no 193, spring 2015

Irrigation Research & Extension Committee

farmers' newsletter

large area edition

IN THIS EDITION

Administration & advertising

The IREC Farmers' Newsletter is published by the Irrigation Research & Extension Committee. It is distributed to irrigators and their advisors in the Lachlan, Murrumbidgee, Murray and Goulburn valleys. If you wish to subscribe to the Farmers' Newsletter, contact the IREC office.

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Editorial

The IREC Farmers' Newsletter welcomes all suggestions and contributions for articles from irrigators, advisors and researchers in government and commercial sectors. If you have suggestions for articles or wish to contribute an article please contact the Editor.

Please submit articles for the next edition, Autumn 2016, to the editor by 1 February 2016.

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Design & production

Richard Howell, TMLC Design. www.tmlc.com.au

Print

Bluestar Print – a Forest Stewardship Council, Chair of Custody certified company. All processes are controlled by an Environmental Management System, certified to ISO14001.

Photography

Cover photo: Students of The Scots College, Sydney, learning about vegetable seed production in the MIA. Photo: Iva Quarisa

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ISSN 0467 – 5282

CHAIRMAN'S REPORT

Welcome to the spring edition of the *Farmers' Newsletter.*

It is great to be receiving good winter rains supplying plenty of moisture for our winter crops. It almost seems like a typical winter — cold and wet with little opportunity to get on paddocks to topdress and spray. It is then surprising to look at our meagre allocations to see Murray irrigators on 0% and Murrumbidgee on 17%.

Uncertainty …. part and parcel

Good winter rainfall but low allocations … a perfect illustration of how things have changed over the last ten to fifteen years in terms of our planning environment. It is certainly not all bad, with the opportunity to underpin some or all of our summer crop plans through a range of options on the temporary water trade front. We, as irrigators, now have the responsibility to manage this variable depending on our own personal business situation. There is also great opportunity for current allocations to improve markedly by the end of spring but that one is out of our control.

So what can we control to improve the use of our most precious resource and reduce our exposure to falling short of our goals?

Grow more with less

It has never been more important than now, that we irrigators are exposed to cutting edge irrigation layouts and technology to make sure our water goes as far as possible. The IREC Field Station at Whitton is poised to help us observe a range of irrigation technologies this season. The earthworks on the bankless channel portion have been completed. With full automation and capacity to measure flows and infiltration, we are hoping to fine tune the management of the system to supply the crop with what it needs with minimal water losses. The subsurface drip portion of the site will be in full swing to give a good comparison.

I would like to acknowledge Riverina Local Land Services, Cotton Research Development Corporation and Cotton Seed Distributors for providing the funds for this project. I would also like to thank the Cotton Growers Association for its support to get things rolling.

The entire block will be planted to cotton this season with our advisory panel of local agronomists giving advice on rotational preferences going forward.

This is an exciting time for IREC and its members. I encourage you to renew your membership this year to ensure you get full advantage of activities that are being organised wholly or in part, by IREC.

Partnerships

IREC has been fortunate to be a part of a consortium that has been successful in securing $1.4 million under the Federal Government's Rural R&D for Profit program. Our sub-project, *Maximising on Farm Irrigation Profitability – Southern Connected Irrigation Systems*, comes under the banner of the Smarter Irrigation for Profit project. We have partnered with NSW DPI, Murray and Riverina LLS, Deakin University and our southern irrigation grower groups: Southern Growers (based at Finley) and Irrigated Cropping Council (based at Kerang).

The grower groups will provide trial sites and some capacity to carry out demonstrations, research and extension. One of the key field projects being funded will be developing key learning sites like the IREC Field Station to compare irrigation systems in all valleys. This project would not have been possible without the support of the Rural Industries Research & Development Corporation — Rice R&D Committee and the Cotton Research Development Corporation. Their financial support has maximised our leverage to the Federal Government funding source.

Farewell CSIRO

After a long and fruitful collaboration (76 years!) between IREC and CSIRO, it is with great disappointment that we learned of the intended closure of the Hanwood site of CSIRO. The site is due to close in May 2016 but most of the research staff has left already.

Deakin University has stepped in to fill the void left due to the imminent closure of the Hanwood CSIRO site. I would like to thank Deakin University for its immediate support and look forward to exploring future ventures together.

Something for you …

IREC thanks Riverina LLS for supporting the production of the ruler that has been enclosed with this copy of your *Farmers' Newsletter*. The ruler contains a lot of useful conversions and scales for the irrigator – we trust it is a handy tool for you, our members.

I trust everyone will enjoy this edition of the *Farmers' Newsletter*. Here's to a good spring and another successful summer cropping season.

Rob Houghton

Chairman IREC

A FEW WORDS FROM THE EO

After a generally successful summer cropping season, I hope you have had a well-earned spell!

New projects for irrigators

IREC finished the season with a flourish! As Rob mentioned in the foreword, IREC is part of the *Maximising On-farm Irrigation Profitability – Southern Connected Irrigation Systems* project, which came about from the research priorities raised at the IREC breakfast meetings in early 2014. Over the three year life of the project, IREC will take the lead in coordinating demonstrations and extension of findings.

In addition to the "Max" project, the IREC Field Station will see two other research projects conducted there, over the next three years. Dr Wendy Quayle from Deakin University (based at Griffith) will be using the field station for the CRDC–funded manure trial commencing this season. And once again the field station will be used as a satellite site for the NSW DPI thrips trial.

As many of you may know, GRDC is currently undergoing a restructure. As of 1 September, all of NSW will be in the GRDC Northern Region (we have formerly been in the Southern Region). As a part of the restructure, GRDC has compiled a Preferred Suppliers List. This list will be used to source organisations to provide research, demonstrations and extension activities for GRDC over the next three years. I'm pleased to inform you that IREC is on that list.

In the meantime, irrigation farming continues to be well represented to GRDC with Geoff McLeod from Finley on the GRDC Southern Regional Panel; and the Regional Cropping Solutions Network for the irrigation zone having most of its representatives of farmers, advisors and researchers from the Lachlan, Murrumbidgee, Murray and Goulburn valleys.

IREC, in conjunction with Irrigated Cropping Council and Southern Growers, is currently developing two project proposals for funding through GRDC. These projects aim to help irrigated grain growers make better decisions based on their water resource and to increase irrigated faba bean yields.

In collaboration with the Rice Extension project *Digitising of Rice Library Resources*, pre-2005 IREC *Farmers' Newsletters* are being scanned and will be freely available on the IREC website. The digitising of non-rice articles has been made possible with funding from Riverina Local Land Services.

Promoting agriculture

In May, IREC organised and hosted a tour of the district for Year 9 agriculture students of The Scots College in Sydney. The tour was successful in its aim to show the wide variety of crops grown in the region, increase knowledge about irrigated agriculture, show the students career opportunities in irrigated agriculture, and highlight the high level technologies used in growing and processing good quality produce. Read more about this tour on page 17 of this edition of the *Farmers' Newsletter.*

Upcoming events	
August 2015	IREC AGM – 10 August Spring edition of the *Farmers' Newsletter*
October 2015	Open day at the IREC Field Station
April 2016	Autumn edition of the *Farmers' Newsletter*
Additional events may be added to the IREC Calendar after printing, so check IREC's website or follow IREC on Twitter and Facebook	

A tour of MIA agriculture by students of The Scots School was very successfully organised and hosted by IREC.

Rejuvenation going well

As you can see, IREC is progressing well with its rejuvenation. This is in large part to you, our members and subscribers. Without you IREC would find it very difficult to justify its existence, so we thank you for your continued support.

Finally, please check the calendar listing the main events for the coming six months, and remember to follow IREC on Twitter and Facebook to keep up with the latest.

Iva Quarisa

Executive Officer IREC

Included with this edition of the *Farmers' Newsletter* is a complementary ruler for our members, which includes useful conversions and scales for the irrigator. Appreciation and acknowledgement to Riverina Local Land Services for its contribution in producing this handy tool.

Cotton speak – unpicking ginning jargon

Photo: Nathan Dyer

By Kate O'Callaghan
General Manager, Southern Cotton

GINNING has its own jargon – and it doesn't really mean much outside of the cotton industry. But given cotton and its by-products are used in the production of a huge range of products, from bank notes and margarine to rubber and medical supplies, educating growers and local communities about this crop, and how it's processed, is important to us.

Here, we've unpicked what two common ginning terms mean – cotton classing and turnout.

What is cotton classing?

Cotton classing is the process of establishing the **overall quality** of cotton. In Australia, this is determined by using both visual and mechanical methods. Cotton merchants, growers and spinning mills use this information to sort bales, make future agronomic decisions and optimise blending.

Cotton is valued on six qualities:

1. Colour
2. Leaf
3. Extraneous matter
4. Length
5. Strength
6. Micronaire.

Cotton turnout – what is turnout percentage?

Turnout percentage is the measurement of the weight ratio of lint to cottonseed in any particular field. For example, if lint percentage is 40 per cent, then 50 per cent may be seed and 10 per cent may be trash and moisture.

This percentage can be affected by a **number of factors**, including:

- Variety
- Trash
- Moisture content
- Truck tare
- Boll maturity – micronaire, boll size and boll position
- Seed size.

Growers can have a **positive influence** on gin sample quality by adopting the following practices:

- Developing a strong relationship with an agronomist to assist in management decisions on crop management including watering, fertiliser management, and growth regulation
- Ensuring crops are defoliated on time
- Correctly timing picking
- Maintaining picking machinery
- Lining up round modules on head or tail drains
- Checking wrap for holes.

Southern COTTON
Quality service for quality growers

"Southern Cotton is committed to exceeding the expectations and supporting both new and existing growers in their cotton processing."

For more information about cotton ginning, or to discuss the benefits of ginning with Southern Cotton, contact Kate O'Callaghan:
Phone: (02) 6955 2755 | kate.ocallaghan@southerncotton.com.au

Visit the Cotton Seed Distributors (csd.net.au) or the ProClass (proclass.com.au/Classing.aspx) websites for more information on cotton classing and turnout.

NITROGEN MANAGEMENT FOR EFFICIENT COTTON PRODUCTION

Kieran O'Keeffe

CottonInfo, Regional Development Officer (Southern NSW)

Ian Rochester

Principal Scientist, CSIRO & Australian Cotton Research Institute, Narrabri

QUICK TAKE

- Know the nitrogen status in your soil before planting and monitor nitrogen early in the crop.
- Getting nitrogen fertiliser rates in the right range is good for the bottom line and the environment.
- An oversupply of fertiliser nitrogen can make crops difficult to manage late in the season.
- Nitrogen management is just one factor in efficient cotton production.

The 2014–15 cotton season in southern NSW will be remembered for exceptional returns. Record breaking yields coupled with prices well over $500/bale made it the best returning season so far.

Everything just lined up. A good early start in late September and early October, warm but not extreme temperatures through the boll fill period, good management of crops and the high potential of the relatively new CSD Bollgard II varieties 74BRF and 71BRF.

Nitrogen rate trails

CottonInfo Regional Development Officers (RDOs) carried out nitrogen rate trials in all the cotton growing valleys of Australia during 2014–15.

The purpose of these trials was to explore the factors that influence the efficiency of the plant when turning applied nitrogen fertiliser into lint — nitrogen fertiliser use efficiency (NFUE). The results of the two southern NSW trials are presented in this article.

Figures 1 and 2 show the yield results for the trials at Benerembah and Darlington Point. Both trials were replicated, and statistical analysis showed no significant yield difference between the treatments.

In both trials it was surprising to see a good yield response from the low nitrogen strips. This indicated that the plants were able to source adequate nitrogen from the soil during the season and losses due to denitrification were minimised.

The lack of yield response also highlighted that adding more nitrogen does not necessarily result in extra yield. Adding more nitrogen results in extra input costs and can lead to crop management problems with rank vegetative growth delaying maturity of the crop. A rank crop can also encourage boll rots and hamper defoliation.

Nitrogen fertiliser response experiments were conducted at Australian Cotton Research Institute (ACRI) at Narrabri in 2014. Yield was measured for a range of nitrogen fertiliser application rates, across three different cotton rotations. Figure 3 shows that the economic nitrogen fertiliser rates were 220, 135 and 153 kg N/ha for cotton in the fallow, vetch and faba bean rotations, respectively.

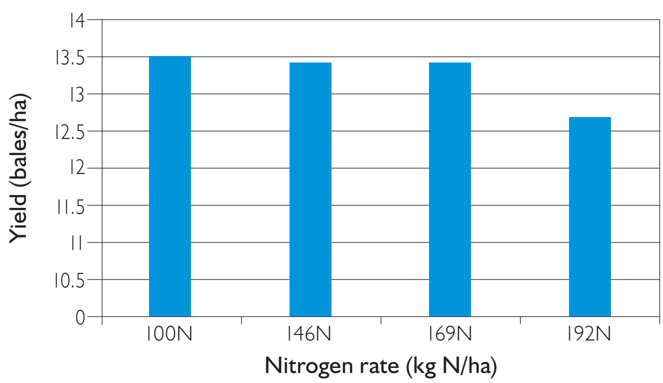

Figure 1. *Yield response to different rates of nitrogen fertiliser at Site 1, Benerembah*

Nitrogen fertiliser rates were assessed in cotton crops at Benerembah and Darlington Point in the 2014–15 season.

