ESP >15
SUBSOIL SODIC and TOPSOIL WATERLOGGED Install raised beds.
SUBSOIL SODIC and TOPSOIL WATERLOGGED Soil amelioration is unlikely to be effective. Use waterlogging-tolerant crops.
Is your topsoil non-slaking, the annual rainfall >450 mm and your land gently sloping?
Did a perched watertable cause waterlogging in your crop?
Is the highest clay layer in the profile within 20–30 cm of the surface?
SUBSOIL SODIC Gypsum may be a long-term strategy.
Is the highest clay layer in the profile within 20–30 cm of the surface?
SUBSOIL SODIC Soil amelioration is unlikely to be effective.

# Soil Compaction Trials


## Cathy Paterson, Sam Doudle and Nigel Wilhelm

SARDI Minnipa Agricultural Centre


Research

## Key message

- **There were no yield increases in cereals following deep ripping at the three sites tested in 2006.**

## Why do the trial?

During the 2003 EPFS farmer meetings, 14 groups nominated soil compaction as an issue that needed further research. Consequently, the EPFS project supported farmers from Buckleboo, Ceduna, Streaky Bay, Piednippie and Koongawa to set up or monitor their own deep ripping demonstrations so they could investigate whether soil compaction was an issue for them (EPFS 2003 Summary, page 121). In addition, the project undertook a soil compaction survey across a range of soil types on Upper Eyre Peninsula during 2004 (EPFS 2005 Summary, page 117).

The research reported here is part of a new project funded by SAGIT to investigate if compaction is causing yield penalties on Eyre Peninsula and, if so, how to correct the compaction. The project will also build on the soil compaction survey of 2004 to develop a more detailed understanding of the soil types and management systems that have caused soil compaction on Eyre Peninsula.

## How was it done?

Three replicated trials were established in 2006 — two small plot experiments at Piednippie and Warramboo and one broadscale demonstration at MAC. These trials will be maintained for at least the next two years.

### Treatments

In 2006, the treatments in the small plot experiments were:

- control — district practice
- deep ripping (prior to seeding with a custom-made ripper)
- deep working (to 10 cm during the seeding pass with knife points)
- rotational tillage (same as deep working in 2006 but will work progressively deeper each season)
- spare plots are available to trial other techniques as the project progresses.

At Minnipa, only deep ripping and district practice occurred as the seeder used in 2006 was not able to perform the other treatments.

### Site details

**Minnipa —** sown on 2 June with Kukri wheat @ 65 kg/ha, fertiliser 18:20:00 @ 50 kg/ha and urea deep banded below seed @ 50 kg/ha. Deep ripped to 30 cm.

**Piednippie —** sown on 1 June with Sloop SA barley and 18:20:00 fertiliser, both @ 60 kg/ha. Deep ripped to 25 cm.

**Warramboo —** sown on 5 June with Wyalkatchem wheat and 18:20:00 fertiliser, both @ 60 kg/ha. Deep ripped to 30 cm.

Deep ripping was applied prior to seeding and deep working treatments were applied during the seeding pass.

Measurements included plant establishment, DM (early and flowering), soil strength, soil characteristics, soil profile description, soil constraints, penetrometer readings after harvest, yield, harvest index, and grain quality. Soil moisture was to be taken at harvest but due to rain events before harvest this was only done at the Piednippie site.

Soil strength measurements were taken after harvest using an artificial soil wetting technique to fill the soil profile to field capacity (FC).

**Searching for answers**

**Location**
Piednippie: John and Ian Montgomerie
Group: Streaky Bay Ag Bureau

**Rainfall**
Av. annual: 368 mm
Av. GSR: 280 mm
2006 total: 268 mm
2006 GSR: 156 mm

**Yield**
Potential: 1.9 t/ha (barley)
Actual: 1.1 t/ha (barley)

**Paddock history**
2005: wheat

**Soil type**
Sandy loam/loamy sand/calcrete rock

**Diseases**
*Rhizoctonia*

**Plot size**
20 m x 1.6 m x 4 replications

**Yield-limiting factors**
Moisture stress, *Rhizoctonia.*

**Location:**
Warramboo: Trevor, Leon and Simon Veitch

**Rainfall**
Av. annual: 325 mm
Av. GSR: 250 mm
2006 total: 229 mm
2006 GSR: 101 mm

**Yield**
Potential: 0.6 t/ha (wheat)
Actual: 0.6 t/ha (wheat)

**Paddock history**
2005: Wheat

**Soil type**
Deep siliceous sand

**Plot Size**
20 m x 1.6 m x 4 replications

**Yield-limiting factors**
Moisture stress, brome grass competition

**Location:**
MAC
Minnipa Ag Bureau

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 1 t/ha (wheat)
Actual: 0.3 t/ha (wheat)

**Paddock history**
2005: barley
2004: wheat

**Soil type**
Red calcareous sandy clay loam

**Plot size**
350 m x 9 m x 3 replications

**Yield-limiting factor**
Moisture stress

## What happened?

### Soil strength

Soil strength (resistance) of 2500 kPa is the theoretical level at which crop root growth is restricted when the soil is at field capacity. Both Piednippie and Warramboo had soil strength over 2500 kPa within the crop root zone (Figure 1b,c).

Whilst not reaching the theoretical level of 2500 kPa, the Minnipa site still exhibited typical plough pan characteristics with a soil strength peak below working depth, around 15 cm (Figure 1a). This is the much talked about plough pan caused by heavy machinery, high load bearing wheels and blunt shares which put pressure on the soil below where they work.

Deep ripping reduced soil strength at all three sites, but only directly down the rip line, not between the lines, which were 50 cm apart (Figure 1a–c).

### Trial results

In 2006, with a below decile 1 growing season rainfall, there were no treatment differences at Piednippie or Warramboo. The broad scale trial at Minnipa (Table 1) showed differences although they were minimal, such as reduced crop emergence on the deep ripped plots, which was most likely due to uneven soil throw at seeding and trifluralin damage.

Deep ripping improved early growth of cereals at Minnipa so it is possible that in subsequent years (and better growing seasons) the deep ripping treatments may realise improved yields.

## What does this mean?

With the small and infrequent rainfall events experienced in 2006, even crops growing in soil profiles with compacted layers below the surface soil may have been able to eventually extract as much water as those growing in deep ripped profiles. Soil moisture after harvest at Piednippie was below wilting point in all treatments suggesting that even the controls completely dried out the profile to at least 400 mm under last season's conditions.

APSIM modelling in WA *(Farming Ahead*, June 2006) has shown that in dry years there is no adverse effect from compacted soils as there is generally very little subsoil moisture available for the crop.

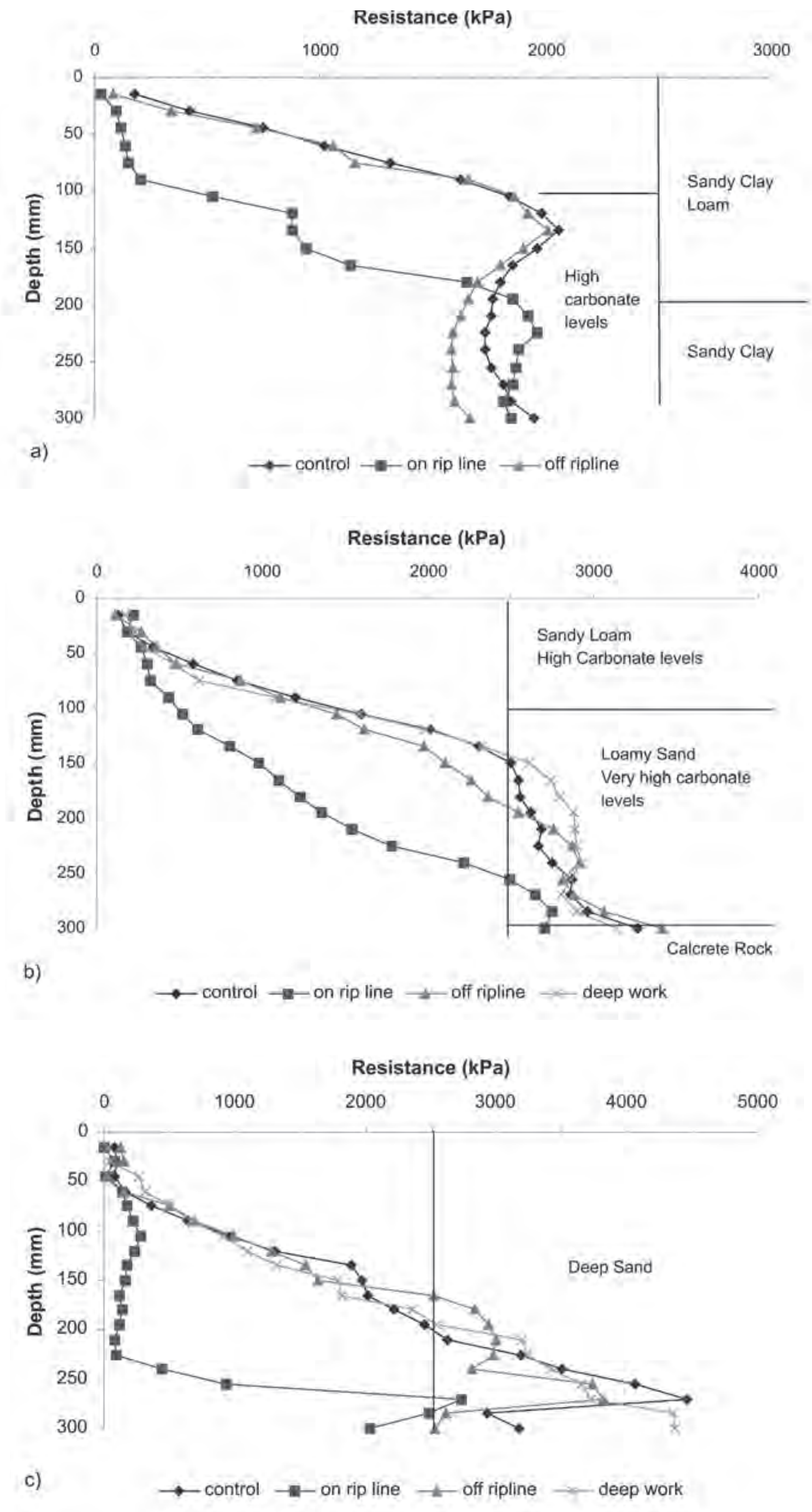



***Figure 1a-c** Soil resistance measurements at the three trial sites, (a) Minnipa, (b) Piednippie and (c) Warramboo. Soil resistance over 2500 kPa is considered to restrict crop root growth.*

*Table 1 Summary of trials results from Minnipa, Piednippie and Warramboo, 2006.*

| Site | Treatment | Emergence (plants/m$^2$) | Early DM (kg/ha) | Screenings (%) | Protein (%) | Yield (t/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|---|
| **Minnipa** | Control | 79 | 561 | 2.0 | 13.7 | 0.33 | 38 |
| | Deep ripped | 68 | 686 | 2.5 | 13.3 | 0.25 | 42 |
| *LSD (P=0.05)* | | *9* | *33* | *0.34* | *0.52* | *0.06* | *3.28* |
| **Piednippie** | Average all* | 117 | 568 | 2.6 | 12.7 | 1.05 | 29 |
| **Warramboo** | Average all* | 78 | 464 | 4.5 | 13.1 | 0.56 | 35 |

**no difference between any treatments*

## Acknowledgements

Thanks to Ben Ward for technical assistance during the year. Also thanks to Damien Adcock, Brendan Frischke, Jack Desbiolles, Cliff Hignett, Neal Dalgliesh and Neil Cordon for their advice during the year. Also thanks to John and Ian Montgomerie, Trevor, Leon and Simon Veitch, and MAC farm staff for provision of trial sites. EPFS provided funding for the research.

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# Subsoil Nutrition on Clay Spread Soil

**Joshua Telfer**
Rural Solutions SA, Cleve

Demo

## Key messages

- **Sandy soil spread with clay that has a high level of calcium carbonate (lime) has the potential to cause extreme manganese (Mn) deficiency, leading to poor crop growth and yield.**
- **Clay must be tested before spreading to gauge the potential for problems and adjust the clay rate accordingly.**
- **Nutrition issues relating to clay spreading can still be apparent many seasons following the clay spreading.**

## Why do the trial?

Clay spreading and delving have frequently resulted in negative yield results on Eyre Peninsula. Impacts fall into two areas:

- crops 'running out of water' at the end of the season — resulting from too much clay or poor clay incorporation
- Mn deficiency — resulting from spreading clays with high levels of calcium carbonate (lime) within the clay.

This work follows on from previous subsoil nutrition and clay spreading research and demonstration work conducted on Eyre Peninsula since 1999, and looks at the possible interactions between subsoil nutrition and clay spreading.

## How was it done?

With support from the Advisory Board of Agriculture (ABA), the Sandy Soils Project and the Dutton River and the Driver River Catchment Projects (both funded by the National Landcare Program), a series of farmer demonstration sites were established in 2005 (EPPS 2005 Summary, page 128). In 2006, a number of these sites were monitored and a number of new sites were established.

Treatments at the new 2006 sites were the same as those applied in 2005 at the initial sites (EPFS 2005 Summary, page 128). Subsoil treatments were applied using a modified Yeoman's Plow prior to sowing. Some landholders chose to roll the area after ripping to help improve establishment following deep ripping.

### Treatments

- Deep-placed nutrients (DN; 35–45 cm) 77 kg/ha 18:20:00, 13 kg/ha $MnSO_4$, 5.7 kg/ha $ZnSO_4$, 4 kg/ha $CuSO_4$
- Shallow placed nutrients (SN; 15–25 cm) 77 kg/ha 18:20:00, 13 kg/ha $MnSO_4$, 5.7 kg/ha $ZnSO_4$, 4 kg/ha $CuSO_4$
- Ripping only (RO; 35–45cm)
- Control (C) — farmer practice.

Additional fertiliser was costed @ $40.50/ha, and deep ripping was costed @ $65/ha (EPFS 2005 Summary, page 128). The landholders, in accordance with their normal programs, undertook seeding. In addition to the treatments applied, each plot received the farmer's standard fertiliser and seeding rate.

### Measurements

Measurements included soil testing of the control soil profile (pH, salinity, texture), plant counts, tissue testing and yield (harvested using cooperator's machinery and weighed in a weigh trailer).

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**Trial information**

**Location**
Port Neill: Brad Davey

**Rainfall**
Av. annual: 226 mm
2006 total: 242 mm
Av. GSR: 165 mm
2006 GSR: 126 mm

**Soil type**
Deep siliceous sand 5+ years after clay spreading

**Soil**
pH (water) 8.7

## What happened?

The Wharminda site is indicative of a manganese response on a sandy soil spread with a calcareous clay. Although the dry season provided very low yields, there has still been a noticeable response to application of nutrients, including trace elements (Figure 1).

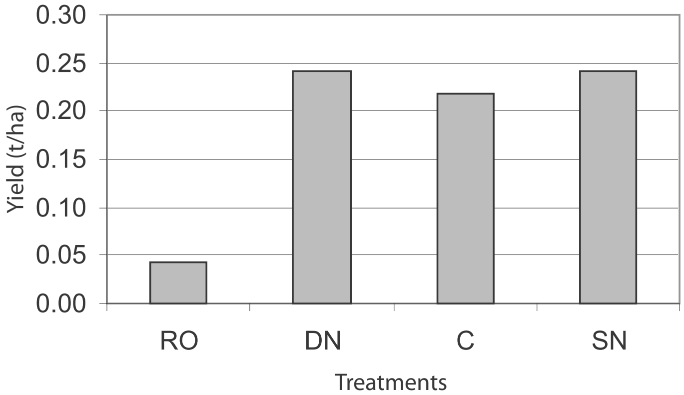


*Figure 1* ***Wheat yield response to treatments on a clay spread sand at Brad Davey's farm, Wharminda.***

Analysis of tissue samples indicates that the key difference between treatments was manganese deficiency in all treatments except the DN in the crop row (Table 1). Differences in tissue copper levels were also measured, but all treatments were in the marginal-adequate bracket.

Plants on the deep ripped and control treatments were double the size of those growing on the shallow and deep nutrient treatments. If the plants had been at the same growth stages at tissue testing, the differences would be even more pronounced.

At this site as well as in the other sites undertaken this season, there was no benefit in placing nutrients deeper (35 cm) compared to the shallower treatment (20 cm). This is different to the 2005 results where there was a noticeable advantage of the deeper nutrient placement at some sites (EPFS 2005 Summary, page 128).

***Table 1 Micronutrient levels in wheat plant tissue at late tillering, Brad Davey's farm, Wharminda, 2006.***

| Treatment | Micronutrient levels in tissue | | | | |
|---|---|---|---|---|---|
| | Cu (mg/kg) | Zn (mg/kg) | Mn (mg/kg) | Fe (mg/kg) | Boron (mg/kg) |
| **DN — inter-row** | 3 | 20.3 | 10.9 | 118 | 31.4 |
| **DN — in row** | 8.9 | 21.9 | 28.1 | 112 | 51.9 |
| **C** | 2.7 | 20.6 | 6.4 | 90 | 37.2 |
| **RO** | 3.2 | 18.5 | 7.9 | 120 | 45.7 |
| **SN — in row** | 10.6 | 21 | 28 | 118 | 61.4 |
| **Deficiency level** | <2 | <15 | <18 | | <24 |

## What does this mean?

By spreading non-wetting sand with clay that has a high level of carbonate, it is possible to 'create' a soil that is extremely manganese deficient, equal to if not more extreme than that seen in 'natural' calcareous soils, leading to poor crop growth and yield. Being aware of this issue and spreading lower carbonate clays where possible can help manage it. As a general rule, the higher the rate of highly calcareous clay used the worse the effect. While the yield penalty can be extreme, this work has identified that a granular application of manganese sulphate can correct the problem, at least in the short term. Another management response is to grow varieties that are more manganese efficient. One cooperator is planning to grow only Maritime barley, a manganese-efficient cultivar, on his clay spread area from now on.

