Irrigation Research & Extension Committee

FARMERS' NEWSLETTER

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In this edition

Irrigation Research & Extension Committee

Administration & Advertising

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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, Spring 2017, to the editor by 1 July, 2017.

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Cover: Irrigators from southern NSW and northern Victoria on tour in northern NSW. PHOTO: Lou Gall, Gwydir Valley Irrigators Association

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Chairman's foreword

Welcome to the *Farmers' Newsletter,* the third in the new digital format. We hope this edition, and IREC's coming events, help you prepare for the winter crop season.

A VERY wet winter in 2016 has presented many challenges in setting up and establishing summer crops for 2017. However, it also has delivered 100% allocation in both the Murray and Murrumbidgee valleys, which is very welcome. With storage dams at reasonable levels for this time of year we can expect a better than average start-up allocation for the 2017–18 crop year. So the ball is firmly in our court to make sound decisions around how we best use this water to maintain a profitable business and have some cash left over to improve our asset base.

There are many ways to improve our irrigation farming systems. The new layout and automated supply system at the IREC Field Station is a great showcase of what is possible to improve our surface irrigation system, providing better crop conditions and a range of lifestyle benefits. The next stage of development is a fully automated recirculation system that will complement the existing automated supply system.

If you haven't had a chance to visit the field station I urge you to do so. It is there to benefit all members. I would like to take this opportunity to thank our sponsors for this project, the Cotton Research & Development Corporation (CRDC), Cotton Seed Distributors (CSD) and Riverina Local Land Services (RLLS) for their ongoing support.

Murrumbidgee Irrigation is busy putting a case study together looking at the possibility of automating some or all of Division 3 Yanco, which supplies the IREC Field Station. This project should get underway this winter, which is an exciting prospect for all of us in the MIA.

IREC is planning a Drone and Technology Day coming up in June 2017. There will be a range of cutting-edge technologies on display from Deakin University, with a close look at the use of drones in our irrigated farming systems. Drone technology is being used on farm now with huge potential for many other applications into the future.

You can read all about the Drone and Technology Day on page 10. Please check the IREC website for details and make sure you book this day in.

IREC recently conducted a three-day bus trip to the Gwydir Valley to attend, amongst other things, the Gwydir Valley Irrigators Association annual research field day. We had a close look at row spacings in cotton, saw the 'smart siphon' in action, and toured Stahmann Farms' pecan nut farm. We learnt a lot from our northern friends and from each other, with some good guest speakers in the evening and plenty of banter on the bus. Thanks everyone who joined this tour. You can read more about the tour on page 6.

Thanks to everyone who gave up their time to participate in the IREC breakfast meetings in February. These meetings are invaluable to IREC and our RDCs, who rely on farmer input for future research ideas and investment. When all the information is collated we will keep you informed of any developments. Until then you can read about the priorities raised from each of the meetings on page 40.

I hope you enjoy this edition of the *Farmers' Newsletter*. Any feedback on the digital format of this magazine would be welcomed.

Regards,

Robert Houghton

A pecan farm was one of several interesting sites visited in northern NSW by a group of irrigators from southern NSW and northern Victoria. PHOTO: Lou Gall.

EXPOSURE TO NORTHERN IRRIGATION RESEARCH AND FARMS

QUICK TAKE

- A group of southern irrigators visited farms, research stations and field days in northern NSW to see new and different approaches to irrigation systems and management.
- The group learnt about research investigating the use of continuous canopy temperature measurement as a basis for scheduling irrigation management of cotton.
- Row spacing research showed benefits with the 60-inch spacings in water-limited years, however productivity was more consistent with narrower row spacings in years of ample water.
- Automated siphons were showcased, and design and management tricks to streamline this relatively new irrigation system were shared.

The *Maximising Irrigation Profitability* or 'Max' project provided southern irrigators with an opportunity to see how their counterparts in northern New South Wales manage water.

Iva Quarisa
Executive Officer, IREC

IN early February a group of irrigators from the Goulburn, Murray and Murrumbidgee valleys took a three-day road trip to Moree in the Gwydir Valley. The tour was a component of the *Maximising Irrigation Profitability* project, which is part of the federally-funded Rural R&D for Profit program from the larger, overarching *Smarter Irrigation for Profit* project.

Responsive irrigation management

The first official stop on the tour was the Australian Cotton Research Institute. CSIRO researchers Drs Hiz Jamali and Rose Brodrick spoke to the group about their Cotton Research & Development Corporation (CRDC) funded project *Irrigation Cotton Agronomy for Tailored and Responsive Management with Limited Water*. This project is another of the suite of projects funded under the *Smarter Irrigation for Profit* project.

The aim of this three-year project is to provide growers with strategies to confidently schedule irrigations to optimise water use and yield of cotton crops.

The project is investigating a plant-based irrigation scheduling method that uses continuous measurement of canopy temperature to monitor water stress in cotton. Using a plant-based method is advantageous as plants respond to both their soil and aerial environment. Using canopy temperature sensors means the information is not dependent on the influence of different soils or soil structures.

Results from previous project sites across NSW and Queensland since 2008 show a strong correlation between cotton yield and canopy temperature. This research is working towards using canopy temperature sensors in water-limited situations.