Table 1. Site details of cotton nitrogen trials in southern NSW

	Site 1	Site 2
Location	Benerembah (Griffith)	Darlington Point
Irrigation layout	Zero grade stepped bankless	Furrow 1:2000 slope
History	Two cereal crops before landforming	5 t/ha poultry manure over that last two seasons, back to back cotton
Starting soil nitrogen (kg N/ha)	Unknown	102 (0 to 90 cm)
Variety	71BRF	74BRF
Irrigation water (ML/ha)	8.2	9.0
N strategy (kg N/ha)	100 N urea 150 N side dressed	130 N gas 100 N side dressed
Average site yield (b/ha)	13.25	13.94

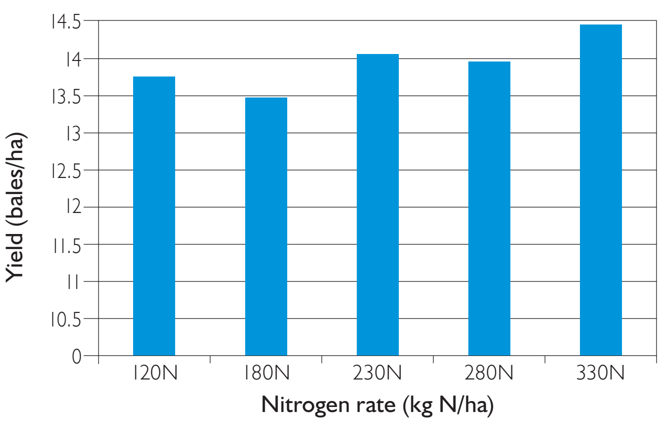

Figure 2. *Yield response to different rates of nitrogen fertiliser at Site 2, Darlington Point*

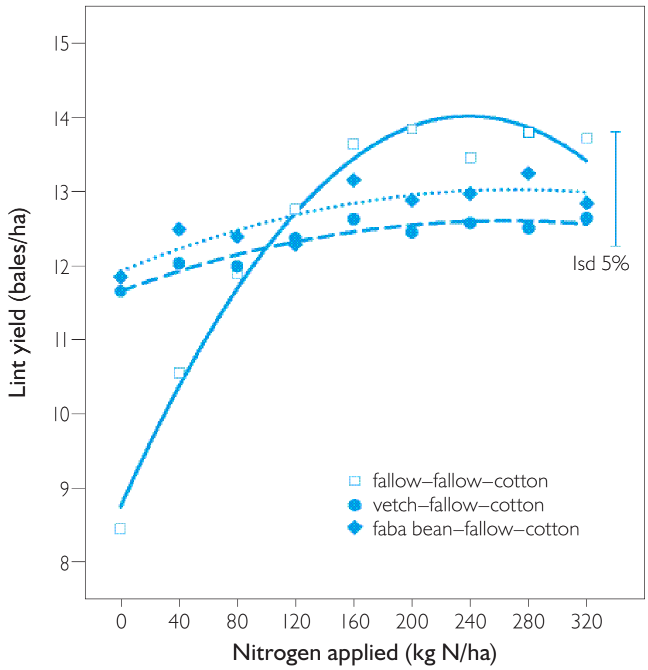

Figure 3. *The economic nitrogen fertiliser rates for cotton in fallow, vetch and faba bean rotations were 220, 135 and 153 kg N/ha, respectively (Rochester 2014).*

Nitrogen fertiliser use efficiency

Growers can monitor the efficiency of their applied fertiliser with a simple calculation using yield in kg/ha of lint divided by the applied nitrogen fertiliser in kg/ha — this is nitrogen fertiliser use efficiency or NFUE.

To achieve the economic optimum nitrogen fertiliser rate, the yield/N fertiliser index should be between 13 and 18. If the index is greater than 18, insufficient nitrogen has been applied; if the index is less than 13, too much nitrogen has been applied (Figure 4).

Table 2 indicates that nitrogen fertiliser use at the Benerembah site was efficient at the 170 to 190 kg N/ha range, which was below the grower rate of nitrogen fertiliser application of 250 kg N/ha for the rest of the field.

Table 3 indicates that nitrogen fertiliser use at the Darlington Point site was efficient between 180 and 230 kg N/ha, which coincided with the grower rate of 230 kg N/ha for the field.

Surveys of grower practices in 2011–12 and 2012–13 indicated that the majority of growers used excess amounts of nitrogen fertiliser to achieve relatively moderate yields.

The survey of 2011–12 (189 respondents) reported average lint yields of 9.45 b/ha and 218 kg N/ha applied. The yield/N fertiliser index for this data set was 10.9, indicating an excess of 75 kg N/ha was applied on average (Figure 4). The 2012–13 data indicated growers used 243 kg N/ha on average and produced 10.2 b/ha, indicating the yield/N fertiliser index for this data set was 9.53, indicating an excess of 110 kg N/ha was applied on average (Figure 4).

Applying more nitrogen than is required to satisfy the crop's demand will not increase yield. Rather, growers need to assess their cropping system's nitrogen use efficiency and determine if other factors are limiting efficient cotton production.

Plans for next season

The main message from this work is to encourage growers and advisors to:

- have a good understanding of starting nitrogen in paddocks through deep soil nitrogen tests
- set up realistic nitrogen budgets/yield targets
- monitor nitrogen status through leaf and petiole testing early in the crop's development.

Deep soil nitrogen tests at the end of the season showed that nitrogen levels were very low at these sites. If cotton is to be grown back to back in these fields this low starting level needs to be factored into the nitrogen budget for next season.

The CottonInfo Regional Development Officers will be conducting more nitrogen efficiency trials this coming season. The main aim of these trials is to investigate what nitrogen losses are occurring through early irrigation events and to look at when is it best to apply nitrogen to the crop comparing all nitrogen up front with split nitrogen applications. Nil nitrogen strips will be conducted over more sites to gauge what is actually coming from mineralised soil nitrogen.

Table 2. Site 1, Benerembah — nitrogen fertiliser use efficiency (NFUE)

kg N/ha	kg lint/ha	NFUE
100	3065	30.7
146	3020	20.7
169	3048	18.0
192	2877	15.0

Table 3. Site 2, Darlington Point — nitrogen fertiliser use efficiency (NFUE)

kg N/ha	kg lint/ha	NFUE
130	3108	23.9
180	3048	16.9
230	3174	13.8
280	3154	11.3
330	3269	9.9

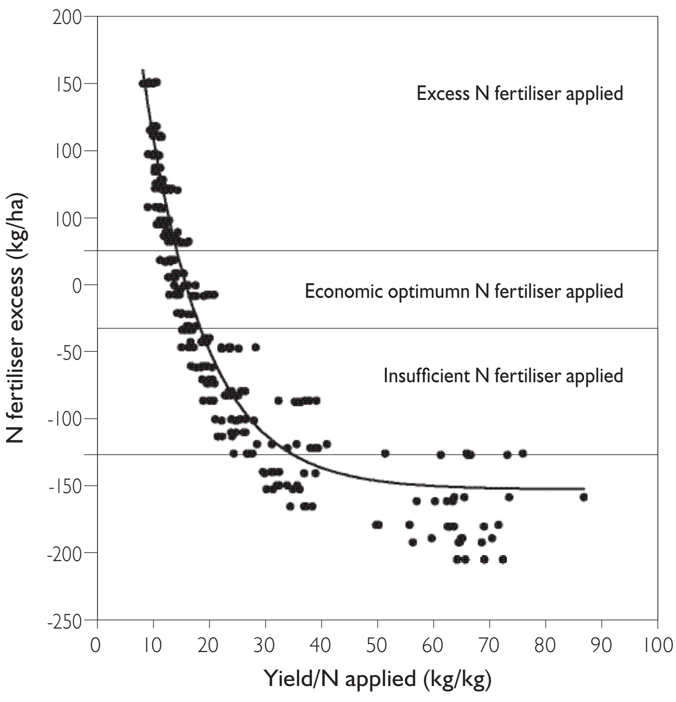

Figure 4. The relationship between excess nitrogen fertiliser application (relative to the economic optimum nitrogen fertiliser rate) and an index of nitrogen fertiliser use efficiency (lint yield/N applied) (Rochester 2014).

Further information

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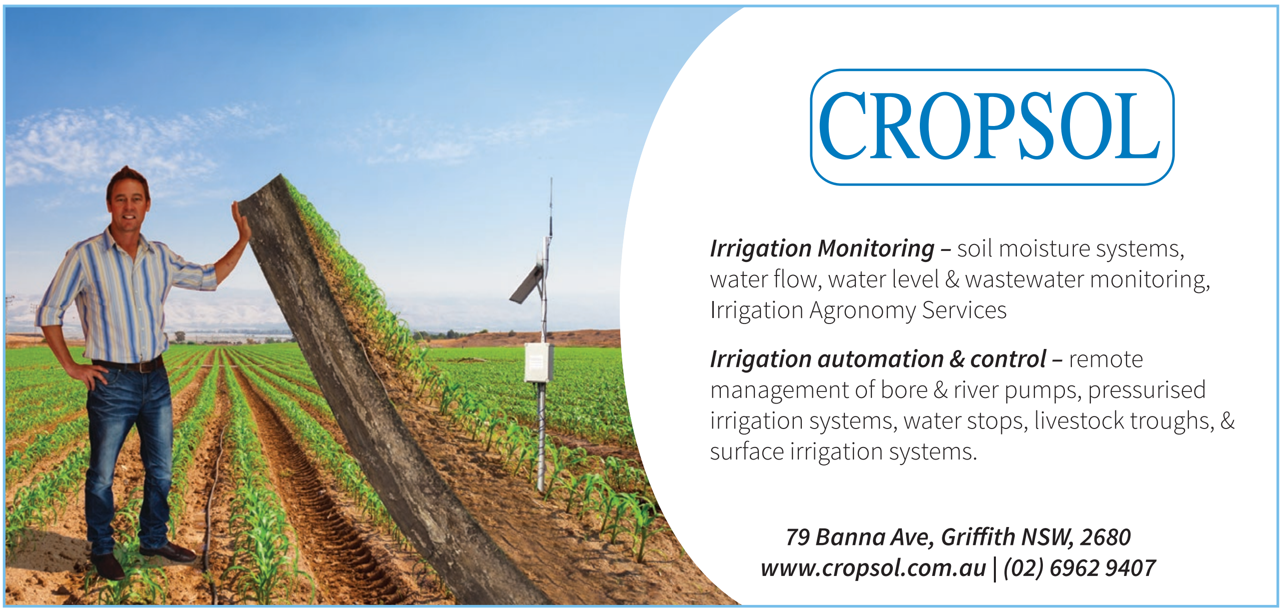
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NOV–DEC SOWING LIFTS SOYBEAN YIELDS

Alistair Lawson

GRDC southern region science writer

QUICK TAKE

› Time of sowing trials for irrigated soybeans showed:

- between mid-November and early December was the best sowing time in southern NSW
- between early and late November was the best sowing time in northern Victoria.

› Hot conditions and heavy rainfall events at harvest affected yield and seed quality but several advanced breeding lines and Djakal performed well.

Irrigated soybean growers in southern NSW can maximise yields by sowing between mid-November and early December while northern Victorian soybean growers can get best results from sowing between early and late November.

These have been the key findings of time of sowing trials conducted by the New South Wales Department of Primary Industries (NSW DPI) and funded by the Grains Research and Development Corporation (GRDC) through the National Soybean Breeding Program and the Southern NSW Soybean Agronomy Project.

The trials, conducted at the NSW DPI's Leeton Field Station, were set up to test the response of 20 advanced stage lines and commercial varieties of irrigated soybean to two times of sowing, 29 days apart:

- 'ideal' – 20 November, 2013 (TOS1)
- 'later than ideal' – 19 December, 2013 (TOS2).

Four commercial varieties — Djakal, Bidgee, Bowyer and Snowy — were trialled, as well as an array of advanced breeding lines.

Harvested in early April 2014, the standout performers for TOS1 was advanced line N005A-80 and commercial variety Djakal, which yielded about 3.8 tonnes per hectare and 3.6 t/ha, respectively. The best performers for TOS2 were advanced unreleased lines P176-2 and MO35-32 with yields of about 3.7 t/ha each.

Difficult season for soybeans

NSW DPI Leader of Southern Cropping Systems Luke Gaynor said that the 2013–14 season was a difficult one for growing soybeans. Temperatures from January to March exceeded the long-term average, resulting in reduced yields.

"The extreme heat coincided with peak flowering and early pod development," Luke said.

"Subsequently, plants were exposed to heat stress and maximum yield potential was reduced because plants were exposed to longer periods of extreme heat.

"We didn't achieve more than 4.0 t/ha in very many crops in the 2013–14 season."

Soybeans are an indeterminate plant type, so it continues to produce leaves and stems during the reproductive phase. This means that soybeans normally respond well after heat stress with adequate water supply. However, Luke said the prolonged heat over summer meant plants lost flowers and pod sites, affecting the grain yield of TOS1 in particular.

"Long-term data indicate Djakal has an average yield of 4.1 t/ha at 12% moisture," he said.

"But in this trial, overall mean yields were reduced by approximately 0.5 t/ha — a direct result of heat stress.

"The grain yield results for TOS2 are in line with what we would normally expect, or slightly better, for this sowing time. The crop at TOS2 managed to avoid any early yield setbacks from the January–February heat as the bulk of the flowering and pod development was after the peak heat periods."

Seasonal effects on seed quality

Seed quality between the two times of sowing varied largely. TOS1 saw a significant amount of weather damaged seed as it matured earlier and was exposed to 100 millimetres of rainfall over March and April. Luke said further analysis of TOS1 showed some pod shattering, generally not a routine issue in southern NSW, which also resulted in the reduction of grain yields.

"Pod shattering is promoted by continued wetting and drying of mature pods — basically tropical environment conditions," he said.

"The 2014 harvest presented such conditions, with warm days and very heavy rain events.

"Harvesting as soon as possible is recommended to avoid pod shattering, especially with early maturing types like Bidgee. Harvesting at a seed moisture of 13% is acceptable by Australian Oilseeds Foundation standards, but it is preferred that soybeans be harvested at slightly higher moisture content and then dried later rather than risk losing the crop due to weather damage."