There are a number of issues arising from this demonstration including:

- The manganese efficient varieties — using Maritime in future work may identify other problems associated with highly calcareous clays that are currently being masked by the dominant manganese deficiency problem.
- Placement of manganese — the Yeoman's Plow places nutrients into rip lines 50 cm apart. In 2006, the wheat plants growing between the rip lines at the Wharminda site were manganese deficient indicating that the movement of manganese in such dry conditions was very limited (Table 1, DN inter-row). This was not evident with the same treatment with the wet spring of 2005 where the crop was far more even across the plot. This might have just been a result of the intensity of the deficient conditions and moisture stress.
- Residual effect — some of the sites established in 2005 were monitored for residual effects in 2006. In particular, a demonstration site established by this project at Mount Pricilla in 2005 showed an early plant growth difference in 2006. However, none of these sites was able to be reaped due to the drought conditions. Other previous research by the EPFS project on a clay spread sand at Kelly has shown a residual trace element benefit up to three years after the trace elements were applied (EPFS 2004 Summary, page 118). In collaboration with the landholders, some of these sites will be monitored in 2007 to further understand when and where there might be a residual effect.
- The treatments applied in these demonstrations are more expensive than standard farmer practice, but manganese deficiency is consistently the primary concern; the fertiliser types and rates applied in a commercial setting would be adjusted to reflect this.

For further information on clay spreading please refer to the recently published manual, *'Clay spreading and delving on Eyre Peninsula — a broadacre clay application manual for farmers, contractors and advisers',* available from your local PIRSA office.

## Acknowledgements

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Government of South Australia
Department of Water, Land and Biodiversity Conservation

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Program

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# Section 10

**Section editor: Nigel Wilhelm**
SARDI
Minnipa Agricultural Centre

# Tillage

## Row Direction, Row Spacing and Stubble Cover Effects in Wheat

**Jon Hancock**
SARDI Minnipa Agricultural Centre

Research

### Key messages

- **Wheat yields were higher when crops are sown north–south rather than east–west.**
- **Wheat yields declined slightly at wide row spacings.**

### Why do the trial?

This trial investigated the effects of row direction, row spacing and stubble cover on grain yield and quality of wheat. As more and more paddocks are sown up and back rather than round and round, the question arises as to whether yield can be improved by sowing in a particular direction and, if so, whether there is any impact of row spacing and stubble cover. The trial was initially set up in the 2005 season and those results were published in the EPFS 2005 Summary (pages 131–132).

### How was it done?

A trial, set up at MAC in 2005, was re-sown in 2006 with identical treatments. Prior to seeding, the stubble was removed from the appropriate plots through burning. The trial was sown on 14 June to Wyalkatchem (at a target density of 180 plants/m$^2$) with 70 kg/ha of 18:20 at 18, 23 and 30 cm row spacings in both north–south and east–west directions. Quadrat cuts were taken at maturity to determine total DM and harvest index. All plots were harvested at maturity and grain samples were retained for quality analysis.

### What happened?

With only 111 mm of rainfall in the growing season, the soil surface was dry for most of the season resulting in low evaporation rates in all treatments. Whilst all grain yields were low, yield was 17% higher when crops were sown north–south rather than east–west (Table 1). The higher yields with north–south sowing were largely due to more grains per head in those treatments. Grain yield declined slightly with wider row spacing (Table 2) but burning stubble had no impact on yield in this trial. With a consistent harvest index of 45% across the trial, total crop DM at maturity was also higher for crops sown north–south. Grain protein declined as row spacing widened (Table 3) but was unaffected by row direction or stubble.

*Table 1 Effect of row direction and spacing on grain yield of wheat at Minnipa.*

| Row direction | Grain yield (t/ha) |
|---|---|
| North–south | 0.78 |
| East–west | 0.67 |
| *LSD (P=0.05)* | *0.10* |

*Table 2 Effect of row spacing on grain yield of wheat at Minnipa.*

| Row spacing (cm) | Grain yield (t/ha) |
|---|---|
| 18 | 0.77 |
| 23 | 0.76 |
| 30 | 0.64 |
| *LSD (P=0.05)* | *0.08* |

*Table 3 Effect of row spacing on grain protein of wheat at Minnipa.*

| Row spacing (cm) | Grain protein (%) |
|---|---|
| 18 | 13.2 |
| 23 | 13.0 |
| 30 | 12.6 |
| *LSD (P=0.05)* | *0.4* |

**Try this yourself now**

**Location**
MAC
Closest town: Minnipa

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
2006 total: 236 mm
2006 GSR: 111 mm

**Yield**
Potential: 1.01 t/ha (wheat)
Actual: up to 0.78 t/ha

**Paddock history**
2005: wheat
2004: wheat
2003: wheat

**Soil**
Red calcareous sandy loam

## What does this mean?

Data from the 2005 and 2006 seasons have both shown that sowing wheat in a north–south direction increased grain yield without additional cost or loss in quality, thereby also increasing profitability. In many cases, this would then be the preferable sowing option provided that paddock shape and orientation are suitable. Bear in mind that when sowing up and back, consideration needs to be given to the length of runs and the size of areas double sown because if these increase due to a north–south sowing, they could erode the benefits gained from the sowing direction.

There was no yield loss to sowing at 23 cm in either year, showing that this is the ideal row spacing in this situation. However, results from the malle e suggest that wider row spacings can maintain yields if ribbon seeding boots are used (see 'Optimising ribbon sowing at 50 cm row spacing in a Mallee environment' in this manual).

## Acknowledgements

Thanks to Wade Shepperd and other staff of MAC for technical assistance. EPFS provided research funding.

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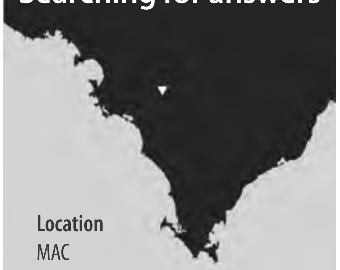
# Wide Crop Rows in Wheat at Minnipa Ag Centre

**Brendan Frischke, Brett McEvoy and Shane Moroney**

SARDI Minnipa Agricultural Centre

Demo

**Searching for answers**



**Location**
MAC
Closest town: Minnipa

**Rainfall**
Av. annual: 325 mm
Av. GSR 242 mm
Actual annual: 236 mm
Actual GSR: 111 mm

**Yield**
Potential: 1.02 t/ha (wheat)
Actual: 0.47 t/ha

**Paddock history**
2006: AGT-Scythe wheat
2005: Yitpi wheat
2004: pasture

**Soil**
Red calcareous sandy clay loam

**Plot size**
9 m x 900 m

**Yield-limiting factor**
Drought (pre- and post-anthesis)

## Key messages

- **Wheat sown on standard rows at 60 kg/ha gave the best outcome in a cereal stubble paddock in 2006.**
- **We are still trying to identify if and where wide row spacings are suited.**

## Why do the trial?

Dr Paul Blackwell (AgWA) conducted research into wide rows (more than 50 cm) in low rainfall environments at Pindar near Geraldton during 2003–06. Wide rows increased yield and improved grain quality on several occasions and were rarely worse off. Yield increases from wide rows ranging from 0.2 to 0.4 t/ha were not uncommon. The original aim of Dr Blackwell's work was to reduce the frequency of crop failures as a result of drought and improve grain quality overall by improving crop performance in those drought years; he does not expect the wide rows to be beneficial in very good years. We identified many similarities in environments between our region and Pindar including rainfall, soil depth, subsoil constraints and temperatures, so we thought it would be worth testing the approach under Minnipa conditions.

If it's working there, it's well worth trying here!

## How was it done?

The demonstration had four treatments — two row spacings, 23.3 cm (normal spacing, NS) and 46.6 cm (double spacing, DS); for each row spacing, wheat variety AGT-Scythe was sown at 30 and 60 kg/ha. The trial was sown late in the seeding program on 4 June into a paddock that was pasture in 2004 and sown to wheat in 2005.

The trial was sown using MAC's commercial seeding equipment. The seeding bar is a 9.1 m model 5100 Gason fitted with a Morris trailing air cart. The air cart has four primary hoses for seed and another four for fertiliser. Each primary hose supplies two distribution heads. Individual seed tubes are arranged so that alternate tines are supplied from a different primary hose. This arrangement is designed to reduce the impact of a blocked primary hose and avoid those dreaded '*Airstrips*'. This arrangement is utilised to sow double row spacings by diverting the seed from one primary hose into the other primary hose supplying the same section of machine. This was done using fertiliser diverters manufactured by Raycol (Western Australia). By switching to double rows in this way the seeding rate is unaffected. While in double row sowing mode, those tines not receiving seed were still working the soil because of the difficulty involved in removing or raising them. Fertiliser (60 kg DAP/ha) treated with Intake (200 mL/ha) was sown with the seed for all treatments.

For each treatment, two machine width strips were sown for the length of a paddock (approx. 900 m). Treatments were monitored for plant population, early DM production, soil moisture near flowering, and were harvested using our commercial harvester. Samples were also hand harvested to measure head density and estimate machine harvest losses.

## What happened?

During the first attempt at double row sowing at 60 kg/ha, several primary hoses had blockages. This was caused by double the material (seed and fertiliser) having to pass through the hoses in use. The problem was easily overcome by increasing the fan speed but it highlighted an important consideration for those thinking of trying this approach themselves. The trial was restarted in another paddock. Table 1 shows establishment and early DM results. Establishment and early DM production (per ha) for double rows were slightly lower than for single rows at both seeding rates. This is probably because double rows increase seed density along the rows and more seedlings are lost from inter-plant competition.

Figure 1 shows soil moisture content to 50 cm at anthesis. Samples were taken from within the crop row and also in the next adjacent row position. For single spacing, this is the next crop row but for double spacing it is the inter-row (the missing crop row). The chart on the left shows average moisture content for three of the four treatments; single row spacing at 30 kg/ha was not sampled. The right hand chart compares in-row and inter-row moisture content for double row spacing at 30 kg/ha. The calculated total water in the profile is 79 mm in single rows at 60 kg/ha, 77 mm in double rows at 30 kg/ha, and 74 mm in double rows at 60 kg/ha. These differences are very small and show that by flowering, wheat had pretty well dried the profile out, regardless of row spacing. However, there is a suggestion in the right hand chart that some extra water may have been present in the topsoil in the inter-row of double row spacing.

Tables 2 and 3 summarise the harvest results. The highest yielding treatment (mechanical harvest) was single rows sown at 60 kg/ha and the lowest were double rows sown at 30 kg/ha — 26% lower yielding. The lower seeding rate reduced yield by approximately 15% for both row spacings. Hand-cut yield results were very similar for three treatments but double rows sown at 30 kg/ha yielded much higher compared to the mechanical harvest result. The hand-cut yields indicate that double rows at 30 kg/ha yielded about the same as single rows at 60 kg/ha — equal highest. The difference could only be explained by harvest losses. Significant lodging was observed in the double rows but was not measured, nor were actual harvest losses measured. This highlights the importance of selecting varieties with good lodging resistance. Although grain quality differences were very small, the weight of evidence tends to favour single rows at 60 kg/ha as producing the best grain. This treatment also produced the most DM at both end of tillering and maturity.

## What does this mean?

Wide rows (double rows) were unable to increase yield or improve grain quality at Minnipa in 2006. It appears wide rows did not work because it did not save water in the soil profile to improve grain fill. Although we do not know what happened below 50 cm, the trends were similar below 30 cm and we can reasonably expect no differences deeper. These results suggest that in 2006 plants were relying on reserves stored within the plant rather than subsoil moisture, and crops with greater DM produced the better yields. It may be that wide rows did not work because we tested it on cereal stubble not pasture with better N availability, or sowing was too late and growth was too retarded by temperature.

It is premature to say that wide rows are not relevant for this area. We do know that there are situations it won't work, albeit not yet well defined, and that the current row spacings should remain for the time being. The evidence from Western Australia suggests that there are only certain situations where wide rows have an advantage. We can therefore rule out wholesale change to a wide row system and that future adoption will require machines with the flexibility of sowing both systems. However, prior to adoption, the circumstances in which the system will work need to be defined. With hindsight we believe we selected the wrong paddock (wheat on wheat) because there were already several yield-limiting factors such as disease carry over from previous cereal, lower N status and late sowing.

***Table 1 Plant population and DM production of single and double row spacings at Minnipa, 2006.***

| Treatment | Plant density (plants/m$^2$) | Late tillering DM (t/ha) |
|---|---|---|
| Double row, seed 30 kg/ha | 64 | 0.86 |
| Double row, seed 60 kg/ha | 114 | 0.99 |
| Single row, seed 30 kg/ha | 75 | 1.02 |
| Single row, seed 60 kg/ha | 136 | 1.06 |

***Table 2 Mechanical and hand-cut harvest yields and estimated harvest losses from commercial harvester for single and double row treatments.***

| Treatment | Pre-harvest total DM (t/ha) | Head density (heads/m$^2$) | Hand-cut grain yield (t/ha) | Mechanical harvest yield (t/ha) | Theoretical mechanical harvest loss (%) |
|---|---|---|---|---|---|
| Double row, seed 30 kg/ha | 1.12 | 71 | 0.49 | 0.36 | 25.8 |
| Double row, seed 60 kg/ha | 1.09 | 102 | 0.44 | 0.42 | 2.9 |
| Single row, seed 30 kg/ha | 1.03 | 68 | 0.45 | 0.42 | 6.7 |
| Single row, seed 60 kg/ha | 1.31 | 114 | 0.50 | 0.49 | 1.5 |

*Table 3 Grain quality for single and double row treatments.*

| Treatment | Test weight (kg/hL) | Protein (%) | Moisture content (%) | Screenings (%) |
|---|---|---|---|---|
| Double row, seed 30 kg/ha | 78.5 | 12.9 | 11.0 | 4.4 |
| Double row, seed 60 kg/ha | 79.5 | 12.9 | 10.9 | 3.4 |
| Single row, seed 30 kg/ha | 78.4 | 13.0 | 11.0 | 4.6 |
| Single row, seed 60 kg/ha | 80.3 | 13.5 | 10.8 | 2.7 |

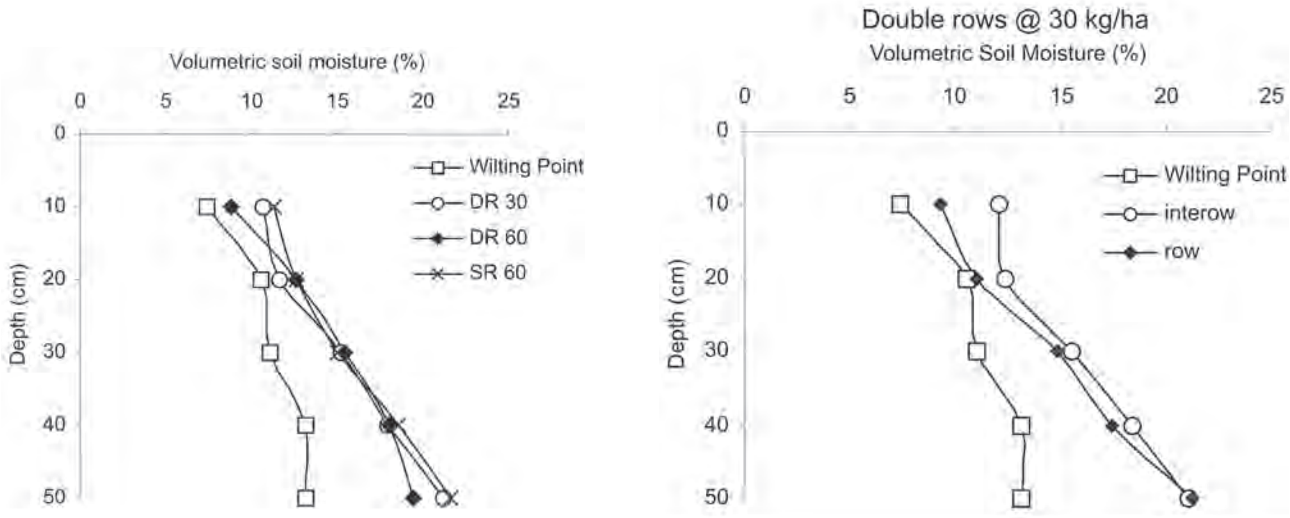



*Figure 1 Soil moisture at flowering.*

In future, we believe we should select paddocks that are primed for rapid early growth, typically those paddocks and circumstances that lead to a great looking crop but disappoint with lower than expected yield and high screenings.

Future research is required to understand the impacts of time of sowing, stored water status, rotation (nutrition and disease impacts), minimum row spacing and suitable crops.


## Acknowledgements

I would like to acknowledge the pioneering work by Dr Paul Blackwell (AgWA, Geraldton) and his advice in gaining an understanding of how the system has worked in a similar environment. Also thanks to Nigel Wilhelm, Sam Doudle and Bruce Heddle for their input into the current trials and support to gain equipment to do future research on this subject.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Department of Agriculture and Food
Government of Western Australia

# Optimising Ribbon Sowing at 50 cm Row Spacing in a Mallee Environment

**Jack Desbiolles**
UniSA, Agricultural Machinery R&D Centre

Research

## Key messages

- **Greater early wheat vigour was measured under double (50 cm) row spacing due to greater fertiliser concentration in the row.**
- **In a Mallee environment, wheat grain yield under ribbon seeding was increased by doubling the row spacing to 50 cm and reducing seeding rate/ha to maintain the same plant numbers in the row.**
- **Maintaining the same plant numbers in the row also minimised the proportion of unfilled heads under drought conditions.**
- **Grain quality was the same in all seeding configurations.**

## Why do the trial?

Edge-row effects observed in research plots and beside wheel tracks in controlled traffic paddocks result from extra soil volume and increased sunlight exposure during their growing season (and hence, extra moisture and nutrients).

Can edge-row effects benefit each and every row under wide row spacings to optimise crop performance in a Mallee environment?

Wide row cropping additionally offers advantages such as lower draft, improved stubble handling ability including easier inter-row sowing strategies, as well as an attractive range of row and inter-row weed management options such as shielded spraying, crop row band spraying and inter-row fallowing or cover cropping. In low fertility soils, permanent rows may also offer cumulative health and fertility benefits in the cropped zones as well as more 'affordable' row-confined improvement strategies such as use of wetting agents and soil amendments.

The limitations of wide row spacing include higher risks of fertiliser toxicity, higher competition between grain-producing plants (potentially reducing grain yield), lower competition with inter-row weeds and increased moisture evaporation in the inter-row (wind and sun effects).

A practical approach to wide row cropping is often to 'double' the existing row spacing. A trial was conducted to evaluate the performance of ribbon seeding at double (50 cm) row spacing, over a range of plant densities relative to the control. The interest in ribbon sowing lay in its ability to reduce fertiliser concentration and inter-plant competition.

## How was it done?

A trial was implemented over two seasons (2002 and 2003) at the Mallee Sustainable Farming Waikerie site (shallow sandy loam soil) using a 165 mm (6½") wide double-shoot ribbon system (Concord Anderson A12) with press wheels.

Three plant densities (low, medium, high) were used at the double (50 cm) row spacing, seeking to match, at the higher limit, similar seed rate/ha and, at the lower limit, similar plant numbers in the row to the reference 25 cm row spacing control (targeted plant density of 140 plants/$m^2$).

Fertiliser was applied to all treatments at 100 kg/ha DAP (3% Zn). In both years, Clearfield JNZ wheat was direct drilled in mid-late May, at 10 km/hr and in a north–south direction. In 2002, 12 mm follow-up rainfall occurred on day 19, while 25 mm was received 2–7 days after sowing in 2003. The growing season rainfall was well below average in 2002 and slightly above average in 2003.

**Almost ready**

**Trial information**

**Location**
Waikerie: A and J Buckley
Group: Mallee Sustainable Farming Inc.

**Rainfall**
Av. annual: 252 mm
Av GSR: 163 mm
2002 total: 253 mm
2002 GSR: 91 mm
2003: total: 264 mm
2003 GSR: 180 mm

**Paddock history**
2000: wheat
2001: triticale
2002: Clearfield wheat

**Yield**
2002 potential: 0.23 t/ha
2002 actual: 0.24 t/ha
2003 potential: 1.70 t/ha
2003 actual: 2.67 t/ha

**Soil type**
Shallow red loamy sand

**Plot size**
40 m x 1.5 m x 4 replications

**Yield-limiting factor**
2002: drought

**Other relevant factors**
Some lodging in wide row plots following significant wind events

*Table 1 Crop establishment in wheat at Waikerie.*

| Plants/m²(% emergence) | | Year 1 (2002) | Year 2 (2003) |
|---|---|---|---|
| 25 cm control | | 146 (99%) | 142 (90%) |
| Double row spacing | Low | 72 (91%) | 69 (97%) |
| | Medium | 93 (84%) | 102 (89%) |
| | High | 123 (83%) | 138 (87%) |

*Table 2 Early plant vigour in wheat at Waikerie.*

| Treatments | | Year 1 (day 90 ) | | | Year 2 (day 89) | | |
|---|---|---|---|---|---|---|---|
| | | Tillers/plant | DM g/plant) | Crop biomass (t/ha) | Tillers/plant | DM (g/plant) | Crop biomass (t/ha) |
| 25 cm control | | 1.3 | 0.31 | 0.45 | 1.5 | 1.21 | 1.71 |
| Double row spacing | Low | 1.6 | 0.56 | 0.40 | 3.2 | 2.02 | 1.38 |
| | Medium | 1.2 | 0.41 | 0.38 | 2.3 | 1.62 | 1.64 |
| | High | 0.8 | 0.36 | 0.44 | 1.8 | 1.35 | 1.86 |

*Table 3 Late crop development in wheat at Waikerie.*

| Treatments | | Year 1 (day 145) | | | Year 2 (day 146) | | |
|---|---|---|---|---|---|---|---|
| | | Heads/plant | DM (g/plant) | Heads/m² | Heads/plant | DM (g/plant) | Heads/m² |
| 25 cm control | | No data due to drought | | 111 | 1.8 | 4.2 | 253 |
| Double row spacing | Low | | | 83 | 3.2 | 7.7 | 216 |
| | Medium | | | 93 | 2.4 | 5.4 | 241 |
| | High | | | 107 | 1.8 | 3.8 | 250 |

*Table 4 Grain yield and yield components of wheat at Waikerie.*

| Treatments | | Year 1 | | | Year 2 | | |
|---|---|---|---|---|---|---|---|
| | | Unfilled heads (% ) | Av. head weight (g grain/head) | Grain yield (t/ha) | Unfilled heads (%) | Av. head weight (g grain/head) | Grain yield (t/ha) |
| 25 cm control | | 21.3 | 0.17 | 0.16 a | Not sampled | 0.99 | 2.51 ab |
| Double row spacing | Low | 7.6 | 0.34 | 0.24 b | | 1.23 | 2.67 c |
| | Medium | 12.9 | 0.30 | 0.20 ab | | 1.07 | 2.57 b |
| | High | 20.0 | 0.19 | 0.16 a | | 0.96 | 2.40 a |

*NB: Grain yield data — differing letters indicate significant differences at 90% confidence level*

*Table 5 Grain quality of wheat at Waikerie.*

| Treatments | | Year 1 | | | Year 2 | | |
|---|---|---|---|---|---|---|---|
| | | Screenings (%) | 1000-grain weight (g) | Protein (%) | Screenings (%) | 1000-grain weight (g) | Protein (%) |
| 25 cm control | | 0.8 | 35.0 | 14.4 | 0.55 | 35.7 | 10.3 |
| Double row spacing | Low | 0.78 | 34.2 | 14.5 | 0.42 | 36.8 | 10.3 |
| | Medium | 0.92 | 34.5 | 14.5 | 0.57 | 35.2 | 10.5 |
| | High | 0.77 | 33.9 | 14.5 | 0.55 | 35.3 | 10.8 |

In 2002, crop emergence with wider row spacing was lower than in the control (i.e. 83–91% of the target density compared to 98% in the control; see Table 1). This was due to 10–15 mm less soil cover and fertiliser applied at the same rate per hectare with the seeds combining with dry soil conditions. In Year 2, crop establishment in the wide row spacing treatments was on target, due to better soil moisture conditions at seeding and 70% of fertiliser deep banded (Table 1and Figure 1).

Plants were sampled at late tillering, flowering and at harvest from inner rows of plots only to exclude edge-row effects.

## What happened?

### Early crop vigour (post-tillering)

In the drier year, 2002, where high competition for moisture occurred, double row spacing at equal paddock plant densities produced similar plant size but fewer tillers than the control. In the wetter year, 2003, both plant size and the number of tillers were higher in these wide-row plots because there was sufficient moisture available to match the plant potential and they were accessing concentrated fertiliser (Table 2). Reducing plant density on wider row spacing maximised individual plant growth and tillering, especially in the wetter Year 2. However, this maximised individual plant growth was not enough to match the crop potential (biomass/ha) of the control, especially in the wetter Year 2.

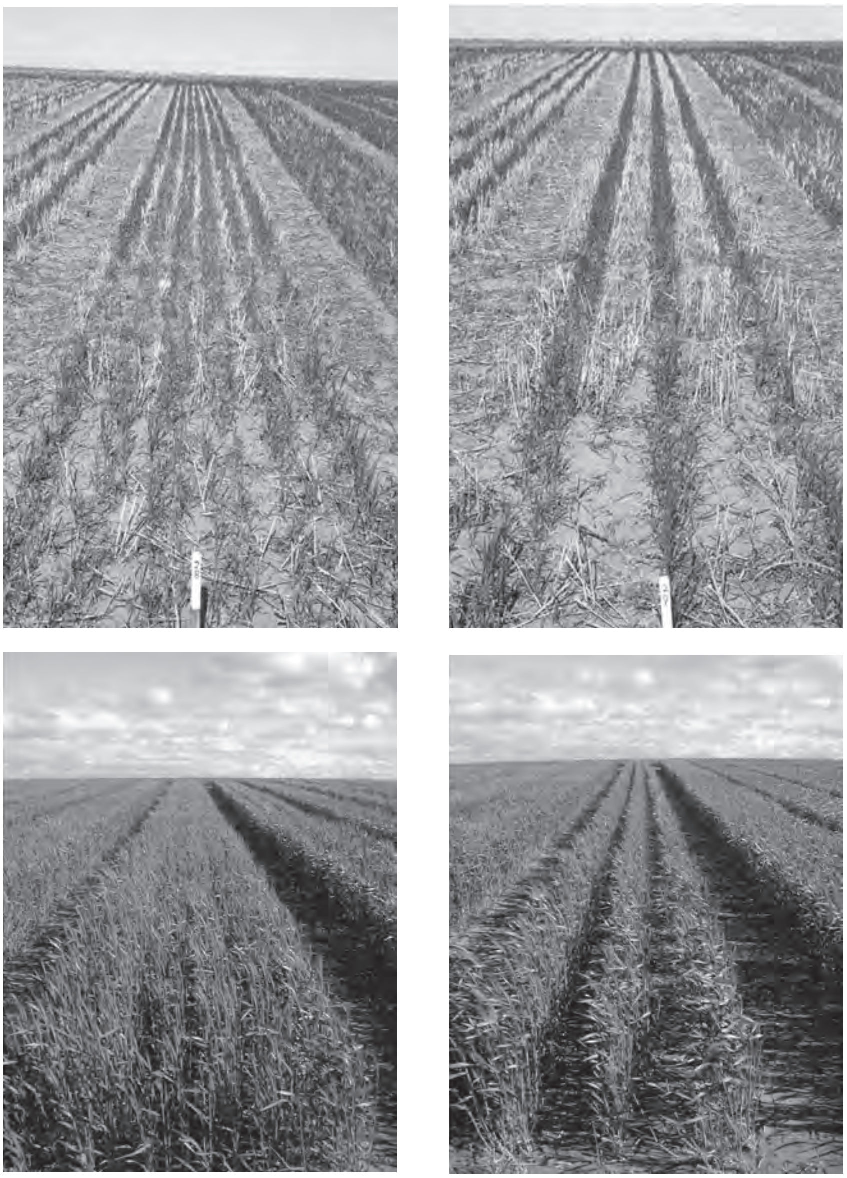

***Figure 1** 25 cm (left) and 50 cm (right) row spacing wheat plots under ribbon seeding. Top: 2002 establishment. Bottom: 2003 late crop development*

### Late plant development and yield

Under the drought conditions of 2002, the plots with high plant density in the double-spaced rows produced similar head density/m² to the control at flowering (see Table 3). However, pre-harvest head sampling revealed that up to 20% of the formed heads in the high-density plots had not filled. The medium and low-density plots showed 13% and 8% unfilled head proportions, respectively, and up to double the grain weight per head (see Table 4). As a result of this compensation process, final grain yield from the double-spaced plots was 25–50% higher at equal row plant density while similar to the control at equal paddock plant density (NB: these high % proportions reflect the low yield values involved).

In the wetter Year 2, plant weight and number of heads per plant at day 146 were highest in the low-density plots, while being similar to the control in the higher density treatment. Head density/m² however remained below that of the control in the low-density plots. At harvest, 83% greater grain weight per head was measured under the low plant density. Grain yield was thus maximised at double-row spacing and under reduced paddock seed rate (i.e. equal concentration in the row), yielding 6% (0.16 t/ha) over the control. In double-spaced rows, maintaining paddock plant density depressed yield by 10% (0.17 t/ha).

## Grain quality

Neither row spacing nor plant density had much effect on grain quality (Table 5). Greater plant crowding in the row slightly increased grain protein in 2003 but not in 2002, when the level of moisture stress overrode plant competition effects. Screenings were low in both years, with no clear trends observed (NB: the high proportions of unfilled heads during flowering in 2002 minimised grain size penalties). The 1000-grain weight was slightly improved under lower plant density.

## What does it mean?

Wider row spacing at reduced paddock seed rate maximised early plant development due to enhanced early access to concentrated fertiliser and reduced inter-plant competition, especially in marginal moisture. If maintaining paddock plant density, the effect of increased plant crowding on the row overrides the above benefits, limiting plant development and crop yield potential.

These results suggest that grain yield performance of ribbon seeding can be optimised in the Mallee environment by doubling the row spacing (e.g. from 25 cm to 50 cm wide) together with halving seeding rates to maintain similar in-row plant densities (crowding).

In this trial, grain quality differences were small or absent, but this would likely vary with each season, soil type and nutrition. For instance, recent row spacing work with narrow seed spread in Western Australia (Dr Paul Blackwell) improved both bulk unit weight and protein levels under double (60 cm) row spacing. In these trials, the fertiliser row spacing was kept at 30 cm as a means to regulate early plant access to fertiliser. It is possible that a similar effect may be induced with ribbon sowing where diluted plant and fertiliser densities would likely reduce early fertiliser access.

Under wide row spacing, practical options are also available to delay N applications until later in the season, regulating early growth and matching season potential.

The advantages of a ribbon system in wide row cropping are linked to the greater seed bed utilisation (SBU) rating (here 30–35% SBU at 50 cm spacing). Under more conventional seed spread systems, the SBU rating would be 3.5 to 4.5 times smaller (e.g. 7–10% SBU), significantly increasing fertiliser toxicity risks and inter-plant competition. Its drawbacks include the extent of soil disturbance increasing risks of poor crop emergence in marginal moisture (as observed in 2002) and significant contribution to weed germination post-seeding.

GRDC Grains Research & Development Corporation

University of South Australia

Mallee Sustainable Farming Inc. SA NSW VIC

# Types of work in this publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad-scale nature, care should be taken when interpreting results from demonstrations.

| Type of work | Replication | Size | Work conducted by | How analysed |
|---|---|---|---|---|
| Demo | No | Normally large plots or paddock size | Farmers and agronomists | Not statistical, trend comparisons |
| Research | Yes, usually 4 | Generally small plot | Researchers | Statistics |
| Survey | Yes | Various | Various | Statistics or trend comparisons |
| Extension | N/A | N/A | Agronomists and researchers | Usually summary of research results |
| Information | N/A | N/A | N/A | N/A |

# Inter-row Sowing in 2006

**Michael Bennet, Amanda Cook and Brendan Frischke**
SARDI Minnipa Agricultural Centre

Demo Research

## Key messages

- **Modest yield increases were measured for inter-row sowing in replicated small plot trials at Kimba and Karkoo.**
- **Demonstrations using farmer equipment at Mudamuckla and Minnipa show improvements in yield for sowing on the previous crop row.**
- **Inter-row sowing benefits are dependent on stubble, crown or root-borne disease pressures and soil nutrition.**

## Why do the trial?

The concept of inter-row sowing gained great publicity in 2004 from trial work at Sandilands on Yorke Peninsula. The possibility of sowing a crop between the stubble rows of the previous season would enable the crop to grow in a zone with less root disease, provide easier stubble handling and perhaps lead to higher yields, as the trials at Sandilands indicated. These trials follow on from work reported in the EPFS 2005 Summary (page 136).

## How was it done?

Inter-row sowing trials and demos were sown on Eyre Peninsula at Kimba, Karkoo, Minnipa and Mudamuckla in 2006. The trials at Kimba and Karkoo were sown over small plot trials established in 2005, while the Minnipa and Mudamuckla demonstrations were sown with commercial farm equipment. The inter-row sowing trials were established using 2 cm RTK autosteer with a Beeline system at Minnipa, and GPS-Ag Auto Farm systems were used at Kimba, Karkoo and Mudamuckla.

The sites at Kimba and Karkoo were sown on 11 and 12 May using Jack Desbiolles' equipment from UniSA. The replicated trials were sown using Primary Sales knife points and boots. Agmaster press wheels were used on 23 cm (9") spacing at Kimba and 25 cm (10") at Karkoo; 23 cm (9") was used for the two broadacre demonstrations at Mudamuckla and Minnipa.

The canola at Karkoo was sown at 4 kg/ha. The wheat at Kimba was sown to a target a germination of 150 plants/m$^2$ with 60 kg/ha of seed sown.

Three row orientations were used at the two replicated sites. 'On row' is where the 2006 crop was sown on the stubble row of the 2005 crop. 'Inter-row' was where the 2006 crop was sown halfway between the 2005 stubble rows. The '1/3' treatment was sown just to the side of the 2005 stubble, which required even greater precision at sowing than the previous treatments.

## What happened?

Early establishment and vigour measurements in the replicated trials at Kimba and Karkoo indicated that there should be a favourable response to inter-row sowing in these situations. These differences translated into small increases in yield on an otherwise meagre crop yield (Tables 1 and 2).