Standout varieties for hot conditions

The extreme summer temperatures were not all bad news. Luke said the heat caused some genotype by environment interactions, which have not been observed in previous years.

"These results give a good basis to further explore these interactions with current germplasm to identify better adapted varieties and improve variety agronomy packages," he said.

"We are after robust varieties that are tough enough to handle hot conditions and the onset of heavy rainfall events at harvest and

NSW DPI Leader of Southern Cropping Systems Luke Gaynor (right) with Victorian grower Phillip Barnes. Photo: Nicole Baxter

we did see some standouts in 2013–14 — namely advanced lines N005A-80, P176-2 and MO35-32 as well as commercial variety Djakal."

Further information

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GRDC project code

DAN00192

Irrigated soybean trials at NSW DPI's Leeton Field Station at Yanco. Photo: NSW DPI

IRRIGATED PULSES PAY THEIR WAY

Cindy Benjamin

Communications Consultant, Pulse Australia

QUICK TAKE

- Maize is the primary grain crop for Boort farmers, Tony and Ann Sawers, providing the best return per megalitre of irrigation water applied.
- Pulse crops keep the system working, providing a disease break for the maize, building up soil nitrogen and condition, and earning a positive return as well.
- Faba beans are the best fit pulse crop for the Sawers but four years are kept between growing the same pulse crop, so the kabuli chickpeas are also part of the rotation.
- Marketing options vary for different pulses — generally there is strong demand for export shipments of faba beans at harvest, whereas it is worth storing chickpeas and watching the market.

An irrigated cropping operation at Boort, in northern Victoria, relies on faba beans and chickpeas to sustain its high-value and high-yielding maize crops.

Since purchasing the Boort property in 1990, Tony and Ann Sawers, of Sawers Farms, have grown a variety of crops, including tomatoes and lucerne. They have now settled on a fairly consistent maize and pulse crop rotation.

"The rotation is generally maize, faba beans, maize and chickpeas," said Tony.

Pulses work well with maize

"Maize is our primary crop and provides our best return per megalitre of water applied and the pulses keep the system working. The pulses provide a disease break for the maize, are good for the soil and earn a positive return as well," said Tony.

"Maize has a high demand for nitrogen so we rely on the pulse crops to provide about 125 of the 300 units of nitrogen that a maize crop uses. We use soil testing to determine the amount of nitrogen required for the maize crop, aiming to have all the nitrogen used by the end of the growing season.

"This way we have the pulses sown into a low nitrogen situation, which will maximise nitrogen fixation and residual nitrogen ready for the next maize crop."

Faba beans are the best fit pulse crop for the Sawers' system but Tony wants to keep four years between growing the same pulse crop so he includes kabuli chickpeas to further spread the risk.

In 2015, the Sawers were hoping to reconstruct the rotation on their drip irrigated paddocks after growing three successive maize crops during the recent dry years.

"While water availability was low we pulled back to maize only on the drip irrigated paddocks to maximise our returns but this was only ever a short-term option," said Tony.

Sawers Farms has 2000 hectares of fertile alluvial soils under irrigation on the edge of the Shepparton floodplain. The deep, self-mulching silt and clay soils have few constraints, making the soils suitable for a variety of horticultural and grain crop options.

In addition to the farms at Boort, Tony and Ann have a pastoral operation in the Flinders Ranges of South Australia. As the opportunity arises they bring young cattle or sheep from the Flinders Ranges to Boort to graze on stubble following faba beans.

"The beans are harvested in November or December and we don't plant maize until the following October, giving us six or seven months to clean up any weeds in the paddocks or check banks," said Tony.

"Finishing store lambs or weaners is opportunity driven. We try to keep the system simple and avoid unnecessarily increasing the workload for ourselves or our staff."

Varieties to fit systems & markets

The Sawers originally purchased the land near Boort to grow lucerne hay for a local lucerne cubing plant. Ten years later they sold the lucerne processing plant but maintained and expanded their farming operation.

"The whole farm is irrigated using either drip or flood irrigation," said Tony.

"We grow different maize varieties to suit the gritting corn export market and the domestic dairy feed corn market. We have successfully grown Fiesta and Nura faba beans in the past but have been disappointed with Rana results. This season we are trying the new variety, PBA Samira."

Tony said the improved resistance to ascochyta blight and the higher yield are strong drawcards for PBA Samira to become their main variety in the next few years.

Under irrigation Tony expects faba beans to yield an average 4.0 t/ha. Depending on stored moisture levels, the Sawers apply a pre-sowing irrigation and two spring waterings.

In terms of chickpeas, the Sawers prefer the large kabuli chickpea variety, 114 Kalkee, but have found it difficult to irrigate.

"Chickpea crops don't like being flood irrigated after they emerge," said Tony.

"Up to now we have just irrigated them pre-emergence and in some years with a dry finish we have seen yield potential drop off."

In 2014 Tony started a trial growing chickpeas on drip irrigation. Having the option to apply water at critical times, particularly around flowering, has considerable benefits. The trial will continue this year as Tony and his farm managers fine-tune the system.

In the current flood irrigation system, chickpea yields have been around 2.5 t/ha in seasons with adequate in-crop rainfall but can drop to 2.0 t/ha in drier seasons. Tony hopes to be able to lift average chickpea yields to 3.0 t/ha or more using drip irrigation.

"It is all about opportunity costs," he said.

"Our drip irrigation area is valuable and we want to be making the best use of it while still achieving crop rotation benefits and spreading our risk. Being able to include chickpea in the rotation on drip irrigation will rely on gaining these higher yields. Last year there was strong local demand for kabuli chickpea that meant we didn't have to worry about the fickle nature of the global market."

The Sawers use border check irrigation for all their flood irrigated paddocks to achieve the best water use efficiency possible. Water is collected in drains at the bottom of the laser-levelled paddocks for re-use.

The large amount of corn crop residue produced each year presents a significant challenge when it comes to planting the next crop. To maintain the tight rotation Tony is trialling some new precision planting equipment this year for their pulse crops.

"Previously we have cultivated the corn trash prior to seeding the pulse crops and in wet years we have often had to burn," he said.

"We want to be able to maintain the trash on the surface so this year we are trialling a planter that sweeps trash aside and direct drills the seed."

Tony is a little concerned about the possibility of reduced efficacy of pre-emergence herbicides with direct drilling not incorporating the chemical but is of the opinion that the irrigated pulses will provide vigorous competition for any weeds that escape control.

Maize crop residue presents a significant challenge when planting the following pulse crop. To maintain a tight rotation Boort farmer, Tony Sawers, is trialling new precision planting equipment.

Flexible marketing options

Sawers Farms maintains a large on-farm grain storage capacity, used to store both maize and pulses. The maize is harvested in April and is generally all sold and delivered before the pulse harvest later in the year.

"We generally don't store the faba bean grain as there is usually strong demand for export shipments at harvest," said Tony.

"Changes in the local delivery arrangements for faba beans have been a real positive for growers in this area and we hope that continues. Last season GrainCorp opened a depot for 5000 tonnes of faba beans in Boort and Unigrain is a long-term supporter of pulse growers in the district.

"The chickpeas, on the other hand, can be well worth storing and watching the market."

Pulse Australia industry development manager, Mary Raynes says faba beans are the pulse crop of choice for flood irrigation in Victoria and southern NSW and as they tolerate waterlogging far better than any other pulse crop, and will grow well under a wide range of soil pH conditions.

"High to average yielding faba bean crops under irrigation can achieve gross margins that stack up well against other winter crops, on top of the soil health benefits that the beans provide for following crops," she said.

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PULSE AUSTRALIA

RICE PLANT POPULATION REQUIREMENTS

Brian Dunn, Tina Dunn, Craig Hodges & Chris Dawe

NSW Department of Primary Industries, Yanco

John Fowler

Local Land Services, Deniliquin

QUICK TAKE

- No difference was observed in grain yield for plant populations from 50 to 300 plants/m^2. This was the case for both aerial and drill sown rice and all of the varieties tested.
- At low plant populations (less than 50 plants/m^2), high grain yields can still be achieved but uniformity in the distribution of the plants becomes increasingly important.
- Grain yield from the 18 and 27 cm row spacing treatments was similar but yield declined at the 36 cm row spacing.
- Yield decline has not been observed at very high plant populations (greater than 400 plants/m^2) but more research is needed to confirm these results.

Current guidelines recommend that an establishment of 200 to 300 plants/m^2 is required to achieve a high grain yield, but high yields have been reported from much lower plant populations.

A RIRDC project has been investigating the optimum plant population required to maximise rice grain yield, determine how low plant populations can go before yield is reduced and if high plant populations lead to reduced grain yield due to increased sterility. Preliminary results from this research are presented in this article.

Over the last three seasons, 14 experiments were established across the Murray and Murrumbidgee valleys to investigate the impact of plant population on rice growth and grain yield.

Experiments & treatments

Eight aerial sown experiments were established over the Murray Valley, at Jerilderie, Mayrung, Morago and Bunnaloo. Each experiment comprised four replicates of four sowing rates: 25, 75, 150 and 300 kg/ha seed.

All aerial sown treatments involved spreading dry seed onto the dry soil using a drop spreader prior to permanent water being applied. This method provided an even seed distribution but low plant populations often occurred, especially on sodic surface soils.

Six drill sown experiments were also established with these located at Jerilderie, Yanco and Leeton. Five of these experiments had row spacing treatments of 18, 27 and 36 cm, which were split with sowing rates of 25, 75 and 150 kg/ha seed with three replicates. The sixth experiment was sown at 18 cm row spacing with multiple sowing rates. Two drill sown experiments also had 18 cm row spacing with a 300 kg/ha sowing rate to provide very high plant populations.

A range of varieties was grown across the experiments and some experiments had multiple varieties within the experiment. All experiments were managed with standard commercial practice with many located in farmers' fields with the nutrition and weed control managed by the farmer.

John Fowler, Leah Garnett and Tina Dunn with the spreader used to establish the aerial sown experiments.

Aerial sown

The aerial sown experiments provided a large range of plant populations, particularly many very low populations. This was a result of the combination of low seeding rates and often poor establishment from the dry broadcast sowing method which involved spreading dry seed on the soil surface prior to applying permanent water. None of the aerial sown experiments achieved the very high plant populations (greater than 400 plants/m^2) that we were aiming for, even though 300 kg/ha seed was applied.

When the results from the eight aerial sown experiments were combined (Figure 1), it could be seen that grain yield was not impacted by plant population densities between 50 and 300 plants/m^2. Below 50 plants/m^2 grain yield declined but there were still many sites that achieved grain yields above 10 t/ha from plant populations below 25 plants/m^2.

The lower plant population shows the greater importance there is on the uniform spacing of the plants to achieve high grain yield. There are examples of grain yields over 12 t/ha being achieved from only 15 plants/m^2 but for this to occur the plants must be very evenly spaced.

Drill sown

A larger range of plant populations was obtained from the six drill sown experiments (Figure 2). All of the sites shown in Figure 2 are 18 cm row spacing treatments, with a range of seeding rates.

As with the aerial sown experiments there was no difference in grain yield between plant populations from 50 and 300 plants/m^2 for drill sowing (Figure 2). The very high plant populations (greater than 400 plants/m^2) did not result in reduced grain yield in these experiments. When plant populations dropped below 50 plant/m^2 some low yields were recorded but also many high yields, as with the aerial sown experiments.

Row spacing

There was no significant difference in grain yield between the 18 and 27 cm row spacing treatments in any of the experiments, but the 36 cm row spacing always yielded significantly less than the other two.

When the data from the five row spacing experiments was combined (Figure 3) it could be seen that many of the 36 cm row spacing treatments achieved a very high grain yield but others yielded much lower. At the wide 36 cm row spacing any time there was a significant gap with no plants in a row, grain yield was reduced, as the neighbouring rows were too far away to compensate for the gap.

Weed control

In the aerial sown experiments the farmer conducted all of the weed control, with the experiment treated the same as the rest of the field. There was no difference in weed control between any of the plant populations.

In one of the drill sown experiments where no broadleaf herbicides were applied, there were more aquatic broadleaf weeds present in the wider row spacing treatments and sparser plant populations than the 18 cm row spacing treatment.

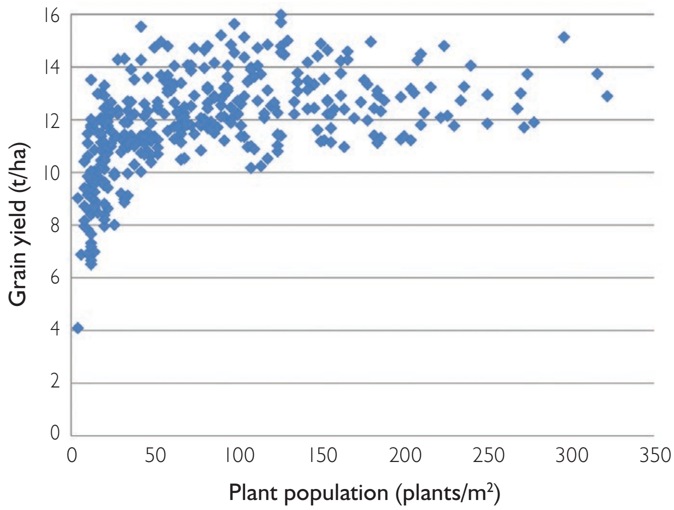

Figure 1. Results from eight aerial sown experiments combined to show the impact of plant population (plants/m^2) on grain yield (t/ha).