***Table 1** Stubby canola response to crop row orientation at Karkoo.*

| Row placement | Canola plants/m$^2$ | Yield (t/ha) | Oil content (%) |
|---|---|---|---|
| 1/3 | 32 | 0.28 | 34.5 |
| On row | 36 | 0.27 | 34.7 |
| Inter-row | 47 | 0.35 | 34.9 |
| *LSD (P=0.05)* | *10* | *0.06* | *ns* |

**Try this yourself now**

**Location: Kimba**
Farmer name: Trevor Cliff
Group: Kelly Landcare Group

**Rainfall**
Av. annual: 341 mm
Av. GSR: 247 mm
2006 total: 185 mm
2006 GSR: 118 mm

**Yield**
Potential: 0.78 t/ha (wheat)
Actual: 0.25 t/ha

**Paddock history**
2005: wheat
2004: wheat
2003: oaten hay

**Soil type**
Red clay loam

**Plot size**
30 m x 1.5 m x 4 replications

**Yield-limiting factor**
Moisture

**Location: Karkoo**
Farmer name: Steve Glover
Group: Lower Eyre Ag Development Association

**Rainfall**
Av. annual: 372 mm
Av GSR: 270 mm
2006 total: 277 mm
2006 GSR: 143 mm

**Yield**
Potential: 1.18 t/ha (canola)
Actual: 0.35 t/ha

**Paddock history**
2005: wheat

**Soil type**
Red sandy clay loam

**Plot size**
20 m x 1.5 m x 6 replications

**Yield-limiting factor**
Moisture

continued

The broadacre demonstration paddocks monitored were MAC N5n (wheat on canola), MAC N7/8 and Mudamuckla Paddock 10 and Paddock 31 (all wheat on wheat). Soil samples were taken the week after seeding and the disease level risk calculated using the RDTS DNA bioassay. Plant samples were collected six to eight weeks after seeding and these were washed and the *Rhizoctonia* disease levels visually scored, and DM recorded. DM cuts were also taken pre-harvest. Yield was taken from the farmer yield monitor at Mudamuckla, and estimated from harvest cuts at MAC (Table 3).

The RDTS results (Table 4) show that inter-row disease inoculum levels were lower than the on-row levels for *Rhizoctonia* but there was little difference in other diseases. After a canola crop, the initial level of *Rhizoctonia* inoculum is low, which is similar to previous trial results at Miltaburra and Streaky Bay (EPFS 2005 Summary, pages 85–88).

## Machinery issues from 2005

In 2005, inter-row sowing at MAC was only moderately successful because of issues with unequally spaced crop rows. Crop row measurements from 2005 revealed more than 25% of crop rows were greater than 4 cm from their intended position. This resulted in unequal row spacings and caused difficulty ensuring that all tines were sowing in between stubble.

At the time the cause was attributed to any or all of the following problems — bent tine shanks, closer plate misalignment, loose points, excessive trash and incorrectly positioned tines.

Before seeding, the MAC bar had a thorough inspection with a tape measure. To our surprise all tines were mounted in their correct position and only two tine shanks required straightening. Many knife points appeared to be twisted and several were loose. All points were loosened, realigned and retightened. After sowing our first paddock, which had emerged before our main seeding commenced, crop rows were measured. The result was only two of 39 tines were out by 4 cm (compared to more than 11 before) and the main cause of misalignment identified. The seeder was fitted with cast single bolt knife points with a special adaptor to a shank with a two bolt foot. As the points worked loose over time, they tended to twist to one side and offset the crop row. The seeder was fitted with knock on knife points and a two bolt wedge to eliminate the possibility of tine working out of position. Following this change, the row spacing appeared to remain constant for the whole seeding program.

**Location: Mudamuckla**
Closest town: Mudamuckla
Cooperator: P Kuhlmann

**Rainfall**
Av. annual: 293 mm
Av. GSR: 219 mm
Actual annual: 204 mm
Actual GSR: 102 mm

**Yield**
Potential: 0.92 t/ha
Actual: 0.88 t/ha

**Paddock history**
*Paddock 10*
2006: Wyalkatchem wheat
2005: Krichauff wheat
2004: Krichauff wheat
*Paddock 31*
2006: Krichauff wheat
2005: Clearfield Janz wheat
2004: pasture

**Soil**
Grey calcareous soil

**Location: MAC**
Closest town: Minnipa

**Rainfall**
Av. annual: 325 mm
Av. GSR: 242 mm
Actual annual: 236 mm
Actual GSR: 111 mm

**Yield**
Potential: 1.02 t/ha (wheat)
Actual: 0.6–0.8 t/ha

**Paddock history** *(N5n)*
2006: Yitpi wheat
2005: canola
2004: Wyalkatchem wheat

**Paddock history** *(N7/8)*
2006: Wyalkatchem wheat
2005: Frame wheat
2004: pasture

**Soil**
Red loam

***Table 2 Wheat response to crop row orientation at Kimba.***

| Row placement | Wheat (plants/m$^2$) | Yield (t/ha) | Protein (%) | Screenings (%) |
|---|---|---|---|---|
| **On row** | 131 | 0.17 | 17.1 | 0.78 |
| **Inter-row** | 141 | 0.25 | 16.8 | 0.59 |
| *LSD (P=0.05)* | *10* | *0.06* | *ns* | *ns* |

***Table 3 Results from the 2006 crop monitoring.***

| Treatment | *Rhizoctonia* root score | Early DM (t/ha) | Late DM (t/ha) | No. of heads (heads/m$^2$) | Est. yield (t/ha) | Act. Yield* (t/ha) |
|---|---|---|---|---|---|---|
| **MAC N5n** | | | | | | |
| **Inter-row** | 1.37 | 1.34 | 4.21 | 86 | 1.01 | |
| **On row** | 1.89 | 0.93 | 3.91 | 80 | 1.15 | |
| **MAC N7/8** | | | | | | |
| **Inter-row** | 1.49 | 0.40 | 2.65 | 62 | 1.16 | |
| **On row** | 1.53 | 0.32 | 3.73 | 71 | 1.36 | |
| **Mudamuckla Paddock 10 (Triad)** | | | | | | |
| **Inter-row** | 1.79 | 0.18 | 2.32 | 51 | 1.08 | 0.85 |
| **On row** | 1.84 | 0.12 | 2.94 | 64 | 1.36 | 1.09 |
| **Mudamuckla Paddock 31** | | | | | | |
| **Inter-row** | 1.76 | 0.20 | 2.85 | 77 | 1.16 | 0.88 |
| **On row** | 1.75 | 0.22 | 3.15 | 75 | 1.27 | 0.78 |
| **1/3 Inter-row** | 1.61 | 0.36 | 2.76 | 77 | 1.13 | 0.82 |

** Taken from farmer yield monitor for the strips.*

*Table 4 RDTS levels at the start of the 2006 season.*

| Treatment | *Rhizoctonia* | Take-all | Common root rot | *Pratylenchus neglectus* | *Pratylenchus thornei* | *Fusarium pseud.* | CCN |
|---|---|---|---|---|---|---|---|
| **Kimba** | | | | | | | |
| Inter-row 6 | High | BDL | Low | Low | BDL | BDL | BDL |
| On row | Medium | BDL | Low | Low | BDL | BDL | BDL |
| **Karkoo** | | | | | | | |
| Inter-row | BDL | BDL | Low | BDL | BDL | BDL | BDL |
| On row | BDL | Low | Low | BDL | BDL | BDL | BDL |
| 1/3 Inter-row | BDL | BDL | Low | BDL | BDL | BDL | BDL |
| **MAC N5n** | | | | | | | |
| Inter-row | BDL | BDL | BDL | Low | BDL | BDL | BDL |
| On row | BDL | BDL | BDL | Low | BDL | BDL | BDL |
| **MAC N7/8** | | | | | | | |
| Inter-row | Medium | BDL | Low | Low | Medium | BDL | BDL |
| On row | High | BDL | Low | Low | Medium | Low | BDL |
| **Mudamuckla Paddock 10 (Triad)** | | | | | | | |
| Inter-row | BDL | BDL | Medium | Low | Low | BDL | BDL |
| On row | Low | BDL | BDL | Low | BDL | BDL | BDL |
| **Mudamuckla Paddock 31** | | | | | | | |
| Inter-row | BDL | BDL | Low | Low | Medium | BDL | BDL |
| On row | Low | BDL | Low | Low | Low | BDL | BDL |
| 1/3 Inter-row | Low | BDL | Low | Low | Low | Low | BDL |

The down side is that 2006 has become a setup (or patch up) year to allow inter-row sowing in 2007. The ability to inter-row sow in 2006 was a little hit and miss due to the inconsistently spaced stubble rows from 2005.

## What does this mean?

Although the yield response to inter-row sowing at Kimba and Karkoo was significant, it was still marginal in terms of both crops falling short of covering their variable costs. Although it was a disappointing final result, differences were found in most of the trials during early establishment and vegetative growth.

No discernible difference was measured in terms of root disease levels with the different row alignments. Crown rot was one of the main drivers of yield differences measured at the Sandilands site, which was not present at the Kimba site. Greater differences could be anticipated with higher disease levels present.

The crop monitoring this season showed some differences in *Rhizoctonia* inoculum levels at the start of the season, but the disease levels scored on the plant roots and the yield results showed little difference as a result of initial seed placement this season.

Further monitoring will be required as results may be different in higher rainfall seasons.

The Mudamuckla and Minnipa data suggest that there may be a greater benefit from sowing on the previous season's crop row, rather than on the inter-row. The crop may be accessing nutrition from the previous season's application, which may have led to this result. Lack of nutrient availability on grey calcareous soils is a well documented problem, which has been a challenge for growers and researchers alike. Further investigation of inter-row sowing is warranted, particularly for this soil type.


## Acknowledgements

MAC thanks Agline for their continued support by providing use of a Beeline Auto Steer system; Pete Kuhlmann and Wade Shepperd for their help with the monitoring; SAGIT for funding the Kimba and Karkoo trials; and Jack Desbiolles from the University of South Australia for sowing. Thanks are also extended to Trevor Cliff and to Steve Glover for the use of their land in the experiments. EPFS provided research funding.


Tillage

# Managing Water-Repellent Sands

**Michael Bennet**
SARDI Minnipa Agricultural Centre

Research

**Searching for answers**

**Location: Wharminda**
Farmer name: Tim Ottens
Group: Wharminda Ag Bureau

**Rainfall**
Av. annual: 322 mm
Av. GSR: 222 mm
2006 total: 215 mm
2006 GSR: 127 mm

**Yield**
Potential: 1.55 t/ha (barley)
Actual: 0.68 t/ha

**Paddock history**
2005: pasture
2004: barley
2003: wheat

**Soil type**
Siliceous sand over clay

**Plot size**
40 m x 1.5 m x 4 replications

**Yield-limiting factors**
Late sowing and drought

## Key messages

- **Barley can survive late sowing, sand blasting, minimal rainfall and still produce grain!**
- **Deeper sowing on water-repellent sands was successful in 2006.**

## Why do the trials?

Growing grain on water-repellent sands has been one of the many challenges faced by farmers with sandy soils. Wharminda on eastern Eyre Peninsula is home to sandy soils which can have very high levels of water repellency. Water-repellent sands have been a source of continued trial and tribulation for locals since the land was first cleared last century. Local experience indicates the best outcomes were achieved when sowing in the rain with narrower row spacing and moderate levels of soil disturbance. However, wind erosion has led many growers in the district to adopt no-till to help keep their soil in the paddock.

Unfortunately, knife points and no-till can cause hassles in seasons with poor opening rainfall events such as in 2004 because, with poor amounts of subsurface moisture available, the point can bring up dry sand while pushing the wet sand onto the inter-row. With the inter-row already wet, it continues to wet up with subsequent rain but the crop row is dry and will continue to remain dry despite further rain. It can be extremely frustrating to see wheat in a water-repellent patch of sand emerge but then die despite adequate moisture nearby.

At a meeting with the Wharminda Ag Bureau in April 2006, growers agreed that water-repellent issues were generally worse since adopting reduced tillage practices, although they were determined not to give up reduced tillage. It was also agreed that paddocks in the season after a pasture were the worst for water-repellent problems.

Two trials were sown to compare different seeding systems and investigate the practicalities of using soil wetters to improve crop emergence.

## How was it done?

The trials were sown to Barque barley with DAP (both at 70 kg/ha) on 31 July using equipment sponsored by SANTFA. In one trial, two wetting agents — Wettasoil and Irrigator — were compared at different rates (Table 1). Wettasoil is a garden soil wetter and Irrigator is a commercial broadacre wetter from Western Australia. The wetting agents were applied through stream nozzles tied behind the press wheels. The second trial compared a range of different sowing systems (Table 2).

Harvest cuts were taken at maturity to measure grain yield because the barley was too short for reliable machine harvesting.

## What happened?

The trials were sown into excellent moisture conditions, with considerable moisture available on the surface and at depth. Soil cover was minimal as the paddock was in pasture the previous season. The barley was sandblasted twice, which severely delayed early crop growth. The results achieved from the soil wetters were erratic, with little visual difference between treatments and difference in final grain yield (Table 1).

***Table 1** Soil wetter result at Wharminda.*

| Product | Rate (L/ha) | Grain yield (t/ha) |
|---|---|---|
| **Wettasoil** | 0.5 | 0.28 |
| **Wettasoil** | 1 | 0.35 |
| **Wettasoil** | 1.5 | 0.31 |
| **Wettasoil** | 2 | 0.41 |
| **Irrigator** | 0.25 | 0.38 |
| **Irrigator** | 0.5 | 0.39 |
| **Irrigator** | 0.75 | 0.24 |
| **Irrigator** | 1 | 0.42 |
| **Control** | | 0.32 |
| ***LSD (P=0.05)*** | | *ns* |

In the sowing systems trial, deeper sowing targeting a sowing depth of 40–50 mm (rather than 15–20 mm) gave the best outcome (Table 2). With good moisture at depth but little rainfall after sowing, these treatments were better able to access soil water. Another advantage for the deeper sowing in this situation was protection from one of the sand blasting events.

The situation of having excellent moisture conditions at sowing is somewhat unusual, especially in the last few seasons. The typical scenario involves a very thin layer of moisture on the surface, with minimal subsoil moisture. In this situation, many growers have experienced frustration from the knife point 'throwing' the wet soil on to the inter-row, leaving the crop row dry. It was anticipated that a disc seeder would perform quite well with those moisture conditions.

One concept the Wharminda growers were interested in was to work up a paddock using knife points and press wheels, then coming back and sow the paddock on the inter-row with discs, as the crop row is often dry and the inter-row wet. This concept required RTK autosteer, but even then it was difficult to achieve this pattern in the paddock. The discs tended to follow the path of least resistance, which saw them run in the press wheel furrows. A linkage seeder may offer enough control to give a better result.

Another concept was to sow half the seed with tynes, then return with discs and sow the remainder on the inter-row. This was still difficult to achieve and did not return any great benefits in this situation, but it did look promising early in the season.

Incorporation of seed behind the press wheels has been successfully trialed in Western Australia, particularly with lupin establishment. In this trial it had poor emergence and this treatment gave the worst establishment in the trial, closely followed by a conventional (sweeps + rotary harrows) treatment.

The K-Hart discs performed poorly, probably due to very shallow seed placement and low press wheel pressure.

***Table 2 Sowing systems result at Wharminda.***

| Seeding system | Modification | Grain yield (t/ha) |
|---|---|---|
| **KP+PW** | 16 mm point, work and sow deep | 0.69 |
| **KP+PW** | 12 mm point, work and sow deep | 0.66 |
| **KP+PW** | 12 mm point + snake chains | 0.31 |
| **S+RH** | Sweep + rotary harrows | 0.28 |
| **KP+PW+ K-Hart** | Offset tynes to sow with disc on inter-row (with no coulter) | 0.22 |
| **KP+PW + K-Hart** | Sow half with points, then half with disc on inter-row | 0.22 |
| **K-Hart** | No coulter | 0.20 |
| **KP+PW** | 12 mm point, work shallow | 0.18 |
| **KP+PW + RH** | 12 mm points + press wheels + rotary harrows | 0.18 |
| **K-Hart** | K-Hart at 8 km/h | 0.17 |
| **KP+PW + K-Hart** | Offset tynes to sow with disc on inter-row (with coulter) | 0.16 |
| **K-Hart** | K-Hart at 12 km/h | 0.16 |
| **KP+PW + RH** | Incorporation of seed behind press wheels | 0.12 |
| **KP+PW** | 16 mm point, work shallow | 0.11 |
| ***LSD P=0.05*** | | *0.17* |

**KP = Knife point, PW = Press wheel, RH = Rotary harrows, S = Sweeps, K-Hart = Wavy coulter + V-twin discs + press wheel*

## What does this mean?

The concept of using soil wetters in a no-tillage system is not new to broadacre agriculture. Wider row spacings help make this practice more economical, due to a greater concentration of wetter in the crop row and less product required per hectare.

The wind erosion post-sowing (as well as lack of rainfall!) did not give the soil wetters an opportunity to perform. Ideally the press wheel furrow should be intact to allow rainfall to run into the seed row, then once in contact with the wetter it should penetrate and soak in.

The best long-term solution for alleviating the water-repellent problem on sands is clay spreading or delving, but financial constraints, hostile subsoils and unavailability of suitable clay limit the use of this option.

Successful crop establishment on water-repellent sands in Western Australia has been achieved through soil wetters, incorporating seed behind press wheels as well as the use of disc seeders and standard knife point and press wheel systems. The combination of late sowing along with very dry conditions post-sowing did not reflect the typical sowing situation at Wharminda. Therefore, following consultation with the Wharminda growers, the range of options trialled will be tested again in 2007 to provide more answers for the water-repellent sands problem under different seeding conditions.


## Acknowledgements

CASE IH for supplied the tractor, GPS, air seeder equipment and Flexi-Coil tynes. Agmaster supplied knife points, press wheels, rotary harrows and sowing boots. K-Hart supplied coulters and discs. Thanks to Tim Ottens for the use of his land and his help with sowing the trial. Appreciation also goes to Ben Ward for his technical assistance throughout the season. This work would not have been possible without the generous financial support of the National Landcare Program and the South Australian No Till Farmers Association.

# Canola Fertiliser Agronomy at Mount Cooper

**Michael Bennet**
SARDI Minnipa Agricultural Centre

Demo

**Best practice**

**Location: Mount Cooper**
Farmer name: Mark Hull
Group: Port Kenny Ag Bureau

**Rainfall**
Av. annual: 350 mm
Av. GSR: 270 mm
2006 total: 266 mm
2006 GSR: 151 mm

**Yield**
Potential: 1.5 t/ha (canola)
Actual: 0.6 t/ha

**Paddock history**
2005: pasture
2004: pasture
2003: pasture

**Soil type**
Red-brown earth over limestone

**Plot size**
24 m x 300 m

**Yield-limiting factor**
Moisture

## Key messages

- **Moderate fertiliser inputs were the best for a poor season.**
- **Good separation between seed and fertiliser is required if high rates of urea are to be applied on canola at seeding.**

## Why do the trial?

This demonstration was conducted to highlight the risk of high rates of fertiliser applied with canola seed under local Eyre Peninsula conditions.

## How was it done?

The unreplicated demonstration was sown on 5 May using Mark Hull's Alfarm seeder set on 23 cm spacings with knife points, press wheels and also towing a rubber-tyred roller. Fertiliser rate and placement was metered through a Morris air cart and double shoot system. A weigh trailer and the Hull's harvester were used for grain yield estimations.

## What happened?

The trial site was located on a shallow red-brown earth so working depth was reduced to avoid damage to the machine from rocks. This meant that separation of seed and deep banded fertiliser was probably not as good as had been planned or as good as the capability of the machine.

A high rate of urea at seeding, despite being separated from the seed and having good seedbed moisture at the time of application, caused a substantial reduction in plant numbers (see Table 1). The plants that emerged in the high urea treatments were also less vigorous and did not fully recover from their poor start. DAP applied at seeding, either directly with the seed or deep banded, had little impact on crop establishment. Heavy soils and moist seedbeds are conditions that minimise fertiliser toxicity at seeding.

## What does this mean?

This demonstration highlights that in shallow soils it is best to avoid sowing with too much nitrogen because it can cause establishment problems and may not be needed anyhow because of the low yield potential of these situations. Strategic broadcast nitrogen after seeding may be the best option to take advantage of a good season and minimise financial and crop risk in a poor season.

## Acknowledgements

Thanks to Mark Hull for the use of his land and equipment for the demonstration, and the National Landcare Program for funding.

***Table 1 Canola response to fertiliser rate and placement at Mount Cooper***

| DAP with seed (kg/ha) | DAP deep banded (kg/ha) | Urea deep banded (kg/ha) | Canola plants/m$^2$ | Yield (kg/ha) | Oil content (%) |
|---|---|---|---|---|---|
| 25 | 75 | 100 | 37 | 371 | 38.6 |
| 25 | 75 | 0 | 76 | 574 | 38.4 |
| 100 | 0 | 0 | 72 | 499 | 38.8 |
| 50 | 50 | 0 | 80 | 485 | 38.4 |

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Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Programme

Section editors: Michael Bennet and Brendan Frischke
SARDI
Minnipa Agricultural Centre

# Weeds

Research

## Management of Brome Grass Seed Banks — A Farmer's Perspective

**Sam Kleemann and Gurjeet Gill**
University of Adelaide, Roseworthy

### Key messages

- **Clearfield wheat and use of Midas herbicide provide an excellent opportunity to control brome grass in the wheat phase.**
- **Success of spray topping is vital in preventing large increases in brome grass seed bank in pasture phases. The practice is extremely sensitive to the timing of application; careful monitoring of the development stage of brome is therefore essential.**
- **The results of these studies show that, with good agronomy and herbicide selection, brome grass seed banks can be effectively managed within two years.**

### Why do the trial?

Brome grass (*Bromus rigidus* and *B. diandrus*) is a difficult annual weed to control and has proliferated across Upper Eyre Peninsula with adoption of reduced tillage and increased cropping intensity. This well-adapted weed competes strongly with crops for nutrients and moisture, resulting in significant reductions in grain yield (>50%). Seeds of brome also contaminate harvest samples resulting in penalties at delivery.

Studies have shown that the seed bank of brome is more persistent than was previously thought, with seed carry-over from one season to the next as high as 29% (EPFS 2005 Summary, page 143). The influence of management, particularly crop rotation and herbicide selection, was shown to strongly affect the trajectory and dynamics of the seed bank. Strategic management employed over consecutive seasons was shown to greatly reduce brome grass seed bank.

In order to validate the effectiveness of on-farm management of brome grass, the brome seed bank of several sites across Upper Eyre Peninsula were monitored from 2004 to 2006.

### How was it done?

In March 2004, 14 farmers were asked to select a site on their property that was considered to be problematic with brome (high brome grass seed bank). Sites were sampled in the same place each year (February to March) based on GPS coordinates and a compass reference point. Starting at the reference point (fixed peg), 40 soil cores (7 cm diameter) were taken at routine intervals to a depth of 10 cm over a 100 m transect. Soil samples taken from each site were bulked and thoroughly mixed to homogenise, and a sub-sample (weight basis) was taken for sieving and separation of brome seed. Only viable seeds were counted and converted to number of brome seeds/m$^2$. The farmers provided information concerning site history and management during the monitoring period.

### What happened?

#### Case study 1

The site had a moderate density of brome grass at the start of this study in 2004 (513 seeds/m$^2$). However, brome grass seed bank declined after Clearfield wheat (73%), which received Midas herbicide (900 mL/ha) on 22 July (Figure 1). Midas herbicide has proven to be extremely effective in selectively controlling brome grass in herbicide-tolerant wheat. Midas applied to early tillering brome grass (<2 tillers) can result in high levels of mortality and can significantly reduce seed set.

Good management in the pasture phase (light tillage and spray topped) resulted in a further 75% decline in brome grass seed bank in 2005 (Year 2). A spray-top operation was undertaken early, preventing the brome from setting viable seed.

#### Case study 2

Poor brome control in the previous wheat crop at this site resulted in a high brome seed bank (1299 seeds/m$^2$) at the beginning of the study (2004). However, in the following year of pasture, glyphosate (1.1 L/ha) applied on 26 August resulted in a high level of brome control, reducing the seed bank by 74% (Figure 2). The next phase of Clearfield wheat (2005), which received a post-emergence application of Midas (900 mL/ha) in late July, further reduced the seed bank (0 seeds/m$^2$). Applications of Midas herbicide to Clearfield wheat currently provide the most reliable option for brome grass control in the cereal phase.

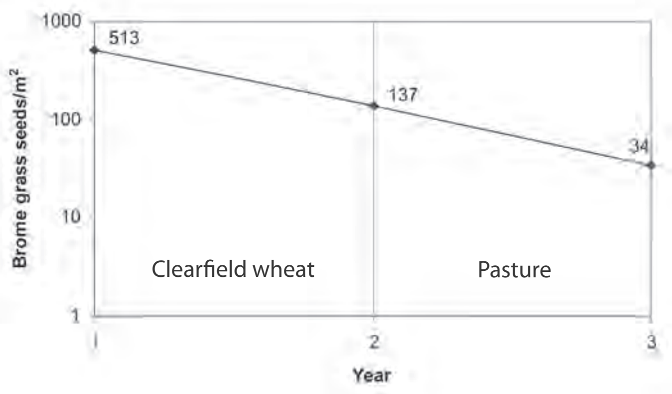


*Figure 1 Changes in brome grass seed bank in Clearfield wheat – pasture phases (CS 1).*

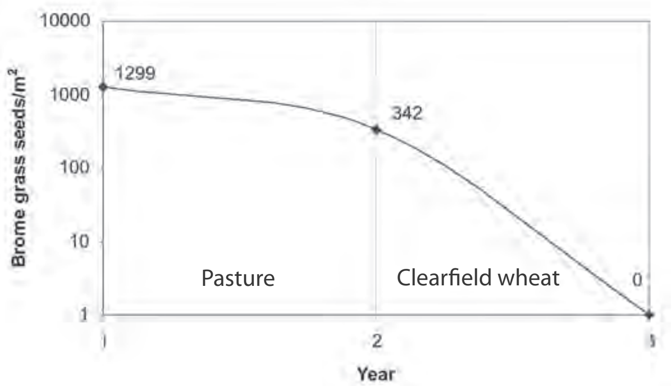


*Figure 2 Changes in brome grass seed bank in pasture – Clearfield wheat phases (CS 2).*


*Figure 3 Changes in brome grass seed bank in barley–pasture phases (CS 3).*

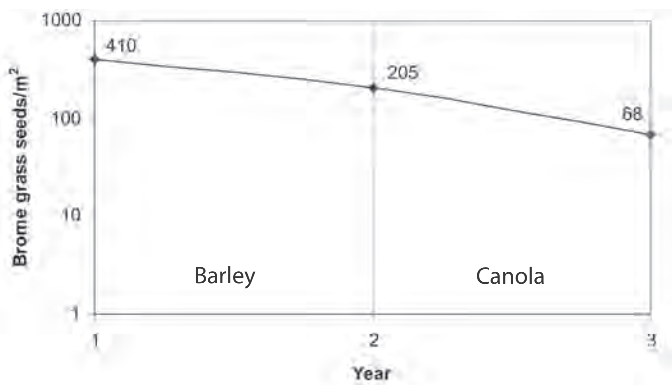


*Figure 4 Changes in brome grass seed bank in barley–canola phases (CS 4).*

## Case study 3

In case study 3, the brome grass seed bank increased after a crop of barley (2004) which received a standard knockdown application of glyphosate (0.5 L/ha) and trifluralin (1.5 L/ha) at sowing (Figure 3). In several trials evaluating herbicides for the control of brome, applications of trifluralin (1.2–1.5 L/ha) have often resulted in poor control of brome, with survivors setting significant amounts of seed to replenish the seed bank. The brome seed bank increased further (444 seeds/m$^2$) in the second year following a pasture phase even though it had been spray topped with paraquat. Spray topping is known for its extreme sensitivity to application timing, and failures to achieve effective seed set control are reported each year.

## Case study 4

At the beginning of CS 4, the brome seed bank was at a moderate density (410 seeds/m$^2$). However, following a crop of barley in 2004 the brome seed bank declined by 50% (Figure 4). This control is attributed to the application of metribuzin (150 g/ha), which was applied initially at sowing as a tank mix with trifluralin (1.0 L/ha) and again post-emergence at 80 g/ha. Tank mixtures of metribuzin and trifluralin have proven to be effective against brome at low densities; however, damage with this herbicide can often result on sandy textured soils where brome is predominately found. Canola sown in the second year of the study (2005) further reduced the brome seed bank (67%), with grass-selective herbicide Targa (350 mL/ha) providing effective post-emergence control. If the break of season permits, break crops such as canola, lupins and peas provide several useful herbicide options for the control of brome.

These case studies show that, with good agronomy and herbicide choice, farmers can maintain a downward trajectory of brome grass seed bank and provide a cleaner option for continuous cropping.

# Acknowledgements

We wish to thank the growers for allowing us to sample on their properties. We gratefully acknowledge the technical assistance provided by Daniel Radulovic and Michael Burdett. GRDC funded this project.

GRDC Grains Research & Development Corporation

# What Stimulates Lincoln Weed Seeds to Germinate? A Query

**Neil Cordon**
SARDI Minnipa Agricultural Centre

At the 2006 farmer meetings on Upper Eyre Peninsula there was widespread support for more research on Lincoln weed in the farming system, with an emphasis on factors that influence seed viability and germination. This was in response to Sam Kleemann's work on brome grass, which has led to a greater understanding of germination traits for that weed.

Sam Kleemann from Roseworthy Campus conducted a seed biology study with Lincoln weed (*Diplotaxis tenuifolia*) in 2005 and a paper has been submitted to the *Weed Science Journal* in the USA. These are his initial findings, which are a step towards understanding a little more about how it geminates.

He found that the species shows little or no dormancy, with near 100% germination within five days of rainfall. Optimal conditions for germination appear to be constant temperatures of 30°C and it shows high preference for germinating from the soil surface, with less than 10% of seeds germinating from depths of 0.5–2 cm.

At low temperatures (10 and 20°C), germination was reduced by 20% with light compared to continuous darkness. In respect to pH, high levels of germination (>80%) were recorded across a range of pH levels (pH 5–9). Hence, pH appears to have little or no effect on the germination of this species. The pH effect likely influences later growth stages, perhaps affecting nutrient.

In all, Lincoln weed is a species that will germinate easily under a wide range of conditions provided that temperatures are high.

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# Types of work in this publication

The following table shows the major characteristics of the different types of work in this publication. The Editors would like to emphasise that because of their often unreplicated and broad-scale nature, care should be taken when interpreting results from demonstrations.

| Type of work | Replication | Size | Work conducted by | How analysed |
|---|---|---|---|---|
| Demo | No | Normally large plots or paddock size | Farmers and agronomists | Not statistical, trend comparisons |
| Research | Yes, usually 4 | Generally small plot | Researchers | Statistics |
| Survey | Yes | Various | Various | Statistics or trend comparisons |
| Extension | N/A | N/A | Agronomists and researchers | Usually summary of research results |
| Information | N/A | N/A | N/A | N/A |

# Competitive Cropping at Ungarra

**Michael Bennet**
SARDI Minnipa Agricultural Centre

Research

**Almost ready**

**Location: Ungarra**
Baldiserra brothers

**Rainfall**
Av. annual: 417 mm
Av. GSR: 333 mm
2006 total: 277 mm
2006 GSR: 218 mm

**Yield**
Potential: 2.23 t/ha (wheat)
Actual: 2.28 t/ha

**Paddock history**
2005: canola
2004: pasture
2003: barley

**Soil type**
Red clay loam

**Plot size**
10 m x 1.52 m x 4 replications

**Yield-limiting factor**
Drought

## Key messages

- **Wheat can still compete with ryegrass at 30 cm row spacings.**
- **Some commercial varieties are more competitive than others.**
- **Increasing crop sowing rate reduces ryegrass seed set.**

## Why do the trial?

The trial was aimed at comparing four commercial wheat varieties at three seeding rates in terms of their weed competition and final grain yield.

## How was it done?

Sowing on 7 June was into excellent moisture conditions using Cummins Ag Services' DBS plot seeder set on 30 cm (12") row spacings, with 1.5 L/ha Trifluralin applied pre-sowing.

The varieties of wheat in the trial were Wyalkatchem, Krichauff, Pugsley and Yitpi. A district practice sowing rate of 80 kg/ha was compared to sowing rates of 140 and 200 kg/ha. The paddock was canola stubble, which should have minimised the impact of different yellow leaf spot tolerances between the varieties.

## What happened?

Despite a large ryegrass seed bank, there was little ryegrass emerging a month after sowing. It was not until seven weeks after sowing that ryegrass began to emerge. This indicates that the combination of Trifluralin and a dry inter-row were temporarily effective on ryegrass in this situation. Late germination may have been selected for in the ryegrass population through a long history of heavy and early knockdown pressure.

Wheat emergence was measured at 160, 240 and 400 plants/$m^2$ with the respective sowing rates of 80, 140 and 200 kg/ha.

Wyalkatchem was the highest yielder in the competitive cropping trial (Table 1), which is why it is a widely adopted variety across Lower Eyre Peninsula and other areas of the state. Head tipping was observed in Krichauff, but was even more frequent in Pugsley.

Grain quality was unaffected by seeding rate or variety. Test weight averaged to 81.4 g/hL, screenings 1.6% and protein 10.2%. The grain quality was exceptional despite the higher seeding rates.

Throughout the trial, the best strategy to reduce ryegrass seed set was sowing rate, but variety also had an impact (Table 2). Pugsley was the most competitive variety followed by Yitpi. Krichauff and Wyalkatchem performed poorly at the 80 kg/ha rate, but all varieties had improved weed competition with increased seeding rates.

***Table 1** Grain yield (t/ha) response to sowing rate at Ungarra.*

| Variety | 80 kg/ha | 140 kg/ha | 200 kg/ha |
|---|---|---|---|
| Krichauff | 1.76 | 2.01 | 1.81 |
| Pugsley | 1.98 | 1.90 | 1.87 |
| Wyalkatchem | 2.28 | 2.25 | 2.02 |
| Yitpi | 1.92 | 1.93 | 1.90 |
| *LSD (P=0.05)* | *ns* | *ns* | *ns* |

*ns=non-significant*

*Table 2 Ryegrass emergence (plants/m$^2$) and seed set (seeds/m$^2$).*

| Variety | 80 kg/ha | | 140 kg/ha | | 200 kg/ha | |
|---|---|---|---|---|---|---|
| | Plants/m$^2$ | Seed/m$^2$ | Plants/m$^2$ | Seed/m$^2$ | Plants/m$^2$ | Seed/m$^2$ |
| **Krichauff** | 183 | 1084 | 97 | 544 | 130 | 418 |
| **Pugsley** | 134 | 626 | 152 | 384 | 72 | 460 |
| **Wyalkatchem** | 135 | 1264 | 108 | 494 | 73 | 419 |
| **Yitpi** | 121 | 861 | 121 | 784 | 141 | 397 |
| *LSD (P=0.05)* | *ns* | *343* | *ns* | *343* | *ns* | *343* |

## What does this mean?

Despite Wyalkatchem's poor early vigour, it will still remain an important variety grown across South Australia. However, growers should avoid sowing it into paddocks with high levels of ryegrass. Many growers have already identified this issue and will only sow it on paddocks with low weed burdens, or manage weeds through other means.