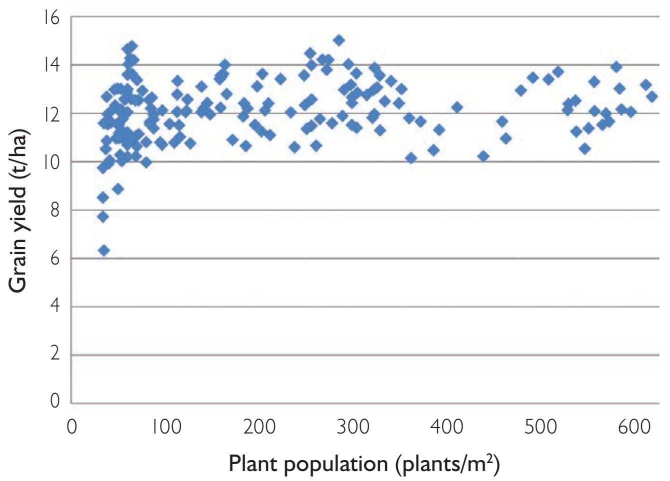

Figure 2. Results from six drill sown experiments combined to show the impact of plant population (plants/m^2) on grain yield (t/ha) at 18 cm row spacing.

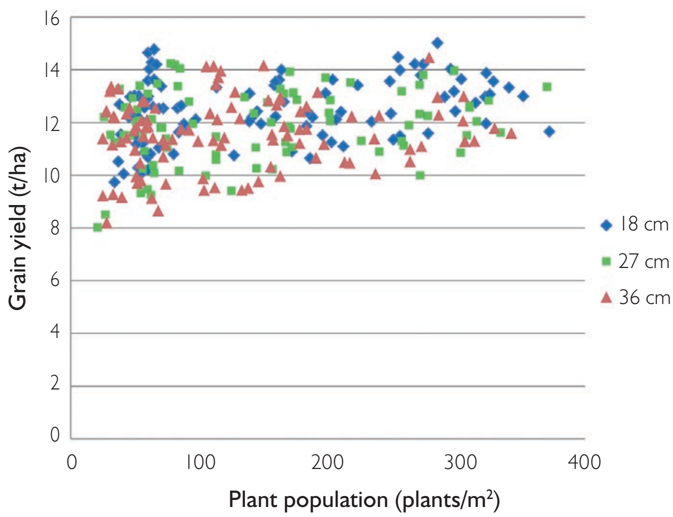

Figure 3. Results from five drill sown row spacing experiments combined to show the impact of plant population (plants/m^2) on grain yield (t/ha) at 18, 27 and 36 cm row spacings.

Uniformity important at low populations

The dry broadcasting sowing method, i.e. dry seed spread on the soil surface and permanent water applied, resulted in very poor plant establishment in some experiments, particularly those with soil surface sodicity. We expect that this was due to the seed being covered by soil on flooding and not being able to access sufficient oxygen to germinate. We would not recommend the practice of dry broadcasting to establish rice unless the field is given a flush irrigation and the soil is allowed to dry a little before permanent water is applied.

When saying that high yields can be achieved with 50 plants/m^2, we are not suggesting that growers aim at achieving that plant population, but when things go wrong and plant stands of 50 plants/m^2 or lower occur, very good grain yields often still can be obtained, providing the plants are uniformly spaced with no large gaps.

Plant populations above 400 plants/m^2 obtained in the drill sown experiments did not result in reduced grain yield but this still needs to be investigated further to determine if that is always the case.

Another season of experiments will be conducted to fine tune the results and look further at different varieties and nutrient management with variable plant populations. The research will also investigate uniformity of rice plant spacing and some measure that would allow growers to quantify uniformity in sparse plant populations. Once this is complete, lower and upper plant population limits will be determined based on the economics of establishing the crop.

Acknowledgements

This research was funded by the Rural Industries Research and Development Corporation and NSW Department of Primary Industries.

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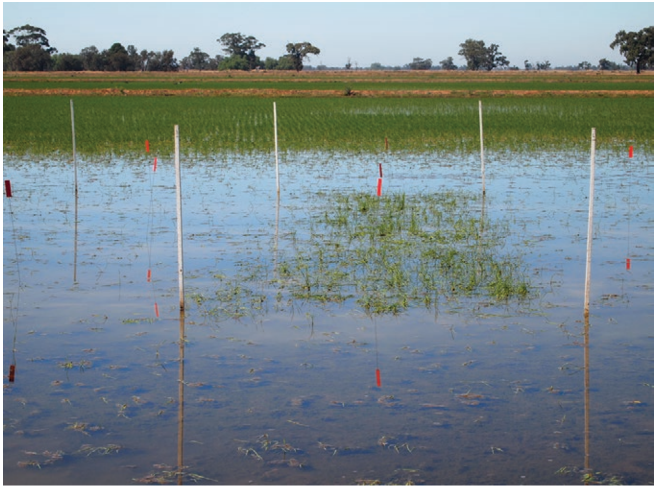

Pre-germinated seed treatment in the centre plot and dry seed broadcast on soil before flooding on either side. All sown at 150 kg/ha seed on a sodic soil.

Differences in plant density showing on 11 November 2014, with the 25 kg/ha sowing rate in the centre plot and the 300 kg/ha rate on the left. All plots were dry seed broadcast on soil surface before flooding.

PROMOTING AGRICULTURE

Iva Quarisa
EO IREC

A group of Year 9 students was shown the diversity of crops, wide-ranging career opportunities and state-of-the-art technology that is agriculture in the MIA but a ride in a cotton picker or a rice harvester was the highlight of the tour for many!

In May of this year, IREC organised and hosted a tour of the Murrumbidgee Irrigation Area for Year 9 agriculture students of The Scots College, Sydney. The tour was the first time most of the 23 students and two masters had been to the MIA.

The aim was to show the wide variety of crops being grown in the region, increase knowledge about irrigated agriculture, show the students career opportunities in irrigated agriculture, and highlight the high level of technology used in growing and processing good quality produce for people in Australia and the rest of the world.

The students visited a number of properties and agriculture-related businesses. They not only spoke with irrigators about the produce they grow but they also spoke with agronomists from Yenda Producers about jobs in agriculture and technologies used.

At Matt Ryan's farm, the visitors were astounded to learn that fish were produced in the area and "waste water" from the pond was used to fertilise the sunflower crop. Amongst other things, the group was very impressed to see the fastest bottling line in the world operating at Casella Wines, and to learn more about growing grapes from Bruno Altin.

The boys from Scots thoroughly enjoyed the opportunity to pick oranges at Mario Marin's Yoogali property, as well as view state-of-the-art colour sorting technology at Mario's Packhouse. For a number of them, the opportunity to ride a cotton picker and rice harvester at Rob Flanagan's and Chris Morsehead's were highlights of the tour.

We enjoyed a lovely lunch and footy match in Eleanor and Phil Hancock's garden after learning all the finer points about growing vegetable seed crops.

Tours of Flavourtech, the Southern Cotton gin and A&G industries exposed the students to the variety, professionalism and sheer number of businesses that the irrigation industry supports in regional communities.

The Scots College intends on making this an annual event and is very keen to further develop the relationship between the school and this region.

A group of Year 9 students from The Scots College, Sydney, toured the MIA to learn about farms, crops, careers and technology in irrigated agriculture.

Learning about the diversity of production in the regions, the tour included a visit to vegetable seed producers, Phil and Eleanor Hancock, South Pacific Seeds.

The students were shown various technologies used in agriculture, including colour sorting of oranges at Mario's Packhouse.

BUSINESS PERFORMANCE AND INVESTMENT ANALYSIS OPTIONS

Michael Ryan
Booth Associates, Griffith

QUICK TAKE

- It is important to regularly measure business performance to ensure you are generating worthy returns.
- EBIT yield (earnings before interest and tax) is a preferred measure of business performance.
- Aim for an EBIT yield of at least 6–8% excluding capital growth.
- It is important to undertake due diligence on investment options to ensure they are worth pursuing.
- Due diligence can include a simple cost benefit analysis, an EBIT yield analysis or internal rate of return analysis.

Profit is paramount to business success and sustainability.

Profits can be used to:

- fund growth
- pay down debt
- strengthen business position (balance sheet)
- invest in new technology or innovation to further improve performance
- pay a return to the business owners
- fund business transition such as succession planning.

Profits are driven by business performance and are measurable. People frequently ask:

- "What is the best way to measure the performance of our business?"
- "How do we analyse investment or growth options"?

There are numerous methods of measure that can be complicated and time consuming, though a significant investment warrants rigorous investigations. My preferred approach is to use simple benchmarks that are relatively easy to understand but sometimes require complex calculations and analysis to generate outcomes you can have confidence in.

Business performance

Crop yield is not a guide of business performance as it does not take into account production costs and the success (or otherwise) of the sales/marketing program.

As with crop yield, **profit is not** a useful measure of business performance either. When somebody states that they made a profit the inherent questions are "was it pre-tax or post-tax?", "was it gross margin or whole of business profit?", or "was it a 'cash' profit hiding a capital rundown?".

Cash in the bank is not a guide of business performance, as you may have cash in the bank following receival of crop sales, but you may also have trade creditors to pay and equipment finance payments due.

In my experience the best measure of business performance is EBIT yield (earnings before interest and tax), which is debt free profit divided by total business assets. This is sometimes referred to as 'return on capital' or 'return on assets managed' and provides the means of assessing your business' capacity to service debt and/or cope with the inevitable vagaries of seasons, markets, interest rate changes, etc.

For comparison, we use the 'risk-free rate', which is the interest rate on term deposits. Interest rates on term deposits are low at present, currently in the order of 2–3% for money fixed for a number of years. Inflation is also low at present, at less than 1.5%, so taking this into account, the real return on term deposits is more like 1–2% per annum.

To justify the risks involved in farming you should aim for an EBIT yield of greater than double the risk free rate, say 6–8% as a start, plus capital growth. Capital growth on land could be 5% in the longer term, which is 2–3% after inflation. Capital growth on water is significant at present [end July 2015] but hard to quantify given the wide variation in markets we have seen over the past 10 years. Agriculture is a long-term capital-intensive industry and the contribution of capital growth is significant. But you have little to no control on capital growth, so you should be careful if budgeting for capital growth.

Recent business performance can be analysed by measuring EBIT yield. In such an analysis, owner's labour should be valued at true market value. Many business owners take a reduced salary for a range of reasons, including to maximise balance sheet growth. When analysing business performance, owner's labour should be valued at the cost to pay an independent manager. This adjustment shows true business returns and ensures impartial comparisons can be made to a range of other investment options.

If there are significant variations in business performance, as many businesses have recorded in recent years due to varying seasons, markets and water allocations, it may be preferable to include an analysis of EBIT yield based on a projected steady state for a business. As always, any budget is only as good as the assumptions around yield, prices and costs. If your EBIT yield is low (less than 5%) you need to analyse in more detail your costs and returns. Often production costs for a particular enterprise are high which is undermining the performance of the business. Aside from cost control, other ways to improve performance include increasing productivity (e.g. improve irrigation layouts) or expanding scale by increasing water access (via supplementary, carryover, temporary transfer or permanent transfer) or accessing more land (buy/lease or share farm).

Investment options analysis

The analysis of an investment option is often referred to as due diligence. A simple way to appraise an investment option is a cost benefit analysis which assesses all the costs involved and quantifies the benefit. As a guide, in agriculture the benefit should be at least double the cost over the lifespan of the investment. For example, if touch-up lasering a field is expected to provide yield benefits for at least five years, quantify the increased yield over a five-year period and compare to the cost of lasering, whilst also having regard for other benefits such as saved water. The lasering cost should be no more than half the value of the improved productivity and saved costs/water.

For long-term, large-scale due diligence analysis we use 'internal rate of return'. Internal rate of return is typically measured over a 10-year period and is simply a measure of capital in, free cash flow and capital out. The critical assumptions include yield, price and costs but also asset value at the end of the 10-year investment cycle, which is a function of your capital in and assumed capital appreciation. Internal rate of return can be assessed on a real basis (today's value of the dollar not considering capital growth or inflation) or on a nominal (or discounted cash flow) basis (taking into account capital growth and inflation). The returns are likely to be higher on a nominal basis. Either way it is critical to understand the assumptions made around capital growth, cost inflators and farm productivity increases.

For an analysis to show an investment with worthy returns the internal rate of return must be greater than the hurdle rate or cost of funds. For example, 10-year fixed interest rates on loans at present are 7.5% so the internal rate of return should exceed 8% for the investment to be worth considering.

Owner operators typically do not think of investment options in 10-year cycles, so another way to assess an investment option is to analyse EBIT yield. Compare the EBIT yield on the existing business against the projected EBIT yield considering increased business performance and increased business value to determine if the investment will provide a worthy return. In such an analysis it is important to remember in most instances no more than half the value of capital expenditure goes to the balance sheet. For example, upgrading a good rice irrigation layout into a row crop ready layout could cost as much as $1000/ha but it is unlikely land values will increase by any more than half this amount.

As always, if you are trying to make complex decisions around investment options it is best to seek advice from your trusted business advisors.

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ROBBIE THE BITTERN – helping connect farming & nature conservation

Matt Herring

Bitterns in Rice Project

QUICK TAKE

- Each year, approximately 25–30% of the world's Australasian bittern population comes to the Riverina rice fields.
- In April 2015, a young bittern called Robbie became the first of his kind to be fitted with a satellite tracking device.
- Just before rice harvest, Robbie took off and travelled almost 600 km, finally settling in wetlands near the coast of south west Victoria.
- It's quite incredible that rice crops can yield ten or so tonnes per hectare as well as future generations of one of the world's rarest, most threatened waterbirds.
- 2015–16 will see continued work in Riverina rice fields to gain more understanding of bitterns' preference for rice sowing method and water management; as well as understanding likely prey of these rare birds.

He was feisty. He was young. Just an egg in a rice crop three or four months ago, he was about to become famous. Robbie: the first ever endangered Australasian bittern to be satellite tracked.

Rice harvest was well under way and the pressure was on. With such humbling support during our crowd funding effort, which saw donations from over 300 people and 20 community groups, and with all of the necessary permits and approvals now in place, we had to get at least one bittern away before the season was over. Finally, the net gun, or at least its operators, produced the goods.

It was 21 April, 2015. Inka Veltheim, a waterbird tracking expert, and I were on a Coleambally rice farm. In a rare late-season aggregation, there had been at least 18 bitterns there a few days earlier. But now we could barely find any. The crop was dry and the puddles in the toe furrows, filled with frogs and carp, were drying out fast. It looked like the waterbird feeding frenzy was over. We were about to head back to another promising site near Leeton.

Then Robbie showed himself and before long he was in our arms while we carefully attached the $4000 transmitter on a little string backpack, with weak links so that it would eventually fall apart, hopefully not before the battery ran out.

So, why all the fuss?

Well, if you haven't heard, through the *Bitterns in Rice Project* we have learnt that the rice crops of the Riverina support the world's largest known Australasian bittern breeding population.

During the 2014–15 season we were able to expand our surveying of randomly selected rice farms from the Coleambally Irrigation Area to include the Murrumbidgee Irrigation Area. To estimate the population size by extrapolating the results, it was our best sample yet: 80 sites, covering just over 2000 hectares of aerially sown rice, on 41 farms. We still have more data analysis ahead, are yet to randomly sample the Murray Valley, and we realise that the population fluctuates between years, not least because of the amount of rice grown. However, it's already clear that in most years between 500 and 1000 bitterns descend on the rice. That's about a quarter or third of the global population.

Until now we had little idea of where the population went after harvest and what network of wetlands the bitterns relied upon until the next rice season.

Sea change for Robbie

For the first week or so, Robbie made local movements, 600 metres this way, 350 metres that, then 800 metres back, and so on, pretty much staying on the same rice farm where we caught him. That all changed on the afternoon of 30 April. He first appeared near Deniliquin, about 90 kilometres away.

He'd be following the unharvested rice, we thought, but we were wrong. He flew and flew, and just kept flying; his youthful vigour taking him across two state borders. He eventually arrived at the recently restored Pick Swamp on the South Australian coast, and instead of listening to trucks passing by on the Kidman Way, he was now hearing the sound of nearby waves, 557 kilometres from where we first met him.

After a brief stay, Robbie moved along the coast back into Victoria, had a stopover at the mouth of the Glenelg River near Nelson, and then settled at nearby Long Swamp, also the site of innovative wetland restoration.

To the delight of staff at Nature Glenelg Trust, and others involved in local wetland restoration, Robbie even showed himself. This is what Lachie Farrington had to say:

> *"… we had a good view and for a couple of blokes who know nothing about animal tracking/transmitters etc, the small attachment on his back was pretty obvious. It was kinda weird seeing a rare bird in the middle of nowhere and being on a first name basis. A field highlight which will be hard to top – just wish I had my camera ready."*

Since then, photographs have emerged. He is alive and well but not without a hitch. One day, the transmitted coordinates put him way out at sea. We thought he was dead, succumbing to that wild Southern Ocean. With thousands of people across Australia, and others from New Zealand to Nepal, following his journey, how would we break the news? More fixes, and still he was at sea. But all was well. We needn't have worried. It turned out he'd been flying into 50 km/h winds, 1.5 km out to sea, heading backwards at about 1 km/h. Risk-taking youngster. No surprises there!

Understandably, the folks down south are thrilled that Robbie has been checking out their wetland restoration works and they reckon he has pretty good taste. It's certainly a great endorsement to have a globally endangered species fly so far and choose their restored wetlands. One of Robbie's greatest achievements is that he's connecting seemingly disparate wetlands and people.

Mark Bergmann, also from Nature Glenelg Trust, captured it well:

> *"For two concurrent and previously unrelated conservation projects to come together like this, when one of those projects started over 500 km away in NSW, I reckon is a pretty amazing, meaningful coincidence!"*

Agriculture provides important habitat

Robbie has also highlighted to his followers that not only are there endangered birds using rice crops but that they are breeding in there as well.

Using the random farms during the 2014–15 season, we found eight nests on five farms, leaving no doubt that there is widespread breeding. Interestingly, one perhaps lucky booming male, had three nesting females in adjacent bays within his territory, thus indicating polygamy. It's little wonder they invest so much energy into booming, the acclaimed call of the Bunyip, to attract females and defend their territory.

Importantly, the discovery of Robbie, and at least one other youngster during the 2014–15 season, also confirmed that bitterns can breed successfully in the rice, producing fully-fledged young before harvest. It's quite incredible that rice crops can yield ten or so tonnes per hectare as well as future generations of one of the world's rarest, most threatened waterbirds.

Robbie the bittern, just prior to release, named by Coleambally Irrigation after Mark Robb, for his significant contribution to the Bitterns in Rice Project.

Robbie's 557-kilometre dispersal from a rice crop in Coleambally to Pick Swamp on the South Australian coast.

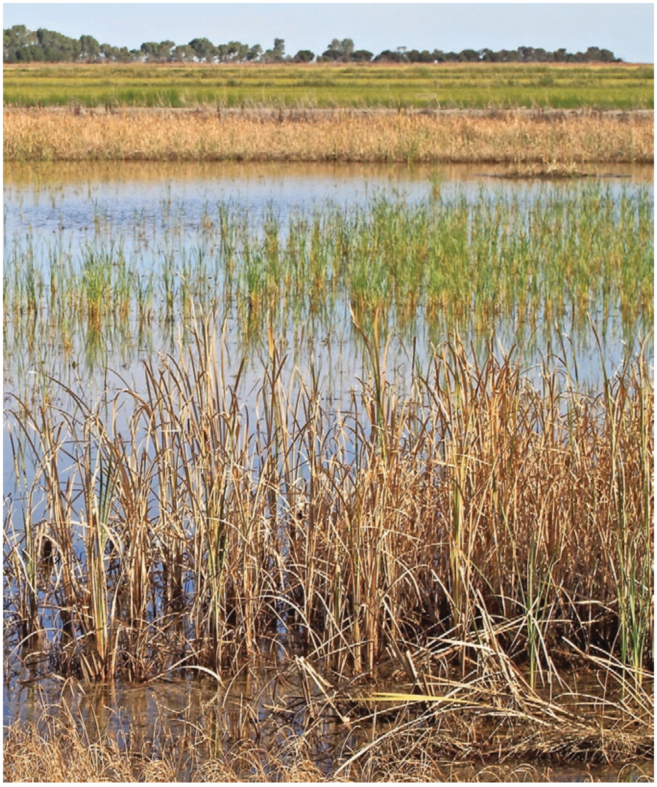
In Australia, we generally manage land and water for agriculture or for nature conservation, rather than both. The *Bitterns in Rice Project* is all about co-management, bringing together two traditionally separate schools of thought. In October, we are delighted to be presenting our paper, "Co-management of water for rice production and wetland biodiversity in Australia", at the 2nd International Conference on Global Food Security in New York. For some, the idea that agricultural habitats, especially irrigation, can be important for nature conservation is foreign, but Robbie is helping them to think again.

Our vision is to see bitterns and other significant wildlife prosper alongside rice farming; building on existing habitat values and demonstrating that agriculture and nature conservation can work together.

Lifting the bittern yield

There are many opportunities. During the 2015–16 season we are planning on looking in detail at sowing methods, water management and bittern prey. We'll be able to test the idea that the preference bitterns show for aerially sown rice is related to the earlier permanent water and lack of dry phases, and the

One of eight 'random' bittern nests found during the 2014–15 rice season.



Adjacent habitats, like this storage dam with shallows and water plants, can augment the biodiversity value of rice fields.

subsequent prey base that makes these crops more attractive than direct-drill, sod or combine sown rice. Given the trend towards delayed permanent water and dry phases, it's somewhat ironic that water saving measures may be disadvantaging wildlife. Radical as it may seem now, supplemental environmental water or subsidising additional water costs to the grower could be used to produce rice while enhancing its nature conservation benefits.

There's also the potential market where a premium could be paid for bittern-friendly rice, covering any additional costs. Anyone for Bunyip Bird Rice?

In the future, we're also keen to explore how growers might improve breeding success, making their crops yield more fledged young. Robbie made it but others did not. Near Leeton, we found a big pile of bittern feathers with a fox scat on top. We've seen chicks hiding in barnyard grass on banks between bays and suspect that increasing the amount of cover like this could help chicks avoid predators. We now know that chicks are fed carp, frogs and tadpoles, and also suspect that management that leads to more abundant prey might increase breeding success. Water and pesticide regimes, the amount of adjacent habitat and other factors affect bittern prey.

Managing or creating habitat adjacent to a rice field is another area of great opportunity to benefit bitterns and other wildlife. From remnant wetlands to storage dams and drainage channels, there is almost always potential bittern habitat surrounding each rice paddock. Habitat ponds, incorporated into a rice field but managed independently and beyond the rice season, is another area we're keen to promote. Growers could use drainage water and target habitat management at bitterns while being mindful to provide additional habitats, such as mudflats to attract migratory shorebirds like the sharp-tailed sandpiper and other threatened species, e.g. the Australian painted snipe. Since 2012 we've recorded 53 different waterbird species and seven different frog species using rice. We're keen on benefiting them alongside the bitterns.

Where to next?

But back to Robbie and false dichotomies like farming and nature conservation. He isn't privy to water politics, state boundaries or other human inventions. He sees the landscape for what it is: a sea of different habitats, with small patches here and there that are suitable for him. He's probably a little young but if he's an early starter, he may try and breed in his first year. Will he stay on the coast, woo a local female or two, or three, and make it a permanent sea change, or will he return to his homeland: the rice fields of the Riverina? We will see.

You can follow Robbie's movements and those of future bitterns on our website: **www.bitternsinrice.com.au**

Acknowledgement

The Bitterns in Rice Project *is a collaboration between the Ricegrowers' Association of Australia and Birdlife Australia, with key support from Riverina Local Land Services, who have funded much of our recent work. We also gratefully acknowledge rice farmers for making the project possible, and for previous funding and support from Coleambally Irrigation, Rural Industries Research & Development Corporation, Norman Wettenhall Foundation, Murray LLS, NSW OEH, Murrumbidgee Field Naturalists, Murrumbidgee Landcare, Murray Irrigation and Murrumbidgee Irrigation.*

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IMPROVING RICE WATER USE EFFICIENCY

Nicola Raymond

Communications Manager, Nuffield Australia Farming Scholarships

QUICK TAKE

- Currently the Australian rice industry is challenged with maintaining its production levels in a volatile water market.
- Direct drilling of rice can save significant water use per hectare, and reduce input costs.
- Present direct drill chemicals may challenge the industry's uptake of the growing technique.
- Cover cropping techniques may have a fit in direct drill rice production.
- Precision agriculture is well adopted in Australian agriculture, and new technologies will help to continually increase yields.

Peter Kaylock's family began experimenting with direct drilling of rice during the millennium drought. They soon realised the possible water savings of the system without loss of yield.

Peter's family has been growing rice at Moulamein for over 60 years, and they have always been willing to adopt new technology. As a result of low irrigation water allocations during the extended drought, the Kaylocks started experimenting with direct drilling techniques in rice in 2006.

On their soil types, Peter identified water savings of at least 2 ML/ha using direct drilling techniques. The continual irrigating and drying of the seedbed, as part of the process, simplified chemical usage and identified substantial input savings. The drying process between irrigations eliminated broadleaf weeds, such as dirty Dora and starfruit, and insect problems, particularly bloodworm and snails. The use of the Kaylock's existing machinery to carry out chemical and fertiliser applications resulted in significant savings compared to hiring an aeroplane to carry out the same procedures.

Peter Kaylock is a 2013 Nuffield Scholar, who was supported by Rural Industries Research and Development Corporation and the Rice R&D Committee. On his Nuffield Scholarship, Peter travelled to many rice growing countries looking at the direct drilling of rice crops, cover cropping, precision agriculture and innovative machinery.

As a result of his Nuffield studies, Peter Kaylock believes that there are many ways for the rice industry to reduce total crop water use and focus on increasing water use efficiency per kilogram of production.

Australia is progressive

Peter Kaylock

2013 Nuffield Scholar and rice grower, Moulamein

Travel to other rice producing countries highlighted just how progressive the Australian rice industry and its growers are.

Australian growers are driving precision agriculture and adopting new techniques at a greater rate than many other countries. Very few countries access so many pieces of the precision agricultural puzzle in the way our industry does.

Attention to detail, the adoption of precision agriculture techniques, and the ability to challenge normal production techniques were a common theme around the world for farmers producing top crop yields.

Precision agriculture

Precision agriculture will continue to develop rapidly. Measurement of biomass on a daily basis will soon be possible. The application of nutrients with sub-metre accuracy is already upon us. Mapping soils will take on a new dimension as sensors that measure multiple elements within our soils help unravel their limitations.

In Australia, precision agriculture has enabled yields to approach an average of 11 t/ha — the highest in the world. While yield maps show that Australian crops, in some areas, are approaching the theoretical yield potential of present varieties, it will be difficult to advance average yields until the limiting factors within a paddock are addressed.

Yield maps from rice crops show much more variation than other irrigated crops. In addition to soil-related issues, research is identifying many other complex factors influencing yield. No single aspect has the potential to increase yield, quality or profitability on its own. Developing further key *Ricecheck* drivers for direct drilling of rice will assist in maximising results.

Direct drilling

Direct drilling of rice was practised in most countries visited, due to soil types, climate, community pressure and small landholdings. Currently, only 25% of Australian rice farmers are direct drilling and 10 years ago, virtually no Australian farmers used this technique.

Cover cropping is an interesting concept. The advantages of weed suppression and moisture conservation are benefits of cover cropping that could assist the establishment of rice crops and minimise chemical usage.