Results show that despite the 30 cm row spacing, the weeds still suffered increased crop competition through variety choice and sowing rate. The effectiveness of crop competition, particularly with wider row spacings, may be reduced when ryegrass germinates soon after crop emergence, unlike in this experiment where the crop had a significant advantage on the weeds.

The trial showed that ryegrass seed set was reduced with heavier seeding rates. However, heavier sowing rates may not be a preferred option in all situations due to the risk of screenings if the crop runs out of moisture in spring. Screenings were low in the trial, perhaps because the season was not a 'sharp' cut off with high levels of crop biomass; it was just a gradual downward spiral of crop potential after August.

It would be extremely valuable to replicate this experiment in a season that had a good spring. Overall, the ryegrass seed set was low in comparison to the potential seed set indicated through other research. This is mostly due to the lack of a finish to the season and the late nature of the ryegrass emergence. It could be anticipated that greater differences between the varieties and seeding rates would be seen in a different season, as well as greater overall seed set.

The impact to an overall farming system needs to be considered when changing management practices. High levels of weed seed set in one season can bring significant management problems, which may take many seasons to recover from. This is why an integrated approach to weed management needs to be taken, to hit them from every angle possible.

## Acknowledgements

Thanks to the Baldiserra family for the use of the land, spraying the trial site and supplying seed for the trial. Thanks to Landmark Cummins Ag Services for their assistance with sowing and harvest. Appreciation goes to Carey Moroney for her patient support in data collection. This work would not have been possible without the generous financial support of the National Landcare Program and SANTFA.

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# Annual Ryegrass Control with Pre-emergence Herbicides


**Peter Treloar**

Rural Solutions SA, Loxton


Demo

Research

**Searching for answers**

**Location**
Pinnaroo: John Angel (Site 1) and Jeff, Adam and Giles Oster (Site 2)

**Rainfall**
Av. annual: 334 mm
Av. GSR: 239 mm
2006 total: 158 mm
2006 GSR: 116 mm

**Paddock history**
2005: peas

**Soil type**
Sandy clay loam over light clay

**Plot size**
32 m x 4 m x 3 replications

**Yield-limiting factor**
Drought

## Key messages

- **Early breaks to the season that allow the use of knockdowns prior to sowing greatly reduce ryegrass numbers in crops.**
- **In seasons with multiple germinations, chemicals with greater residues will offer the most control.**
- **Following dry seasons, plant back requirements should be checked to avoid crop damage.**

## Why do the trial?

Controlling annual ryegrass in continuous cropping rotations can put extra pressure on chemicals and particularly trifluralin. To help avoid resistance and improve control with pre-emergence chemicals, various combinations of chemicals have been evaluated.

## How was it done?

Various chemicals combined with trifluralin were compared to a control of no chemical and standard rate of trifluralin in two replicated large-scale demonstrations in 2006 (Figures 1 and 2). Each treatment was applied onto pea stubble prior to seeding with no-till machines, using knifepoints and press wheels.

Ryegrass counts were taken during the season, early and late at one site, while at the other only one count in October was taken due to low ryegrass numbers.

## What happened?

The cost of each treatment per hectare is shown in Table 1.

## What does this mean?

The drought conditions in 2006 reduced yields, meaning there was no effect of treatments on yield at both sites. The staggered germination can be seen at Site 1 where rains in July bought on a fresh germination. In late counts done at the end of September, there were at least two distinct groups of different maturity, with a question mark over the viability of the youngest ryegrass plants.

The extra residual control from Logran, Glean and Avadex can be seen at Site 1, which experienced the lowest increase in ryegrass numbers through the year. Although the same ability to offer residual control can also cause problems for following crops, especially after a dry season like this one, farmers should consult the label for plant back information of various chemicals.

There were no significant differences between treatments at Site 2, but there was a halving of ryegrass numbers compared to the control by most treatments.

Prolan is a chemical registered for use in horticulture so, along with the high cost and limited effect on annual ryegrass at the rates used, it is not a reasonable alternative. In future the trial will aim to include other uncommon chemicals to compare on small areas so farmers may see the results for themselves.

***Table 1** Cost of herbicide treatment per hectare.*

| | TriflurX | TriflurX x2 | Prolan* | Prolan | Logran* | Glean* | Avadex* | Lexone* | Dual Gold* | Diuron* |
|---|---|---|---|---|---|---|---|---|---|---|
| Rate/ha | 1.3 L | 2.5 L | 600 mL | 1 L | 15 g | 20 g | 1.6 L | 200g | 400 mL | 1 kg |
| Cost ($/ha) | 8.84 | 17.00 | 29.84 | 52.00 | 11.99 | 11.38 | 34.28 | 19.64 | 19.14 | 22.49 |

**includes 1.3 L TriflurX. Prolan and Lexone are not registered for use in wheat.*

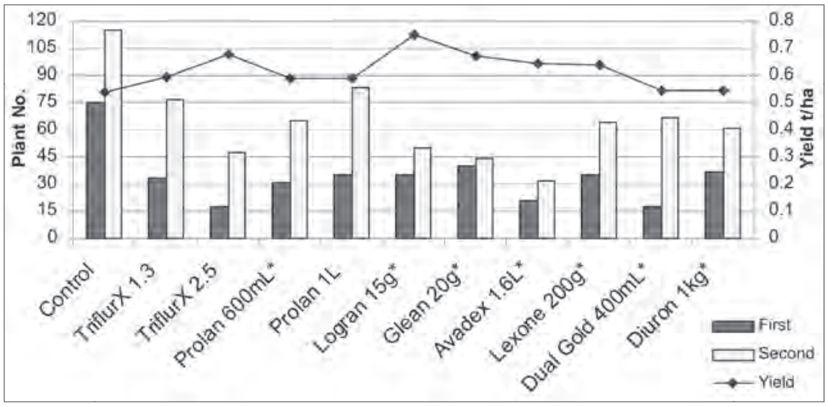


*Figure 1 Ryegrass numbers/m² early and late, and resulting wheat yield at Site 1.*

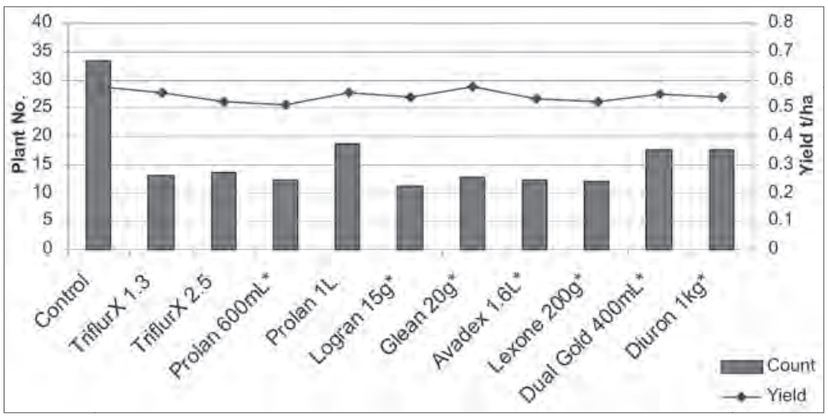


*Figure 2 Ryegrass numbers/m² and resulting wheat yield at site 2.*

## Acknowledgements

Thanks are extended to John Angel, Jeff, Adam and Giles Oster, Pinnaroo; Graham Fromm, Rural Solutions SA, Murray Bridge; Richard Saunders and Andrew Biele, SARDI Field Crop Evaluations Unit, Loxton; National Landcare Project; and DWLBC.

# Trifluralin Alternatives at Mount Cooper

**Michael Bennet**
SARDI Minnipa Agricultural Centre

Research

## Key messages

- **Good crop safety observed with some alternative ryegrass herbicides.**
- **Barley is tougher than ryegrass!**

## Why do the trial?

The trial was a response to grower concerns of trifluralin resistance in the Mount Cooper district, given the long history of group D herbicide use in the area. The trial aimed to determine which herbicides are suitable alternatives to trifluralin by comparing their efficacy on annual ryegrass and their crop safety.

## How was it done?

Different herbicide treatments were sprayed across the trial using a 3 m wide hand boom on 19 May (Table 1). The boom was set up with 11001 Turbodrop Airmix nozzles that were calibrated to deliver 75 L/ha. The trial was sown to SloopSA barley at 70 kg/ha which incorporated the herbicides within four hours of the applications.

A John Shearer Universal bar with knifepoints and press wheels on 30 cm spacings was used for seeding the trial. Ryegrass plants were counted after crop emergence and after the trial was harvested with a plot header at maturity.

**Searching for answers**

**Location**
District: Mount Cooper
Group: Port Kenny Ag Bureau

**Rainfall**
Av. annual: 350 mm
Av. GSR: 270 mm
2006 total: 266 mm
2006 GSR: 151 mm

**Yield**
Potential: 1.9 t/ha (barley)
Actual: up to 1.36 t/ha

**Paddock history**
2005: wheat
2004: peas
2003: wheat

**Soil type**
Red sandy clay loam

**Plot size**
24 m x 3 m x 4 replications

**Yield-limiting factor**
Drought

Weeds

***Table 1** Ryegrass control (ARG) and barley yield with alternative herbicides at Mount Cooper in 2006.*

| Herbicide | Rate | Herbicide group | ARG/m$^2$ | % ARG control | Yield (t/ha) |
|---|---|---|---|---|---|
| **TriflurX + Avadex** | 1.5 L/ha + 1.6 L/ha | D+E | 17 | 77 | 1.36 |
| **TriflurX + Diuron + Dual Gold** | 1 L/ha + 1 L/ha + 1 L/ha | D+C+K | 23 | 70 | 1.25 |
| **TriflurX + Diuron + Dual Gold** | 1 L/ha + 700 mL/ha + 500 mL/ha | D+C+K | 23 | 70 | 1.08 |
| **TriflurX** | 1 L/ha | D | 24 | 69 | 1.15 |
| **TriflurX + Dual Gold** | 1 L/ha + 300 mL/ha | D+K | 31 | 60 | 1.23 |
| **TriflurX** | 2 L/ha | D | 33 | 57 | 1.24 |
| **Simazine** | 1 L/ha | C | 37 | 52 | 1.05 |
| **Cinmethylin** | 275 mL/ha | ? | 47 | 39 | 1.07 |
| **Diuron + Dual Gold** | 700 mL/ha + 500 mL/ha | C+K | 48 | 37 | 1.28 |
| **Control (no spray)** | | | 77 | | 1.09 |
| ***LSD P=0.05*** | | | *22* | | *0.18* |

*TriflurX is 480 g/L Trifluralin, Diuron is 500 g/L Diuron, Dual Gold is 960 g/L S-Metalochlor, and Simazine is 500 g/L Simazine.*

## What happened?

The lack of rainfall after sowing greatly reduced the activity of the soluble herbicides Simazine and Diuron, and the level of crop damage was much less than anticipated. When adequate soil moisture is present, the rates of Diuron used here can be effective at controlling barley and barley grass.

Due to the lack of rain, most of the ryegrass within the plots died prior to harvest, but the barley was able to finish.

The most effective herbicide mix was TriflurX and Avadex applied at 1.5 and 1.6 L/ha, respectively; it greatly reduced ryegrass numbers and improved grain yield (Table 1). A mix of two herbicides is often used in situations where group D herbicides are ineffective on their own due to resistance issues. Diuron and Dual Gold applied at 700 and 500 mL/ha, respectively, performed poorly, but did a much better job when used in combination with 1 L/ha of TriflurX. It was unusual to observe no large improvement of ryegrass control with a double rate of TriflurX.

Simazine partially controlled the ryegrass present, but this rate, included to demonstrate extreme crop damage, would control most of the barley in a wetter season. The crop treated with Simazine looked poorer and ended up being the lowest yielding treatment. The experimental herbicide Cinmethylin performed poorly in this trial, which backs up other trial data that suggest this herbicide needs a reasonable amount of moisture post-sowing to be effective. This herbicide, however, was effective on ryegrass in the 2004 disc seeder research by SANTFA (EPFS 2004 Summary, pages 125–126).

## What does this mean?

Trifluralin is currently one of the cheaper herbicides to use for ryegrass control, but this is not likely to be the case in the future. Consistent applications of trifluralin will eventually lead to widespread resistance to the herbicide and growers will have to adopt other options. Tank mixing trifluralin with alternative herbicides will help slow the rate of ryegrass resistance. The use of wide row spacings such as 30 cm can increase crop safety; this is especially important with some of the more damaging soil-applied herbicides. Significant crop damage can result from excessive soil throw with the more soluble herbicides such as Diuron and Dual Gold.

In addition to seeking new chemical options, growers should take a long-term approach to weed management, and endeavour to keep weed numbers low. A diverse rotation with seasons of total weed control by non-chemical means will reduce the reliance on herbicides, therefore prolonging the life of existing chemical groups.

## Acknowledgements

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

SANTFA

Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Programme

# Sharing Information

**Section editor:**
**Amanda Cook**
SARDI
Minnipa Agricultural Centre

Information

## The Low Rainfall Collaboration Project

**Geoff Thomas and Nigel Wilhelm**
Low Rainfall Collaboration Project

The GRDC-funded Low Rainfall Collaboration Project (LRCP) aims to foster greater sharing of knowledge and ideas between a number of farming systems groups in southeastern Australia. This project is now in its second phase of funding from GRDC.

All of these groups normally receive less than 450 mm of rainfall per year. In a year like 2006 this could include most of southern and western Australia, but the groups formally involved in this project are Eyre Peninsula Farming Systems, Upper North Farming Systems, Mallee Sustainable Farming, BCG (formerly Birchip Cropping Group) and Central West Farming Systems. We also maintain contact with similar groups in Western Australia, especially in the Esperance and Geraldton areas.

### There are several reasons for the low rainfall project:

- The low rainfall areas have untapped potential for improvement in productivity and sustainability. They have attracted relatively less research and extension resources in the past than their higher rainfall cousins.
- Farmer groups are widely recognised as an essential component of the testing and integration of new technologies into farming systems.
- There is a shortage of experienced scientists working in low rainfall areas, which makes the need to share expertise and information with and between groups even more important. Whilst individual environments may be different, the principles will be similar.
- There is a need to reduce duplication and fragmentation. Everyone is short of resources, a situation that will not improve in the short term. It is essential to share research resources not only between the groups themselves but also with universities, CSIRO and state research facilities.
- The existence of a strong network is attractive to funding bodies that can easily lock into existing groups to ensure that the results of their investments have greater impact.
- Teamwork between the groups provides mutual support and satisfaction.

### The new LRCP builds on its predecessor and now has four components:

1. **Communication —** This involves a regular newsletter between the groups; an annual workshop on technical issues and those issues important for t he effective operation of the groups themselves; a program of visits by farmers to farms, research facilities and field days in other areas; and ongoing information support to the groups.
2. **R&D support —** This involves bringing scientific 'grunt' together and making it available to all the groups; brokering of relevant technical support to groups; establishment of guidelines for R&D so that results can be better shared; a compendium of the work being done by all the groups and also by others who work on issues relevant to the groups; and support for the groups during their interpretation and priority setting phases to extract the most value from group resources and the results they have achieved. An expert panel is being convened to bring intellectual support from across southern Australia to help with these issues for all the groups.


3. **Farm decisions and economics** — The importance of integrating technologies into the farm system cannot be over emphasised, but it is not just the technical issues of including them in farm operations. The adoption of many technologies, whilst they improve production, will result in higher costs and risks. The aim is to assess the emerging technologies in economic and risk terms. In the end, the purpose is to help farmers achieve acceptable profits at acceptable levels of risk.
4. **Evaluation —** It is no longer adequate to assess our performance in terms of farm production alone. A balance of economic, environmental and social aspects is essential, and their integration involves quite complex tools. It is more efficient if groups can share these tools and compare the results collectively.

The project is funded by GRDC and runs until 2009. The Project Manager is Geoff Thomas and Dr Nigel Wilhelm is the Scientific Consultant, both of whom have spent most of their careers doing extension and research with groups, especially in low rainfall areas.