The direct drilling of rice has potential as a viable system for irrigators in Australia. This technique already offers substantial savings of water, chemical inputs and machinery costs. Combine cover cropping and further precision agriculture technologies to the direct drill system, and we have the potential to increase productivity, lower input costs further and reduce variability in yield.

As Australian rice growers continue to face water availability restrictions it is timely for the rice industry to further improve water use efficiencies and practices. The rice industry needs to investigate all avenues of growing more rice with less water.

Lifting industry yield

SunRice has highlighted its requirement to maintain the level of average annual rice production at 950,000 tonnes (June 2015). It is difficult to achieve this production in the existing water market. The industry has to make a quantum leap in production per megalitre used, which is a long-term project.

We need new varieties with greater yield potential, and increased drought and cold tolerances, which will take some time to breed. Better understanding of soil limitations is needed to address the yield variation across paddocks. Better measurement of crop nutrition will also help increase yields. All these factors are achievable but they may not satisfy the short-term needs of SunRice.

Recommendations for industry

1. Improve plant vigour and drought tolerance in new variety releases.
2. Reduce total crop water use and increase water use efficiency (WUE) per kilogram of production. Growers should be encouraged to show productivity as "kilograms produced per megalitre" to highlight crop WUE.
3. Evaluate hybrid varieties for the Australian industry. They have increased vigour, with potential to increase yield and WUE and could well be suited to the northern areas of Australia.
4. Evaluate Clearfield® technology for use in Australia, as a backup in the event of grass weed resistance to present chemicals and practices.
5. Further evaluation of the chemical quinclorac to provide another mode of action against grass weeds in direct drilled rice.
6. Update the Ricecheck booklet to discuss methods of direct drill establishment of rice in more detail and develop key checks to aid the establishment of rice in specific weed control systems.
7. Evaluate cover crop rotations and sowing methods for direct drill rice.
8. Educate growers about increasing the organic content of their soils to assist crop establishment, moisture retention and nutrient availability.

Read Peter's report:

www.nuffieldinternational.org/rep_pdf/1433474374Kaylock_Peter_FinalReport.pdf

View Peter's presentation:

https://vimeo.com/109226338

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FOCUS ON IRRIGATION LAYOUTS

Iva Quarisa
EO IREC

QUICK TAKE

- There is a wide range of surface irrigation designs and deciding which system to use can be difficult but the choice is very important.
- For all the growers featured in this article, irrigation efficiency and labour savings were the biggest drivers behind investing in a new irrigation system.

We all know water flows downhill but getting it to flow evenly and efficiently is the real challenge.

Over the past few years a huge amount of money has been invested on irrigation properties across the region to improve surface irrigation efficiency. These systems not only involve a significant capital investment but they also require a unique technical design for each location.

There is a range of surface irrigation designs around and deciding which system to go with can be difficult but the choice is very important. From a soil health and financial perspective, farmers only want to move soil once in order to get the ideal layout.

During the 2014–15 summer, IREC and Riverina Local Land Services coordinated two bus trips for irrigation farmers and industry representatives to look at some of the range of irrigation layouts across the district, and learn about these systems from other irrigation farmers.

Hills in bays with rollover banks

The original layout at Anthony Ryan's Leeton property was a lasered rice layout with a 1:1600 fall that could be adjusted to siphon irrigation. Blocks were 20 hectares and it would take seven days to irrigate 110 ha.

During the 2012–13 summer the new 'hills in bays with rollover banks' layout was installed. The bays, with one metre hills that are parallel with banks (running east–west) are fed by a bankless channel/ditch (running north–south). Rollover banks between the blocks allow 1.6 kilometre agronomic runs.

The bays have been lasered with a positive 1:20,000 fall back to the bankless channel, which means the water is being "pushed up hill", to ensure drainage. Bays are around 320 metres in length with zero side fall.

The first bay is smaller, as it fills up from Murrumbidgee Irrigation supply only, but the next bay is larger to handle flow from supply as well as drainage from the bay above.

There are no subbing problems and no energy costs. The one metre hills also mean that Anthony can run his dual-wheel machinery all the time and not damage or split the tyres. The system is flexible and with a small modification to the banks, it is suitable to grow rice.

Maintenance of the bankless channel is very important, in order to keep the irrigation system running efficiently. Anthony has had issues with some stops washing.

Pipe through the bank

Ben Witham had a conventional siphon layout, with 1.8 m beds at his Coleambally property. In the winter of 2014, Ben modified the supply from the traditional rota buck to a pipe through the bank.

Works began with a road grader digging a small pontoon (bankless ditch), in place of the rota bucks.

"You need to make sure your main supply channel is lower than the bankless ditch," Ben said.

The bankless ditch can drain completely and dry out so you have easy access for in-crop activities.

Each bay has a Padman rubber door stop attached to two lengths of 450 millimetre pipe through the bank ending with a concrete bubbler. Bay lengths range from 500–800 m with 36–40 beds in each bay. Bay widths are in multiples of eight rows to suit farm machinery and the natural slope of the land.

Ben has found that stubble management and furrow compaction are very important issues with this system. If a large stubble load remains in the paddock, furrows can be blocked which inhibits even flow, as does furrow compaction.

For Ben, one of the main advantages of this system is the ability to access the field between irrigations, as no time is wasted knocking down and pulling up rota bucks. He can push more water down the furrows than was possible with siphons.

One metre hills in bays. Observers are standing in the bankless channel and on the roll-over bank.

Terraced beds in bays

When Trent Gardiner bought "the worst farm in Coleambally — with great soil but shocking layout" some people thought he was mad. The farm was a mixture of steep unlasered and lasered contour country. The farm had a general slope of 1:1000, with some very steep areas and some deep undrainable holes amongst that. While it took around seven days to irrigate 190 ha, some paddocks took 4–5 days to drain and there were areas that would pond for days.

The new 'beds in bays' layout was installed between February and May 2014. The bays have zero side fall, with 1.83 m wide beds running parallel with the banks. The bays that are over 400 m in length have a 300 mm deep bankless channel at each end.

Bay width is dictated by the natural slope in order to minimise earth moving costs and preserve soil health, while still aiming at multiples of four beds. All water structures between bays can handle a 40 ML/day flow rate and are 1 m x 1 m stops with 2.5 m long wings and a 2.4 m long chute to minimise turbulence.

This layout gets water on very quickly and drains very well.

"This has turned what was one of the worst layouts around into a very good one, using the undulating country to our benefit. But don't put the structures in too high," warns Trent, "you'll lose them from turbulence on the down side".

A pontoon dug with a road grader feeds water into border check bays made up of 36–40 beds.

Key drivers

For all the growers, irrigation efficiency and labour savings were the biggest drivers behind investing in a new system.

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Table 1. Comparison of key layout features for three irrigation layouts

Property	Ryan – Leeton	Witham – Coleambally	Gardiner – Coleambally
System	Hills in bay with rollover banks	Pipe through bank	Beds in bays
Area (ha)	110	80	190
Cost ($/ha)	1200	300	1580
Supply flow rate (ML/day)	30	30	30 (+15 from recycle)
Step between bays (mm)	150	0	100–500
Structure size (ML/day)	50	12	40
Time to irrigate bay (hours)	6–8	6–12	4–12
Bay slope	1:20,000 +	1:1800–3000	zero
Days to irrigate	2.5	2	3
Can be automated	yes	yes	yes

NEW OPERATING AND PLANNING SYSTEM FOR MIA WATER

Leonie Williams

Manager Water Resources, Murrumbidgee Irrigation

QUICK TAKE

- A new information system will enable Murrumbidgee Irrigation to improve the efficiency and effectiveness of day-to-day operations of MI's core business of delivering water to irrigators.
- By using real-time network simulation models, water delivery by MI can be a proactive planned approach rather than a reactive approach.
- The new system, coupled with existing information management programs, provides a way of viewing and analysing the success of automation and modernisation projects currently being implemented by MI.

In order to provide the best possible service to irrigators of the Murrumbidgee Irrigation Area (MIA) and prepare Murrumbidgee Irrigation Limited (MI) for future changes to water availability and irrigation requirements, MI is installing a new information system.

The new system will improve the efficiency and effectiveness of day-to-day operations of MI's core business of delivering water to irrigators. In addition, the system will enable better planning for short- to medium-term water requirements, as well as longer-term asset requirements.

Since the early 2000s, MI has implemented an extensive drainage capture and re-use network throughout its area of operation. The need for drainage reuse was first addressed in the Murray–Darling Basin Salinity Management Strategy (2001–15), realising that as Australia's 'food-bowl' it was imperative that water use efficiency was maximised for the sustainability of the basin.

Murrumbidgee Irrigation continues to recognise the importance of efficiency and sustainability. A new operation and planning system is an efficient way to provide additional security for MIA irrigators in a time where water is scarce and changes in climate patterns are driving water availability and allocation across the Murray–Darling Basin.

Better management

Worldwide, water utilities and irrigation companies face increasing challenges to understand and manage their distribution networks. For MI, this has created a pressing need to integrate the information systems that control water coming in and going out of the MIA with technology that predicts the demand for water. Water demand will include customer (irrigator) requirements, the influence of weather (evaporation, rainfall, etc) and regulations (required drainage volumes).

In March 2015, MI implemented a new system, simply called the Murrumbidgee Irrigation Operation and Planning System or MIOPS. The system uses a combination of leading edge software and technologies that can use data from existing information systems used by MI, as well as automated data from organisations such as CSIRO and the Bureau of Meteorology.

Water delivery mechanisms used by MI are predominately operated via a gravity-based delivery system, which can present challenges in equitable water delivery during difficult operating circumstances, such as a water shortages or spiked increases in demand during a heatwave at the height of the irrigation season.

By using real-time network modelling to predict demand for water, water delivery by MI can be proactive rather than reactive. This creates opportunities to optimise water delivery and improve system efficiency, especially in times when best water management is required to meet peak irrigation demands.

How does MIOPS help MI?

The benefits of MIOPS are yet to be fully realised as MI is only part way through implementing the system into its day-to-day operations and business planning.

Planning

The data that is collected through MIOPS and existing systems is being used to provide essential information for asset planning and long-term demand forecasting. Staff can take a "snapshot" of the MI delivery system and test options for the viability of asset replacement, modernisation, automation and rationalisation projects and the impacts of these options on the operations of the current system. This provides data to assist with the decision making process related to long-term capital investment.

Demand forecasting

The new system provides staff with the ability to forecast crop water demand at the channel, division, district and whole-of-system operating level. There is additional capability to improve 6 and 7 day water ordering from Water NSW by determining crop water requirements based on previous crop water patterns, current and predicted rainfall, current and predicted evaporation, coupled with customer water orders.

Water administration

Customer services staff is able to assess the impacts of internal trading of delivery entitlements and flow rate share apportionment, in line with the company's water contracts and policies. This tool, coupled with current and historical operating data, is also used in the asset planning and maintenance process to determine asset use against company revenue and levels of service.

Water & environmental compliance

MIOPS is able to provide data to assist staff with metering and water compliance requirements in line with the company's contracts, policies, operating and environmental licenses. The use of real-time data allows for a more proactive approach to environmental and water monitoring, metering compliance and program management. Future additions to the system will assist with reducing the burden of field compliance and resourcing.

Water storage & management

The models and real-time data used through MIOPS assist MI to maximise water diversions, water storage, capture and reuse. This in turn enables operational staff to optimise secondary water from mis-match of orders and catchment and drainage runoff for capture and reuse in other parts of MI's supply system.

Water balances

MIOPS provides for an accurate approach to providing water balances at division, supply and system level and the ability to understand and target areas for investigation in determining and assigning water loss categories such as seepage, non-compliance and operational.

Supporting business growth

MIOPS coupled with existing programs used by MI can view and analyse the success of automation and modernisation projects currently being implemented by MI. To date, MIOPS has been valuable in providing MI with the necessary technology and information to assist with the delivery of projects under the Private Irrigation Infrastructure Operators Program for NSW (PIIOP).

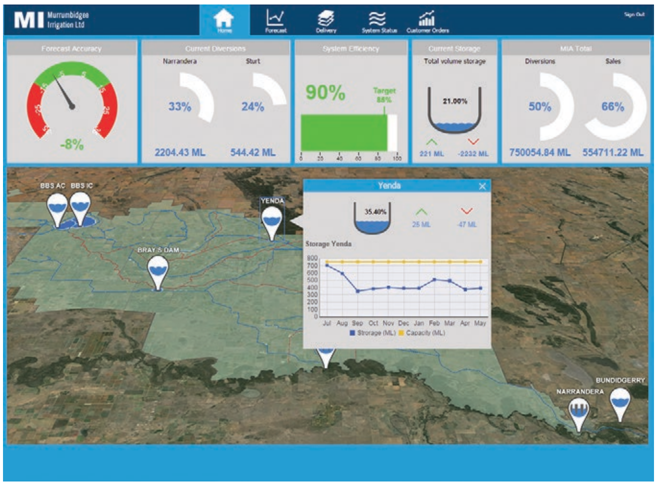

Figure 1. An example of information that the MIOPS can provide about MI business.

Benefits of the system

Key of the benefits of MIOPS are:

- improved decision making — time, quality and data integrity
- improved customer service — scheduling, ordering and delivery efficiency improvements
- improved system efficiency — knowledge gained and used in near-real time (30 min intervals)
- meeting compliance demands — increased understanding of water losses
- enhancing data quality and consistency — providing much need business intelligence.

MI will be spending the next 12 months, testing, fine tuning and calibrating the system and its functions for future use.

MI is also exploring opportunities and ways to provide inputs from MIOPS to customers that is valuable in their day-to-day business needs. MI envisages that as this system matures the efficiency of operations and the benefits of forward planning (and its accuracy) will be expressed in improved and efficient delivery to its customers, no matter the operational hurdle presented.

Acknowledgements

This work was collaboration between Murrumbidgee Irrigation, Adasa (Adasa Sistemas) and Deakin University. The hard work, vision and dedication by the staff at MI, Adasa and Deakin University was instrumental to this project, with special mention to Chris Smith (MI), Noel Heath (MI), John Hornbuckle (Deakin), Josep Selles (Adasa), Jordi Ayats (Adasa), Xavier Valls (Adasa) and Antonio Morales (Adasa).

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THE EFFECT OF LAYOUTS, SOILS & AGRONOMY ON YIELDS OF NON-RICE CROPS

Sam North

Research Hydrologist, Department of Primary Industries, Deniliquin

QUICK TAKE

- An analysis of wheat crops sown after rice harvest in the Murray Irrigation Ltd districts found that lifting yields required different management, depending on soil type and irrigation layout.
- Four management factors that limit winter crop yields were identified: waterlogging, late season water stress, under-fertilisation and low soil pH.
- In the MIL districts alone, lifting wheat yields after rice from the current median to the 80th percentile would result in an additional 20,000 to 30,000 tonnes per annum ($4–6 million at $200/t).
- If all the area in rice each year was sown to wheat after harvest and 80th percentile yields achieved, then an additional 128,000 to 138,000 tonnes of wheat would be produced ($26–28 million at $200/t).

The solutions to improving grain production and profitability on irrigated soils may well be at hand for irrigators of the southern Murray–Darling Basin. It's just a case of knowing where to look — and maybe retesting some theories and findings from previous decades.

In the establishment of a project to identify and develop cereal varieties for irrigation (the *High yielding genotypes of winter cereals for irrigated regions of south east Australia* project), Dennis Toohey and Associates determined the potential of irrigated grain production in the southern Murray–Darling Basin. The study, published in 2006, had three key findings.

- There is a need to lift productivity and profitability of irrigated grains because of cut backs in water entitlements and to achieve higher efficiencies from the use of irrigation water.
- Water use efficiency of irrigated wheat is low. Average wheat yields in 2006 of 3.0 t/ha achieved 10 kg/mm/ha. There is potential for improvement to 22 kg/mm/ha if yields are 10.4 t/ha — a figure being achieved in variety trials and by some farmers.
- Farm gate value in 2006 for all crops studied was $176 million. If yields rose to best trial levels (as at 2006), farm gate value would nearly double to $347.7 million.

Eight years later, the situation appears largely unchanged.

A new project being conducted by the Irrigated Cropping Council, DPI Agriculture, Deakin University, Murray LLS and Precision Agriculture, with financial support from GRDC, commenced in July 2014. The long-term objective is to "increase grain production and profitability from surface irrigated soils in the GRDC Southern Region by improving the understanding of the interaction between crops, soils, and irrigation, and their effects on crop production".

Two questions arose in response to this objective.

- What increase in grain production can we realistically expect from irrigated grains in the GRDC Southern Region if major constraints can be overcome?
- What are the major constraints limiting grain production in surface irrigated systems in the GRDC Southern Region, how do they interact, and what can be done to overcome them?

Realistically-achievable yields

An on-line survey, conducted in 2014 across the irrigation areas of northern Victoria and southern NSW, asked irrigation croppers what their average/expected yields and best ever yields were. The rationale behind this was that if a 'best yield' can be achieved once, then it should be possible to achieve it again. Our goal is to work out why it isn't achieved regularly and see if we can do something about making that happen.

One hundred responses to the survey were received from irrigators with a wide range of farming systems. The results (Table 1) support the contention that there is significant potential to increase yields in all crops across the region: 2.0 t/ha increases for the cereals and 0.8 t/ha for oilseeds.

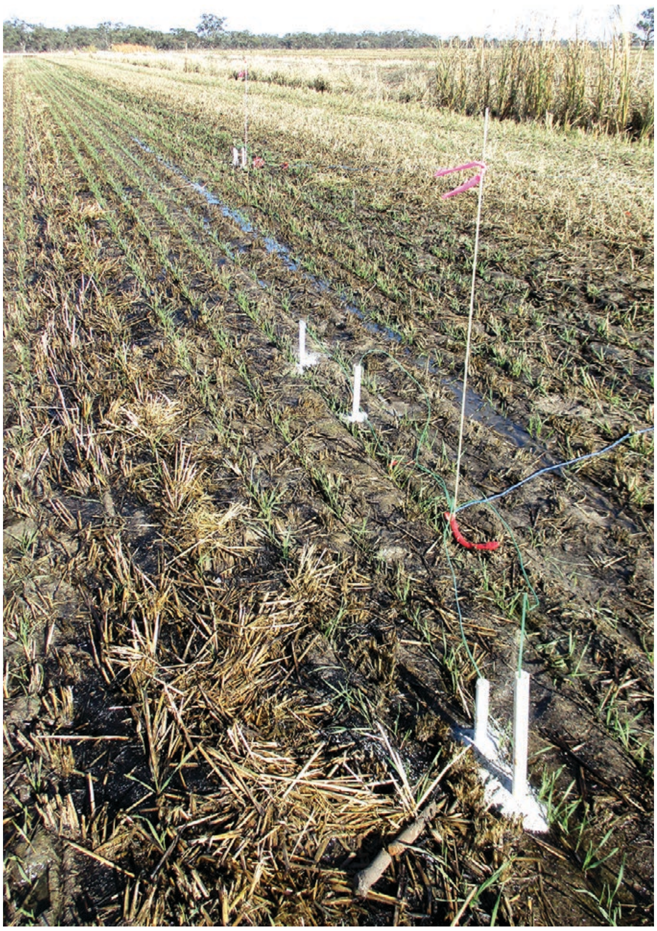
To determine if yield increases are realistically achievable, and what factors might be behind 'lower than possible' yields we looked at using “big data” collected from GIS and satellite imagery in the Murray Irrigation Ltd (MIL) area of operations. We were restricted to the MIL districts because digitised soil maps of the MIA are not currently available. Work to include the MIA will be done this coming summer following digitisation of these maps.

We found 145,500 ha of basin (contour) irrigation systems in the MIL districts that are currently used to irrigate crops, and we categorised this area based on surface drainage and internal soil drainage. Using Landsat NDVI imagery taken in late August/early September, we estimated the mid-season biomass of wheat sown after rice in 2013 and 2014 and compared the NDVI readings with header grain yield from paddocks we knew had not been water-stressed in spring. This allowed us to estimate the potential (non-water limited) yield of wheat sown after rice across the MIL districts categorised according to surface drainage and soil type.

Assuming that 80th percentile yields are achievable through better crop management, then the results of this analysis (Table 2) can be summarised as follows.

On soils with **better internal drainage** (i.e. red-brown earths, transitional red-brown earths and self-mulching clays):

- landforming to improve surface drainage will lift wheat yields by around 1.2 t/ha
- better crop management can increase wheat yields by 2–3 t/ha in landformed bays
- improving crop management in combination with landforming will produce the greatest yield increases of 3–5 t/ha.



Waterlogging following surface irrigation and large rainfall events is a major cause of sub-optimal yield for crops on heavy clay soils.

Table 1. Expected and ‘best ever’ yields of a range of crops grown in the irrigation areas of the southern Murray–Darling Basin based on the average of 100 responses to a survey of growers.

	Rice (t/ha)	Cotton (bales/ha)	Soybeans (t/ha)	Wheat (t/ha)	Barley (t/ha)	Canola (t/ha)	Faba beans (t/ha)	Chick pea (t/ha)
Expected yield (t/ha)	10.1	10.1	3.1	4.7	4.0	2.3	3.9	2.5
‘Best ever’ yield (t/ha)	12.1	12.8	3.9	6.6	5.9	3.1	4.6	3.4
Yield gap (t/ha)	**2.0**	**2.6**	**0.9**	**1.9**	**1.8**	**0.7**	**0.8**	**0.9**
Total no. responses	*46*	*9*	*16*	*78*	*47*	*53*	*14*	*3*

Table 2. Potential yield (median and 80th percentile) and yield gap for estimated areas of the Murray Irrigation area planted to wheat in rice layouts in 2013 and 2014.

	Surface drainage	Bay	Bay	Bay	Contour	Contour	Contour
	Internal soil drainage	Fair	Poor	V. poor	Fair	Poor	V. poor
2013	Median yield (t/ha)	3.5	3.5	3.2	2.9	2.3	2.8
	80th percentile yield (t/ha)	5.8	5.5	4.2	4.1	3.1	3.8
	Yield gap (t/ha)	**2.2**	**1.9**	**1.1**	**1.1**	**0.8**	**1.1**
2014	Median yield (t/ha)	3.6	3.6	2.4	2.3	2.1	2.2
	80th percentile yield (t/ha)	7.0	7.0	3.2	2.9	2.5	2.8
	Yield gap (t/ha)	**3.4**	**3.4**	**0.9**	**0.6**	**0.4**	**0.6**

On soils with **very poor internal drainage** (i.e. non self-mulching clays):

- landforming to improve surface drainage will lift wheat yields by only 0.4 t/ha
- better crop management only results in appreciably better yields if paddocks are not subjected to waterlogging (e.g. 0.5 t/ha in 2014 when autumn was wet, compared to 1.0 t/ha in 2013 when autumn was dry)
- solutions to improve productivity are being investigated.

If the yield of wheat sown straight after rice can be lifted from the current median to the 80th percentile (Table 2), then there is the potential to increase wheat production in the MIL districts by 20,000–30,000 tonnes per annum ($4–6 million p.a. at $200/t).

If all the area under rice in the MIL districts was sown to wheat straight after rice harvest, and 80th percentile yields were achieved, then an additional 128,000–138,000 tonnes of wheat would be produced ($26–28 million p.a. at $200/t).

Caution is needed as these figures are based on a "potential" yield estimated from NDVI and don't take into account the rice area sown to wheat after a fallow. It also omits border check and sprinkler systems and doesn't include the irrigated cropping areas of northern Victoria and the Murrumbidgee Valley. Despite this, it is the first time we have estimated wheat crop production across an irrigation district using objective data. This has allowed us to identify and prioritise RD&E areas, estimate the potential returns from that investment, and provided a method by which we might monitor our progress.

Major constraints to increased productivity

A review of the literature, focus group discussions with irrigators, monitoring of commercial crops, and soil testing on 12 farms in RIRDC's precision agriculture project revealed four major management factors that are limiting winter crop yields:

- waterlogging
- late season water stress
- under-fertilisation, particularly of crops sown after rice harvest
- low pH in rice soils.

These factors are discussed in detail in the next article of this edition of the *Farmers' Newsletter.*

What can we recommend?

There are existing technologies that can minimise and help overcome the identified yield-limiting factors. But before doing anything, your first action should be to investigate the issue to determine what the problem really is. Keeping records and seeking advice will help in this task.

For **very poor soils** in **good layouts**, the following principles should be applied to ameliorating degraded soils:

- monitor soil chemistry:
  - plan to lime when soil pH is less than 5.2
  - apply gypsum to sodic and dispersive soils
- for structurally degraded soils:
  - de-compact any hard set layer
  - preserve desirable structure and prevent re-consolidation
  - increase biological activity.

For **all cropping soils** in **good layouts**, adopt the following best management practices:

- sow on time, and sow and fertilise at rates appropriate for the water available to the crop
- schedule irrigations, and get water on and off bays in 10 hours or less
- promote good soil physical health by retaining stubbles, minimising cultivation and controlling traffic.

Improve **poorly drained layouts** so irrigation water is on and off bays in 10 hours or less by:

- applying published design criteria for basin and border check systems
- improving drainage, particularly for paddocks flatter than 1:1000 (beds/hills, individual supply and drainage to basins).

Opportunities & needs for further RD&E

The work conducted to assess achievable yields within different layouts and on different soil types clearly showed the greatest potential increases to productivity will come from:

1. improving yield of non-rice crops on non-self mulching clays
2. increasing the area and yields of wheat sown directly after rice harvest.

Soil monitoring and plant measurements in a number of wheat trials have shown diversity in the response of current wheat breeding lines to waterlogging. This opens up the possibility of selecting varieties that are better suited to our heavy rice soils. Additionally, we are investigating existing technologies such as higher fertiliser rates, soil amendments and subsoil manuring to assess their effectiveness in lifting yields in problem soils.

Our review of the literature, however, identified two soil-related issues that are limiting or threatening to irrigation productivity:

1. the effect of alternately saturated (reduced) and aerated (oxidised) conditions on the productivity of non-rice crops in the rice farming system
2. the instability of surface irrigated soils subjected to repeated cycles of rapid wetting and drying and the need for practical and cost effective solutions.

Unfortunately, investigation of these two issues is outside the scope of the current project.

Acknowledgements

Thanks to Murray Irrigation Limited and staff for sharing and allowing us the use of their GIS soils and rice area data, and to the NSW DPI Southern Cropping unit for access to their trial sites.

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MAJOR CONSTRAINTS TO INCREASED PRODUCTIVITY

Sam North

Research Hydrologist, Department of Primary Industries, Deniliquin

QUICK TAKE

- Four management factors that are limiting irrigated winter crop yields, particularly in rice layouts, have been identified in a new GRDC funded project:
  - waterlogging
  - late season water stress
  - under-fertilisation, particularly of crops sown after rice harvest
  - low pH in rice soils.

In the Murray Irrigation districts alone, lifting wheat yields in crops sown after rice harvest from the current median to the 80th percentile could result in an additional 20,000 to 30,000 tonnes of grain per annum ($4–6 million at $200/t).

The findings of initial investigations of a new project, see pages 30–32 of this edition of the *Farmers' Newsletter*, identified four major management factors that limit winter crop yields:

- waterlogging
- late season water stress
- under-fertilisation, particularly of crops sown after rice harvest
- low pH in rice soils.

Waterlogging

Waterlogging following surface irrigation and large rainfall events is a major cause of sub-optimal yield for crops on heavy clay soils.