# Grazing Cereals in the Upper North

**Ali Cooper**
UNFS Coordinator, Rural Solutions SA, Jamestown

Research

**Searching for answers**

**Location**
Closest town:
Morchard and Warnertown
Cooperator: Morchard Community, Brendon and Graham Johns
Group: Upper North Farming Systems

**Rainfall**
*Morchard*
Av. annual: 330 mm
Av. GSR: 233 mm
Actual total: 214 mm
Actual GSR: 90 mm
*Warnertown*
Av. annual: 330 mm
Av. GSR: 236 mm
Actual total: 237 mm
Actual GSR: 143 mm

**Yields**
Potential yields:
*Morchard*
1.40 t/ha (wheat),
1.80 t/ha (barley)
*Warnertown*
1.89 t/ha (wheat),
2.29 t/ha (barley)

**Actual yields**
*Morchard*
0.44 t/ha (wheat),
0.24t/ha (barley)
*Warnertown*
1.15 t/ha (wheat),
1.02 t/ha (barley)

**Paddock history**
*Morchard*
2005: wheat
2004: wheat
2003: grass pasture
*Warnertown*
2005: peas
2004: barley
2003: wheat

**Soil**
*Morchard*
alkaline, red clay loam
*Warnertown*
alkaline, grey light sandy clay loam

**Land value**
$650/ha (Morchard),
$1875/ha (Warnertown)

**Plot size**
10 m x 2 m, 4 replications

## Key messages

- **Grazing reduced grain quality of cereals at both low rainfall sites.**
- **DM production was higher for barley than wheat and Italian ryegrass.**
- **Grazing reduced grain yields at Morchard by 6%.**
- **Late grazing of cereals at Warnertown had no effect on grain yield.**

## Why do the trial?

For many years farmers have practiced grazing oats as an option to fill the autumn – early winter feed gap that many cereal zone farmers face. The choice of grazing oats has come into question recently amongst the Upper North farmers with results from the EP Grain & Graze project showing that oats are similar in DM production to barley, but do not recover as well.

In 2006, the UNFS group decided to look beyond grazing oats and focus on grazing wheat and barley to determine what impact grazing has on grain yield and quality. Italian ryegrass was also included in the Morchard trial to determine whether it has a role in filling the autumn feed gap.

## How was it done?

The trials were a split plot design, with four replications. Morchard was sown on 1 June and harvested on 25 November. Warnertown was sown on 30 May and harvested on 7 November. Single sowing rates of wheat and barley were 60 kg/ha and double sowing rates were 120 kg/ha. The single sowing rates for ryegrass were 15 kg/ha and double rates were 25 kg/ha. 75 kg/ha of DAP (18:20:00) was used across both sites, except on selected nitrogen rate treatments at Morchard (Table 1).

DM cuts were taken at late tillering to early jointing growth stages. Grazing was simulated by mowing the plots with a domestic lawn mower. The sites were mowed on 22 August at Morchard and 28 July at Warnertown. Treatments included wheat, barley and ryegrass, single or double seeding rates, and variable upfront nitrogen rates. Grain yield and quality was assessed.

***Table 1 DM production (DM kg/ha) and grazing value at Morchard.***

| Treatment | Fertiliser rate (kg/ha) | DM production (kg/ha) | Grazing value* ($/ha) |
|---|---|---|---|
| **Ryegrass single** | 14N 15P | 101 | 6.90 |
| **Ryegrass double** | 14N 15P | 141 | 9.64 |
| **Yitpi single** | 12N 13P | 167 | 11.47 |
| **Wyalkatchem single** | 14N 15P | 168 | 11.53 |
| **Yitpi single** | 14N 15P | 235 | 16.11 |
| **Yitpi single** | 32N 15P | 273 | 18.72 |
| **Yitpi double** | 14N 15P | 288 | 19.73 |
| **Wyalkatchem double** | 14N 15P | 296 | 18.45 |
| **Sloop SA single** | 14N 15P | 324 | 22.16 |
| **Maritime single** | 14N 15P | 380 | 26.04 |
| **Sloop SA double** | 14N 15P | 381 | 26.08 |
| **Maritime double** | 14N 15P | 486 | 33.27 |
| *LSD (P=0.05)* | | *77* | |

**Grazing value has been calculated assuming that 1 DSE will consume 1 kg of DM/day. Values are based on the 2006 Rural Solutions SA Farm Gross Margin Guide, where the value of a Merino is $25/DSE/year.*

# What happened?

## Morchard grazing results

Barley produced higher amounts of biomass than wheat, which produced more biomass than sown ryegrass (Table 1). From these results, it suggests that the grazing value of barley is approximately three times the value of sown ryegrass.

The higher nitrogen rate Yitpi treatments produced higher biomass than the lower nitrogen rates. Doubling seeding rates increased DM production by an average of 30%.

Due to the lack of substantial rainfall events after grazing, no post-seeding nitrogen was applied to selected treatments.

Simulated grazing reduced all grain yields by an average of 6% ($3–4/ha).

Grain quality was reduced by simulated grazing, with the ungrazed plots having higher protein levels and lower screenings (Table 2).

Nitrogen rates on Yitpi had no effect on grain yield or quality.

## Warnertown results

The site was mowed later than desired, with the barley at late jointing and wheat at first node. The double seeding rate of Maritime barley produced more biomass than the single seeding rate of Maritime (Table 3). Barley produced more biomass than wheat, equating to approximately four times the grazing value.

Due to the lack of substantial rainfall after grazing, no post-seeding nitrogen was applied to selected treatments.

Grazing did not affect grain yield. There is a lot of variability within the results, which reduces confidence in the results being repeated in a different year. There is no guarantee that, in following years, no yield reductions will be observed from grazing.

Grain quality was affected by grazing with higher screenings and lower protein levels.

# What does this mean?

The results from the UNFS grazing cereal trials are consistent with those from the past two years of research on Eyre Peninsula. Grazing cereal crops is a risk management tool that has the potential to return some additional dollars to the farming system, provided that the feed is actually needed, i.e carrying more stock, filling the autumn – early winter feed gap or finishing stock.

***Table 2** Grain yield and quality and total gross margin for the 2006 grazing cereals trial, Morchard.*

| Treatment | Grade | Yield (t/ha) | Protein (%) | Test wt (kg/100 L) | Screenings (%) | Total gross margin* ($/ha) |
|---|---|---|---|---|---|---|
| Maritime double G | F3 | 0.08 | 12.6 | 59.1 | 1.7 | -71.96 |
| Maritim e double UG | F3 | 0.22 | 12.5 | 58.3 | 1.3 | -76.98 |
| Maritime single G | F3 | 0.13 | 10.8 | 59.7 | 3.7 | -45.13 |
| Maritime single UG | F2 | 0.29 | 11.4 | 60.4 | 1.2 | -37.16 |
| Ryegrass double G | – | – | – | – | – | -99.26 |
| Ryegrass double UG | – | – | – | – | – | -108.90 |
| Ryegrass single G | – | – | – | – | – | -82.00 |
| Ryegrass single UG | – | – | – | – | – | -88.90 |
| Sloop SA double G | F1 | 0.09 | 9.4 | 64.2 | 6.1 | -75.33 |
| Sloop SA double UG | F2 | 0.08 | 9.8 | 60.0 | 4.9 | -104.43 |
| Sloop SA single G | F2 | 0.12 | 9.5 | 60.2 | 4.2 | -54.60 |
| Sloop SA single UG | F1 | 0.09 | 9.3 | 63.7 | 4.0 | -82.21 |
| Wyalkatchem double G | Feed | 0.23 | 7.9 | 72.1 | 11.9 | -46.17 |
| Wyalkatchem double UG | AGP | 0.41 | 13.3 | 73.1 | 6.9 | -9.06 |
| Wyalkatchem single G | Feed | 0.21 | 14.9 | 73.4 | 11.3 | -42.79 |
| Wyalkatchem single UG | AGP | 0.33 | 15.2 | 73.2 | 6.3 | -14.21 |
| Yitpi double G | Feed | 0.19 | 14.4 | 72.2 | 12.4 | -53.09 |
| Yitpi double UG | AGP | 0.32 | 15.4 | 74.4 | 9.8 | -34.01 |
| Yitpi single G | Feed | 0.18 | 14.6 | 74.1 | 13.4 | -44.36 |
| Yitpi single UG | Feed | 0.34 | 15.1 | 74.1 | 10.3 | -27.67 |
| Yitpi single 12 G | Feed | 0.44 | 13.6 | 75.1 | 13.4 | 9.17 |
| Yitpi single 12 UG | Feed | 0.53 | 14.1 | 75.6 | 15.2 | 16.15 |
| Yitpi single 32G | AGP | 0.39 | 15.7 | 74.2 | 10.0 | -7.26 |
| Yitpi single 32 UG | AGP | 0.51 | 15.8 | 73.6 | 10.0 | 5.43 |
| *LSD (P=0.05)* | | *ns* | *1.49* | *ns* | *2.72* | |

**Total gross margin = Grazing value + (Yield x ESR) – seeding costs*
*Costs include seed, fertilisers, chemicals and operational costs taken from the Rural Solutions SA 2006 Farm Gross Margin Guide.*
*Estimated silo return (ESR) price based on daily cash price at Booleroo Centre. Yitpi Hard attracts a $10 premium.*
*G= Grazed, UG = Ungrazed, Single = standard seeding rate, Double = double seeding rate, 12 = 12 kg N/ha at seeding, 32 = 32 kg N/ha at seeding.*

*Table 3 DM production (DM kg/ha) and grazing value at Warnertown.*

| Treatment | DM production (kg/ha) | Grazing value* ($/ha) |
|---|---|---|
| Yitpi single | 151 | 10.32 |
| Yitpi double | 234 | 16.00 |
| Maritime single | 575 | 37.41 |
| Maritime double | 1139 | 78.04 |
| *LSD (P=0.05)* | *90* | |

**Grazing value has been calculated assuming that 1 DSE will consume 1 kg of DM/day. Values are based on the 2006 Rural Solutions SA Farm Gross Margin Guide, where the value of a Merino is $25/DSE/year.*

*Table 4 Grain yield and quality and total gross margin for the 2006 grazing cereals trial, Warnertown.*

| Treatment | Grade | Yield (t/ha) | Test wt (kg/100L) | Protein (%) | Screenings (%) | Total gross margin* ($/ha) |
|---|---|---|---|---|---|---|
| Maritime D G | F3 | 1.1 | 51.7 | 10.8 | 0.37 | 195.70 |
| Maritime D UG | F2 | 0.61 | 61.8 | 12.6 | 0.38 | 18.35 |
| Maritime S G | F2 | 0.85 | 62.0 | 11.7 | 0.45 | 123.50 |
| Maritime S UG | F1 | 0.62 | 63.2 | 12.7 | 0.40 | 44.50 |
| Yitpi D G | AH | 0.97 | – | 15.3 | 2.02 | 165.65 |
| Yitpi UG | AH | 0.85 | – | 15.8 | 1.28 | 119.43 |
| Yitpi S G | AH | 0.90 | – | 15.1 | 2.43 | 155.50 |
| Yitpi S UG | AH | 0.92 | – | 15.8 | 1.52 | 152.87 |
| *LSD (P=0.05)* | | *ns* | *ns* | *ns* | *0.19* | |

**Total Gross Margin = Grazing value + (Yield x ESR) - seeding costs*
*Costs include seed, fertilisers, chemicals and operational costs taken from the Rural Solutions SA 2006 Farm Gross Margin Guide.*
*Estimated silo return (ESR) price based on daily cash price at Crystal Brook. Yitpi Hard attracts a $10 premium.*
*G= Grazed, UG = Ungrazed, Single = standard seeding rate, Double = double seeding rate.*

Morchard saw a 6% grain yield reduction ($3–4/ha loss) in 2006, while grazing contributed $16–27/ha, meaning the benefits of grazing outweigh the costs and loss in yield potential. As the opening to the 2006 season was highly suited to the growth of winter crops, the same benefits seen from grazing in 2006 could be questionable in years with poor season openings.

It is quite surprising that there was no yield reduction in the grazed treatments at Warnertown, particularly as the simulated grazing was done at an undesirably late growth stage (late jointing). Warm growing season conditions and lighter soils may have benefited the recovery of the grazed treatments. The Warnertown district struggles to make malting grades from barley due to excessive early biomass production, so grazing may be able increase crop value through canopy management.

The use of sown ryegrass is questionable in the Upper North as few varieties are suited to low rainfall environments. Results from the 2006 trials suggest that it is more economical to use a cereal where additional value from grain yield can be obtained.

## Acknowledgements

GRDC made this research possible through funding of the Upper North Farming Systems project. Technical support from Martin Lovegrove (Rural Solutions SA) and Bentley Foulis (farmer, Willowie), cooperation from Brendon Johns (farmer, Warnertown) and Gilmour Catford (farmer, Morchard) and the use of the Morchard Community land is greatly appreciated.

GRDC Grains Research & Development Corporation

# Cleve Area School Trials

**John Solly, Andrew Smith and Linden Masters**
Cleve Area School

Research

## Key messages

- **Students were provided with the opportunities to problem solve, teach each other and learn new life skills. The combination of research and its practical application to seek answers and solve problems has advanced student learning.**
- **The Cleve Area School Certificate in Agriculture course has formed a stronger relationship with MAC through participating in the EP Grain & Graze and EPFS project as a 'farmer group', and by being part of monitoring biodiversity in farming systems.**

## What was done?

Eyre Peninsula Grain & Graze project staff Alison Frischke, Emma McInerney, Brian Ashton and Gill Stewart met with Cleve Area School representatives Ben Ranford and Linden Masters and the Year 10, 11 and 12 agriculture students and staff in February 2006. This meeting was held to determine what the students would like to learn about, and then design trials or demonstrations to meet these needs.

## How was it done?

The students formed groups depending on their area of interest and came up with ways of investigating the issues they wanted to learn more about.

The following trials and demonstrations were devised in consultation with MAC staff:

1. Designing and planning trials
2. Small-plot crop variety trial
3. Grazing barley trial
4. Soil type trial in 'Bottom' paddock
5. Biodiversity trial (sustainable futures subject; e.g. pit traps, etc.)
6. Tri-Solfen (mulesing anaesthetic) trial.
7. Comparison of sheep breeds — Merino versus SAMM cross versus Suffolk cross lambs

A strength of this liaison between the school, MAC and Rural Solutions SA staff was the school's flexibility to incorporate these ideas into the curriculum, providing students with new and relevant learning opportunities.

### Trial outcomes and student comments

1. **Designing and planning trials**
   Students designed and sowed a replicated small plot trial and a broadacre soil-type and variety comparison.

   *Student comment:* Jared Siviour, Cleve: 'We learned the things you need to include when setting up trials and the variables that need to be taken into consideration.'
   Sarah Horne, Wharminda: 'Everything has to be very precise and the sowing machine needs to be checked regularly to make sure mistakes aren't made.'
2. **Small-plot crop variety trial**
   The trial was not harvested due to the poor season but Kukri and Scythe looked like better wheat varieties early on. Grazing oat varieties were sown and looked promising. Unicorn (90 day) barley was sown late, in early August, with no rain after it was sown. Unicorn yielded as well as other barley varieties despite this disadvantage.

   *Student comment:* Jim Snodgrass, Ungarra: 'We were able to see how a lot of cereal and legume and pasture varieties grew on Sims Farm's soils, so we could pick the best ones for the farm in the future.'
3. **Grazing barley trial**
   The object of this trail was to determine the economics and practicality of grazing a barley crop to be harvested. The grazing set the crop back, but the poor season resulted in noticeable crop yield differences. The grazing was a bonus

   *Student comment:* Damian Kelly, Lock, said 'after seeing the trial he now understood how important and careful you needed to be with timing and stocking rates are if this practise is to work.'

   Jared Siviour, Cleve, said 'he had learned when grazing starts to seriously affect the yield of the crop and the benefits of the practice.'
4. **Soil type trial in 'Bottom' paddock**
   Over the years, a noticeable difference in wheat yields between two areas had been seen in 'Bottom' paddock. The cause had not been determined. The students devised a broadacre trial using three cereals across the two areas. The council dug a soil pit in each area, and the subsoil proved to be different. There were no valid conclusions due to the poor season which reduced any difference between the two areas.

   *Student comment:* Rebecca Lehamann, Cleve: 'This trial helped us see which cereal grows on which soil better. The soil pits made this easier to understand too, because we could see the difference between the two soils and where soil constraints were, like hard pans and carbonate layers. We could see why the crops weren't doing very well.'
5. **Biodiversity trial**
   The biodiversity trial was part of the Grain & Graze project and was coordinated by the University of Tasmania. Five ecosystems were compared on a low rainfall farming property (Sims Farm). The fauna was monitored at each site during Autumn and Spring, including birds, small vertebrates, insects and soil biota. This trial is ongoing.

   *Student comment:* Ben Dohnt, Snowtown, learnt 'how data was collected, and what kind of data was analysed for large scale trials' and that he learned 'how some animals that he didn't even know existed contributed to biodiversity'.
6. **Tri-Solfen (mulesing anaesthetic) trial**
   See Brian Ashton's article in this manual.

   *Student comment:* Lauren Segon, Cleve, said 'I understood the reason for applying the treatment and how to apply the treatment properly.'
   Daniel Argent, Port Lincoln: 'I learned how difficult it was to measure lambs behaviour.'

**7. Comparison of sheep breeds — Merino versus SAMM cross versus Suffolk cross lambs**

CFA Merino ewes were mated to either a Lawral Park SAMM or Uralba White Suffolk terminal sire to compare lamb growth rates. On average, the white suffolk cross lambs were 54 kg live weight at point of sale and the SAMMs were 52 kg. But there was no statistical difference between the two groups because the lamb weight ranges varied substantially, e.g. the standard deviation was higher than 2 kg (there were 37 lambs in each group).

*Student comment:* Jock Hollitt, Streaky Bay: 'We weighed the growing lambs and were able to see how the different breeds grew at different rates and which ones might be best to grow at home.'