Soil water monitoring in commercial wheat crops in 2014 showed that contour and border check systems experienced a period of waterlogging of 1–3 weeks following irrigation and then rain in early September. A number of co-operators also reported very wet conditions following sowing.

In the 15 crops monitored, eight experienced significant waterlogging. Yield was affected in four of these paddocks, all of which had either poor surface drainage or were on non-self mulching clays with poor internal drainage, or had both. One crop was waterlogged early and grew out of it (circled green in Figure 1), and post-irrigation waterlogging did not affect yield where crops were only irrigated once in spring (circled blue in Figure 1). One crop was affected by both waterlogging and water stress (circled red in Figure 1).

Waterlogging has been identified as a major constraint to productivity in surface irrigated systems in the GRDC Southern Region, particularly for winter crops in basin (rice) layouts. However, only 8% of respondents to an on-line survey considered waterlogging to be a major/severe constraint to productivity. This difference in perception may be due to a number of reasons: regional watertables fell with the onset of drought in 2002; the majority of surface layouts have been landformed; farmers may attribute lower yields to "low fertility" rather than to characteristics

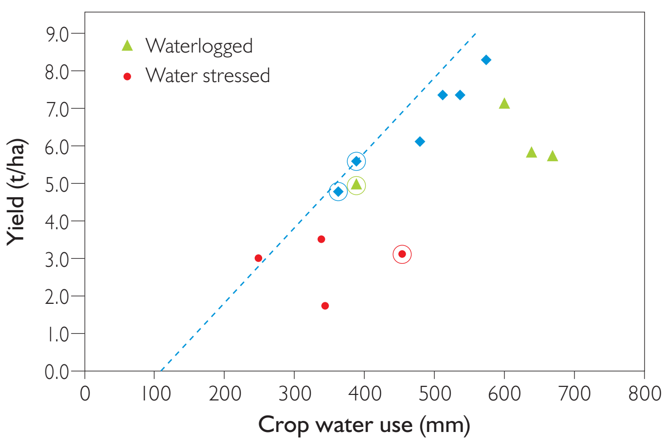

***Figure 1**. Yield and estimated crop water use of 15 commercial wheat crops monitored in 2014. The dashed line indicates a water use efficiency of 20 kg/ha/mm after allowing 110 mm for soil evaporation.*

which make some soils prone to waterlogging and anoxia; and the incidence of waterlogging is event driven, so lower yields may be attributed to a "poor season".

The low recognition of waterlogging as an issue for non-rice crops, together with the importance of rice in southern NSW irrigated systems, has seen many new layouts in the rice growing areas of southern NSW being graded flat. This is despite a general understanding throughout the irrigated areas and districts of the southern Murray–Darling Basin of the need for a minimum slope of 1:2000 on bays to ensure winter drainage (this doesn't apply to beds in bays). Further north, the cotton industry promotes a minimum slope of 1:1500.

It appears there is a need to raise awareness of the effect of waterlogging on irrigated productivity and profitability. It is important to have good surface drainage so that irrigation water is on and off bays in less than 10 hours. On soils with very poor internal drainage (i.e. sodic, non-self mulching clays), improving surface drainage alone will not be enough. Cost effective solutions are needed to improve the physical characteristics of these soils.

Late season water stress

Insufficient water severely restricted the yields of four of the crops monitored in 2014 (Figure 1). Water use efficiency was good in two of these crops, but very poor in the others because of either late sowing or waterlogging.

This is an issue we are yet to fully investigate. We aim to quantify the impact of late season water stress by matching time series satellite imagery (NDVI) with header yield monitor data. However, we need more data to finish this task.

Under-fertilisation of crops after rice

Warren Muirhead and Ian Willett investigated 'rice stubble disorder' at CSIRO Griffith in the mid-80s and found it was caused by phosphorus tie-up on iron oxide crystals, which formed when soils re-oxidised following rice drainage.

Nitrate nitrogen is also lost as nitrogen gas because of the reduced conditions in the soil under rice. Consequently, little/no nitrate nitrogen is available after rice until the soil has re-oxidised and mineralisation of the organic nitrogen pool makes nitrate nitrogen available.

To maximise yields from the water available in the soil after rice, it is important to band phosphorus at sowing and split nitrogen applications, with the topdressing at first node particularly important.

Recommended rates of phosphorus and nitrogen for crops sown after rice and for a range of spring watering scenarios were published in this publication (Autumn 2006, No. 186). However, many farmers interviewed in the group discussions indicated they applied fertiliser at rates well below the recommended levels. This was particularly the case in the Murray Valley and can be explained by the results from the initial scoping study (pages 30–32 of this edition). Namely, a high risk of scalding and a poor yield response to fertiliser from crops growing on poorly drained soils is unlikely to encourage irrigators to apply higher rates of fertiliser.

Our data shows that landforming to improve surface drainage may not be enough to overcome the physical limitations of non-self mulching clays in order to get a good return from an investment in fertiliser.

Irrigators willing to share yield monitor data and/or digitised EM and cut/fill maps are encouraged to get in touch with Sam North (03 5881 9926) at Deniliquin or John Hornbuckle (02 6960 1583) at Griffith.

Low pH in rice soils

As soils become more acidic, aluminium becomes more soluble and becomes toxic at levels greater than 5%. This happens in some Riverine plains soils when $pH_{(CaCl_2)}$ less than 5.2, but applies generally when $pH_{(CaCl_2)}$ less than 4.8.

Eighteen out of the 33 sites sampled in the RIRDC Precision Rice project had $pH_{(CaCl_2)}$ less than 4.8. This is a greater proportion of sites with problem acidity than was observed in previous surveys of soil pH — at Coleambally in the late 1980s, across all rice soils in 2000–01, and in rice soils in the MIL districts in 2002–03.

Rice growing leaches cations (calcium, magnesium, sodium, potassium) from the soil and they are also removed in grain and straw. Failure to replace these cations results in hydrogen ions dominating the soil structure (exchange complex) and acidifying the soil. This may also be symptomatic of the breakdown of clay minerals under repeated flooded and drained conditions, (as occurs with rice) in a process called ferrolysis which can reduce cation exchange capacity and result in a structureless, low fertility soil.

The message about the risk of soil acidity, particularly in rice soils, should be very clear — ***monitor pH and apply lime to keep*** ***$pH_{(CaCl_2)}$ greater than 5.2 (don't wait for it to drop below 4.8)***.

Further information

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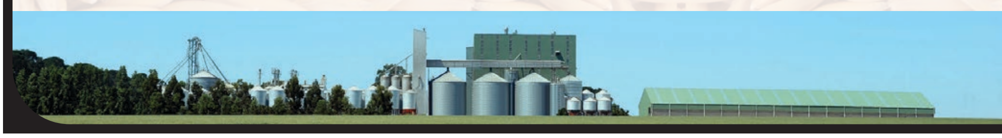

SOUTHERN IRRIGATED CROPS PROJECT UPDATE

Tony Napier, Deb Slinger, Luke Gaynor, Neroli Graham & Cynthia Podmore

NSW Department of Primary Industries

QUICK TAKE

- Results from the first season's trials show that varietal selection and crop management both have a significant effect on irrigated cereal and canola production potential.
- First season's results for the Murrumbidgee area were published in the previous edition of the *Farmers' Newsletter* (No. 192 Autumn 2015).
- The second seasons' irrigated cereal and canola trials have been sown and will be on show for the 2015 spring field day season.

The Southern irrigated cereal and canola varieties achieving target yields *project has already proven to be a very valuable investment of research funds. Growers and advisers now have access to the first year's data that identifies high yielding varieties and management practices that maximise production potential.*

The extensive project covers six research nodes (nine locations) in the southern GRDC region, across New South Wales, Victoria, South Australia and Tasmania. Each research node is comparing the effect of different variety and agronomic management (e.g. sowing time, plant population and nitrogen management) on grain yield, grain quality and other factors, including lodging. The research questions being evaluated differ in each location based on each region's needs; and the questions were originally identified through grower and advisor surveys. The treatments are adapted each season based on previous results and feedback from growers and advisors (Table 1).

The third and final year of trials will be in the 2016 winter cropping season. In 2017, an irrigated wheat manual and an irrigated canola manual will be published, along with variety specific agronomic packages (VSAPs) for each trial node.

Field days

Spring field days will be held at each of the trial nodes/locations where growers and advisors can view trial progress and discuss outcomes from the previous year's trials. For field day details, not finalised at the time of writing, please contact the trial manager in your area (Table 2).

Acknowledgements

This research is part of the Southern Irrigated Cereal and Canola Varieties Achieving Target Yields *project (DAN00198; 2014–17) which is co-funded by GRDC and NSW Department of Primary Industries.*

Further information

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Canola trial at Coleambally (4 June 2015)

Table 1. Research nodes and the treatments evaluated in trials during the 2015 winter growing season

Node and location	Crop management treatment	
	Cereal	Canola
Murrumbidgee – Leeton	wheat variety plant population nitrogen management time of sowing irrigation frequency	variety plant population time of sowing
Murrumbidgee – Coleambally	wheat variety plant population nitrogen management	variety nitrogen management
Murray Valley – Deniliquin	wheat variety time of sowing nitrogen management	
Murray Valley – Finley	wheat variety time of sowing nitrogen management	variety time of sowing plant population
North-west Victoria – Kerang	wheat variety plant population plant growth regulator barley variety durum variety milling oats variety time of sowing	variety plant growth regulator soil ameliorant
Lachlan – Hillston	wheat variety time of sowing nitrogen management	variety nitrogen management
Lachlan – Condobolin	variety nitrogen management	variety population nitrogen management
South-east South Australia – Bool Lagoon	wheat variety time of sowing nitrogen management grazing	variety time of sowing nitrogen management grazing
Tasmania – Cressy	wheat variety fungicides	variety grazing nitrogen management sowing rate nutrition fungicides

Table 2. Field day locations and trial manager contact details

Node and location	Trial manager	Email
Murrumbidgee – Leeton and Coleambally	Tony Napier	tony.napier@dpi.nsw.gov.au
Murray Valley – Deniliquin and Finley	Tony Napier	tony.napier@dpi.nsw.gov.au
Lachlan – Condobolin	Neil Fettell	nfettell@une.edu.au
Lachlan – Hillston	Rachel Whitworth	rachael@aggrowagronomy.com.au
North-west Victoria – Kerang	Damian Jones	damian.jones@irrigatedcroppingcouncil.com.au
South-east South Australia – Bool Lagoon	Amanda Pearce	amanda.pearce@sa.gov.au
Tasmania – Cressy	Heather Cosgriff	hcosgriff@sfs.org.au

R&D PRIORITIES OF FINLEY RICE GROWERS

John Lacy

Agricultural Consultant, Finley

QUICK TAKE

- Effective identification and communication of research priorities ensures that research is relevant to farmers' needs.
- A report of Finley rice growers' top research priorities was sent to the RIRDC Rice R&D Committee, and feedback is that the priorities raised will influence research decisions.
- New shorter-season and higher-yielding varieties were overwhelmingly the top priority area for future research.
- Establishment, nutrition, weed control, water use and rotations were moderately rated as research priorities.

Relevant research in farming requires farmers to effectively communicate their priorities for research, development and extension (RD&E) to the committees and organisations that manage RD&E.

Recognising the importance of rice farmers' identifying and communicating their research priorities to the RIRDC Rice R&D Committee, the Finley Discussion Groups nominated their top research priorities during the 2014–15 rice season.

At the November establishment and December PI meetings, farmers were requested to nominate their top three priorities for research, development and extension relevant to rice growing. Each priority was written on a card.

Off the cuff answers were reduced by informing farmers of the exercise by email a few days prior to the meeting. This gave farmers the time to think about their priorities. The cards were sorted under subject headings (e.g. varieties, establishment, nutrition, etc).

The farmers were then asked to tick the three highest priority cards from all the displayed cards. All issues that received two or more ticks are shown in Table 1. In addition to the issues shown in Table 1, there were many issues raised that were ticked once or not ticked in the second stage of the process. These non-ticked priorities are not included with this article but are available from the author.

The results of the process were collated and a report sent to RIRDC Rice R&D Committee members. There has been feedback that the priorities raised will influence research decisions.

Top priorities

Overwhelmingly, the top research priority for growers was the development of new shorter-season and higher-yielding varieties.

Several issues — establishment, nutrition, weed control, water use, rotations and pests — were moderately rated as RD&E priorities.

Further information

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The Finley Discussion Groups identified their research, development and extension priorities during the 2014–15 rice season and submitted a report of the top priorities to the RIRDC Rice R&D Committee.

Table 1. The key areas and issues that Finley rice growers regard as RD&E priorities for rice growing

Subject area	Total ticks	Issues within subject area receiving two or more ticks	# ticks
Variety	49	shorter growing season	12
		higher yielding	12
		cold tolerance	9
		seedling vigour	5
		higher whole grain millouts	3
		growth regulators for Koshihikari	3
		higher yield, short season and lower water use varieties	3
		disease resistance (blast)	2
Establishment	16	establishment	7
		improve establishment technique (all sowing methods)	3
		time lapse camera on rice over first 21 days to assess what happens to the seeds	2
Nutrition	11	trace element requirements	4
		fertiliser trials (other than nitrogen) to reduce crop variability within bays	2
		fertiliser placement starter and urea/depth	2
Weeds	11	cheaper and more effective chemicals	6
		residual dirty Dora control	2
		application methods	2
Water use	10	decrease water use/increase efficiency	8
		system trials to get best gross margin per ML	2
Rotations	9	double cropping in rice systems	5
		allow other soil types for rice in the rotation for winter crop herbicide resistance	2
		rotations	2
Pests	8	better snail control	6
		new chemicals	2
Costs	4	decrease costs/ha	4
Precision agriculture	2	water depth yield effects	2

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