## Highlights

- Students had greater ownership of their learning by being asked what agricultural topics they wanted to investigate or learn more about, as well as involving them in planning and running these trials.
- This work provided students with industry and research contacts that broadened their experience and provided links for them in the future.
- These projects helped to provide the course with the endeavour to provide best practice and opportunities for excellence.
- By selecting a complex problem on Sims Farm (the soil constraints), the students could see and use real life resources to help understand and solve the problem. Many collaborators were involved in helping the students in this process. The Cleve District Council excavated soil pits, EM38 surveys of the paddock were carried out by Terry Evans (Rural Solutions SA), Linden Masters and Josh Telfer (Rural Solutions SA) provided expertise on soil chemistry and constraints, and Jon Hancock (SARDI MAC) explained and took measurements to calculate plant-available water. The paddock was yield mapped in 2005 by community member Geoff Bammann.
- Students devised a suitable farmer trial to compare the growth of different cereal crops across two problem soil types. The trial was sown and reaped into a weigh trailer by students, supervised by farm manager Rodger Story.
- Tri-Solfen trial — Brian Ashton and Ben Ranford helped students gain hands-on experience using a product that has the potential to become commonly used. The students gained experience in looking for indications of stress by observing animal behaviour, and how to minimise stress on animals. Lessons learned from this trial will help guide future trials.

## Acknowledgements

All MAC and Rural Solutions SA staff involved are thanked, along with Ben Ranford and Greg Treloar of Cleve Area School.

# Eyre Peninsula NRM Board

**Rachel Stringer**
Eyre Peninsula NRM Board, Port Lincoln

Information

- **The Eyre Peninsula NRM Board engages the community in the conservation and enhancement of the natural resources of the Eyre Peninsula region.**
- **Natural resource management is vital for the economic and social wellbeing of the Eyre Peninsula community.**
- **The Eyre Peninsula NRM Board works with the local community to develop, budget for, and coordinate regional NRM plans and activities.**
- **The Eyre Peninsula NRM Board conducts integrated management of soils, pest plants and animals, water resources, coasts and marine environments and biodiversity.**
- **Assistance can be provided to landholders in accessing technical support and incentives to undertake activities on their properties.**

## What are our natural resources and why do we manage them?

Natural resources such as coastal and marine environments, air, water, soils, and native plants and animals are vital to our on-going prosperity and wellbeing. Industry and economic activity in the region rely almost entirely on Eyre Peninsula's natural resources, either directly or indirectly. Everyone relies on natural resources in some way.

The Eyre Peninsula community is a major stakeholder in natural resources management (NRM), with the largest investor being landholders themselves. In fact, a recent study completed by the Australian Bureau of Statistics (ABS) showed that Australian farmers have been reported as spending $3.3 billion on NRM during 2004–05. This includes pest plants and animals, erosion and salinity control, soil condition and catchment management.

## How do we manage our natural resources?

People on Eyre Peninsula and across South Australia now understand that the many elements of the state's natural resources such as catchments, land and marine ecosystems, and landscapes are interrelated. Natural resource managers and users accept that impacts on one element reverberate throughout the system. Management of natural systems is based on the understanding of each element of these systems and their relationships.

The Eyre Peninsula NRM Board works with the local community to develop, budget for, and coordinate regional NRM plans and activities, including support for the activities of numerous volunteers working through programs such as Landcare, Coastcare and Bushcare. The region also has approximately 100 local and regional community and school groups that assist NRM in the region.

## NRM in South Australia and on Eyre Peninsula

Implementation of the *Natural Resources Management Act 2004* saw the development of South Australia's NRM Plan, a SA NRM Council, and eight NRM Boards across the state, of which the Eyre Peninsula NRM Board is one. The integration of Catchment Water Management Boards, Soil Boards, Animal and Plant Control Boards and the interim NRM Groups into single entities provides a means for natural resources to be managed in a collaborative manner. The eight NRM Boards in operation across the state are:

- Kangaroo Island NRM Board
- South East NRM Board
- SA Murray-Darling NRM Board
- SA Arid Lands NRM Board
- Adelaide and Mt Lofty NRM Board
- Northern and Yorke NRM Board
- Alintijara Wilurara NRM Board
- Eyre Peninsula NRM Board

In addition to state government funding, the Eyre Peninsula NRM Board secures funds from the Australian Government through annual Natural Heritage Trust (NHT) Investment Strategies and Community Water Grants. Further funding is sourced from the local community through NRM levies and in-kind support to ensure that NRM programs are delivered across the region adequately.

The Eyre Peninsula NRM Board consists of eight community members who have been selected for their knowledge, experience and ability to manage natural resources in the region. These members are recruited for a three-year period, after which a call for new applications for positions is made. The current NRM Board members are:

- Brian Foster — Presiding Member (*Coulta*)
- Evelyn Poole (*Port Lincoln*)
- Tony Irvine (*Ceduna*)
- Sean O'Brien (*Wudinna*)
- Cecilia Woolford (*Kimba*)
- Sandra McCullum (*Tumby Bay*)
- Jim Pollock (*Whyalla*)
- Peter Treloar (*Cummins*).

To assist the Eyre Peninsula NRM Board with addressing community issues and concerns in regards to NRM, four NRM Groups have been established in the previous Soil Board areas. These are the Southern Eyre, Eastern Eyre, Western Eyre and Central Eyre NRM Groups. Each group consists of seven community members, with a vested interest in local NRM issues, who meet regularly to discuss local activities and topics of interest or concern. Outcomes from these meetings are then referred to the Eyre Peninsula NRM Board for discussion and, if required, action. The NRM Groups are the vital link between the Eyre Peninsula NRM Board, staff and the community for effective NRM on Eyre Peninsula.

# Eyre Peninsula NRM projects

With consistent investment through NHT and NRM levies along with a 10-year regional NRM Plan in development, there is currently a diverse range of programs in operation across the region for long-term management of natural resources. The Eyre Peninsula NRM Board conducts integrated management of soils, pest plants and animals, water resources, coasts and marine environments and biodiversity. The following are examples of activities that are delivering NRM results and assisting landholders and the general community across Eyre Peninsula.

### Integrated Weed Management

This program aims to provide control measures for Bridal Creeper (*Asparagus asparagoides*, Weed of National Significance), Bridal Veil (*Asparagus declinatus*) and other Asparagus weeds, including the newly identified Western Cape form of *Asparagus asparagoides* that poses environmental threats to biodiversity. Bridal Creeper is widespread across Eyre Peninsula and is increasing its spread into the medium to low rainfall areas. It directly affects 23 threatened plant species in the region and 10 threatened habitats. Control of Bridal Creeper predominately involves the use of three biological control agents, with landholders assisting with the collection and distribution of these agents across affected areas.

### Integrated Pest Management Program

Landholders on Eyre Peninsula have been engaged and involved with a range of integrated vertebrate pest management programs for several years. The community driven Integrated Pest Management (IPM) program has been implemented to protect biodiversity and improve productivity on properties in the region. Landholders attending the summer and spring field days conducted by NRM Authorised Officers receive fox baits, safety information and best-practice information for fox control. Assistance with rabbit control and associated equipment is also available through the program. Community members and Eyre Peninsula NRM staff take part in a number of different activities across the region to monitor the success of the program. The program also provides a platform for collaborative research programs to be conducted such as the rabbit haemorrhagic disease release.

### Bush Management and Conservation

This program provides support and information to landholders through establishment and management of heritage agreements, coordinating on-ground works for threatened species and communities, providing technical support to enhance biodiversity conservation and sustainable agriculture, and assisting with the facilitation of monitoring programs across the region.

### Management of Water Affecting Activities

The Eyre Peninsula NRM Board has the responsibility of ensuring the sustainable development and use of water resources while protecting and restoring the natural environment. The board is the regional authority for managing water resources and Water Affecting Activities (WAA) on Eyre Peninsula by undertaking assessments, investigations and reporting on permitted activities and compliance matters. WAA are those activities that can have an impact on the health and condition of water resources, water quality and quantity, and other water users. Activities include construction of dams, depositing of solid material or objects in a water course, prevention of destruction of native vegetation in a water course and building structures in a water course.

### Pest Animal and Plant Control

Authorised Officers are available to landholders and the community for consultation, information and advice on pest management issues. The Eyre Peninsula NRM Board aims to involve stakeholders in protecting the environment, in particular by minimising the impact of pest plants and animals through eradication, planned programs and example with preparedness to enforce the legislation of the interim NRM Plan where necessary. Activities include weed inspections and control, fox and rabbit control programs, use of bio-control agents, and protection of native vegetation.

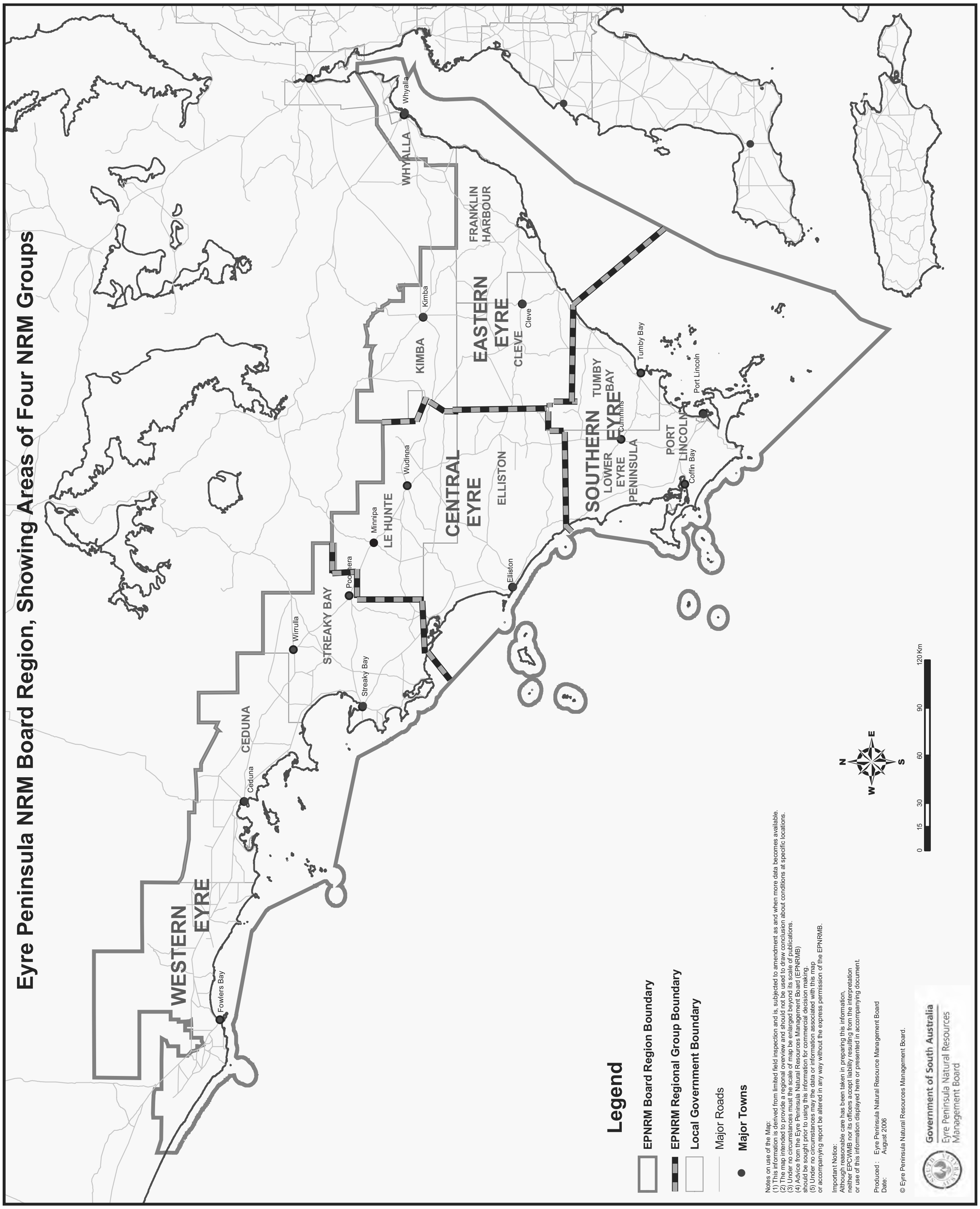
# Future directions

The Eyre Peninsula NRM Board is currently developing a comprehensive NRM Plan for the region which will outline a 10-year strategy for the effective management of natural resources for the peninsula (to be completed by June 2008). Development of this regional NRM Plan will occur in consultation with the local community to ensure that our NRM goals meet the social, environment and economical needs of the region.

Anyone on Eyre Peninsula, including landholders, can contact the Eyre Peninsula NRM Board to find out more about integrated NRM, local projects, funding and NRM planning. Everyone is encouraged to get involved in restoring and protecting our natural resources. Assistance can be provided to landholders in accessing technical support and incentives to undertake activities on their properties, and community members are invited to join in with some of our volunteer activities such as wetland, shorebird, Yellow-tailed Black Cockatoo and Malleefowl monitoring, weed control, fox baiting and revegetation — all support is appreciated and vital to the management of our natural resources. Everyone uses natural resources and caring for our natural resources is everyone's responsibility.

For further information visit the Eyre Peninsula NRM Board website at www.epnrm.sa.gov.au or ring us direct on (08) 8682 5655.

**Government of South Australia**
Eyre Peninsula Natural Resources Management Board




Sharing Info

# Grant Funding Available through the Eyre Peninsula NRM Board for On-ground Works

Information


## Sophie Keen and Naomi Scholz

Natural Resource Management Officers, Eyre Peninsula NRM Board


Funding incentives or grants are available from the Eyre Peninsula NRM Board to assist you with NRM activities on your property. Incentives are subject to change depending on the source of funding, levels of funding and financial years, so contact your local NRM Officer to get the most up-to-date information. Incentives can also vary depending on the quality or condition of a site, and are allocated according to the regional priorities.

- Fencing to protect remnant vegetation, revegetation and windbreaks from degrading activities (e.g. stock damage) —
  Incentive rate $1075–3045/km.
- Fencing to land capability to facilitate appropriate land use and sustainable practices —
  Incentive rate $1522/km.
- Revegetation to mitigate the impacts of erosion, salinity, fragmentation and invasive species —
  Incentive rate $168/km.
- Clay spreading to prevent erosion, nutrient leaching and improve soil moisture availability —
  Incentive rate $75/ha (20 ha limit).
- Perennial pasture establishment to mitigate soil erosion, salinity, soil compaction and provide alternative fodder sources —
  Incentive rate $87/ha.

**For more information on biodiversity and landscape management activities call your local NRM Officer.**

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Government of South Australia
Eyre Peninsula Natural Resources Management Board

Australian Government

# Acronyms and Abbreviations

| | |
|---|---|
| **ABA** | Advisory Board of Agriculture |
| **ABS** | Australian Bureau of Statistics |
| **AFPIP** | Australian Field Pea Improvement Program |
| **AGO** | Australian Greenhouse Office |
| **AGT** | Australian Grain Technologies |
| **AH** | Australian Hard (Wheat) |
| **AM fungi** | Arbuscular Mycorrhizal Fungi |
| **APSIM** | Agricultural Production Simulator |
| **APW** | Australian Prime Wheat |
| **AR** | Annual Rainfall |
| **ASBV** | Australian Sheep Breeding Value |
| **AWI** | Australian Wool Innovation |
| **BCG** | Birchip Cropping Group |
| **BYDV** | Barley Yellow Dwarf Virus |
| **CBWA** | Canola Breeders Western Australia |
| **CCN** | Cereal Cyst Nematode |
| **CLL** | Crop Lower Limit |
| **DAP** | Di-ammonium Phosphate (18:20:00) |
| **DM** | Dry Matter |
| **DPI** | Department of Primary Industries |
| **DSE** | Dry Sheep Equivalent |
| **DWLBC** | Department of Water, Land and Biodiversity Conservation |
| **EP** | Eyre Peninsula |
| **EPARF** | Eyre Peninsula Agricultural Research Foundation |
| **EPFS** | Eyre Peninsula Farming Systems |
| **EPR** | End Point Royalty |
| **FC** | Field Capacity |
| **GM** | Gross Margin |
| **GRDC** | Grains Research and Development Corporation |
| **GSR** | Growing Season Rainfall |
| **IPM** | Integrated Pest Management (Program) |
| **LEADA** | Lower Eyre Agricultural Development Association |
| **LEP** | Lower Eyre Peninsula |
| **LRCP** | Low Rainfall Collaborative Project |
| **LSD Test** | Least Significant Difference Test |
| **MAC** | Minnipa Agricultural Centre |
| **ME** | Metabolisable Energy |
| **MLA** | Meat & Livestock Australia |
| **MRI** | Magnetic Resonance Imaging |
| **NDF** | Neutral Detergent Fibre |
| **NLP** | National Landcare Program |
| **NRM** | Natural Resource Management |
| **NVT** | National Variety Trials |
| **PAWC** | Plant Available Water Capacity |
| **PDRF** | Premier's Drought Relief Fund |
| **PEM** | *Pantoea agglomerans*, *Exiguobacterium acetylicum* and *Microbacteria* |
| **pg** | Picogram |
| **PIRD** | Producers Initiated Research Development |
| **RDE** | Research, Development and Extension |
| **RDTS** | Root Disease Testing Service |
| **SAFF** | South Australian Farmers Federation |
| **SAGIT** | South Australian Grain Industry Trust |
| **SANTFA** | South Australian No Till Farmers Association |
| **SARDI** | South Australian Research and Development Institute |
| **SBU** | Seed Bed Utilisation |
| **SGA** | Sheep Genetics Australia |
| **SU** | Sulfuronyl Ureas |
| **TE** | Trace Elements |
| **TT** | Triazine Tolerant |
| **UNFS** | Upper North Farming Systems |
| **WAA** | Water Affecting Activities |
| **WP** | Wilting Point |
| **WUE** | Water Use Efficiency |
| **YEB** | Youngest Emerged Blade |
| **YP** | Yield Prophet |

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