Optimised row configuration

One highlight of the tour was attending the Gwydir Valley Irrigators Association annual research field day. One of the project sites visited as part of the field day was the *Optimised Row Configuration* trial at Auscott Midkin. This is an extension to a trial conducted over the 2014–15 and 2015–16 seasons.

The trial is investigating the relative yield potential and water use efficiency of three row configurations: 30 inch, 40 inch and 60 inch.

The researchers have found that establishment in 60-inch rows is more difficult than in narrower rows, as getting water to the centre of the beds is problematic. The 60-inch row spacing is more advantageous in water-limited years and has good water use efficiency. Along with the 30-inch spacing, the 60-inch spacing has the added advantage of fitting in with the three-metre wheel spacing typical of broadacre farming in the region.

In abundant water situations, the narrower row spacings (30 and 40 inches) have a more consistent water use efficiency and much better yields than the 60-inch spacing, with 40 inch yielding 15 bales/ha while 60 inch yielded 13.3 bales/ha, in the 2015–16 season.

Research in the Gwydir Valley comparing row configurations of 30, 40 and 60 inches for cotton production.

Automated siphons

The second site of the GVIA field day was *Red Mill* to see how Islex Smart Siphons work as part of the *Investigation of Siphon Automation Options* project. This system of siphon management is new technology that has great potential to save labour.

At *Red Mill* the Islex Smart Siphon system has a 75 mm straight pipe drilled through the supply channel bank to feed a furrow. Up to 100–150 pipes are linked by a cable back to the winch controller.

At the supply end of the siphon there is a 90 degree elbow with a riser pipe. To start the flow the Smart Siphon rotates at the elbow, lowering the pipe end into the water. To stop the flow a winch controller rotates the elbow to raise the pipe out of the water.

The main issues with this system have been trash getting caught in the elbow and the rota bucks being eroded away after a few irrigations due to the velocity of the water. A new prototype has been designed to address the issues identified this season.

Both the optimised row configuration and automated siphons projects, as well as the GVIA annual research field day, are funded through the *Smarter Irrigation for Profit* project (under Rural R&D for Profit program) and the Cotton Research and Development Corporation.

Siphon automation is being investigated at *Red Mill* to determine benefits of labour saving and to see if water efficiency is maintained or even improved.

Broadacre nuts

The next stop of the tour was to the impressive pecan farm of *Trawalla*, where the 20-metre tall pecan trees provided a cool reprieve from the scorching Moree heat.

Trawalla is the flagship property for the operations of Stahmann Farms. The 700-hectare pecan orchard east of Moree was started by Deane Stahmann Jnr not long after he came to Australia from the United States in 1965.

Deane found the varieties of Wichita and Western Schley produced the best yields and quality.

Cross-pollinating rows are planted throughout the orchard, which has 10x10 m plant spacing. Flowering occurs in September, with nuts fully formed by February.

The whole orchard was originally set up to be flood irrigated down the inter-row, with water use at 10–12 ML/ha. Over the past few years, the team at Stahmann Farms has been working to convert the farm to subsurface drip irrigation (two drip lines per row at 20–30 cm deep), and 40% of the farm is converted so far. This has seen water use fall to 5–6 ML/ha.

Stahmann Farms wants to keep trees at a height of 12–20 m and to achieve this they have a pruning rotation, where trees will be pruned on one side every year. This way, the trees will not suffer a yield decrease. Across the river the company's new property has 120 ha of pecans planted at 10x5 m spacing. At this narrower plant spacing, trees will be kept to 8 m tall. A further 140 ha will be planted this coming autumn.

Pecans are biennial yielders, so yield varies from year to year. In the off-year Stahmann Farms harvests between 1500 and 1700 tonnes of nuts, this increases to 2200–2500 tonnes in the on-year.

As pecans have staggered ripening, pecan harvest is made up of two rounds of shaking. The first shake starts late April and is finished by mid-May. After the trees lose their leaves and the remaining nuts have ripened, the second shake occurs in June–July.

At harvest, the nuts are shaken from the trees onto the ground, swept into windrows and then collected into bins. The nuts are de-husked on farm at Moree, and then shipped and cool-stored at Stahmann Farms' Toowoomba plant where they are shelled and packed as required.

Hi-tech handling for high quality grain

On our return home, on day three of the trip, we made an impromptu visit to Phillip and Natalie Christie's property *Ellematta* located near Bellata, south of Moree.

Phil and Natalie run a dryland and irrigation enterprise growing cotton, wheat, chickpeas and faba beans, along with some livestock. Nine years ago the Christies set up a grain-handling business.

The state of the art grain business includes weighbridge, 25,000 tonnes of sealed storage and computer controlled grain moving equipment. All of this allows the Christies to blend grain to obtain ideal moisture content, protein levels, screenings and test weights, all in a safe and efficient way.

Grains handled through the system include wheat, chickpeas, faba beans and occasionally sorghum. The Christies cater specifically for the overseas container market and export to countries sourcing high-quality grains.

More automated siphons

The final site visited was Steve Carolan's Wee Waa property, *Waverley*. Steve and his farm manager Andrew Greste operate 6500 ha of crops, both irrigated and dryland, growing cotton, wheat, faba beans and chickpeas.

Andrew showed us the automated siphon system installed at *Waverley*. The siphons are actually 4 m long, 75 mm straight pipes, installed through the bank of the field supply lateral with a laser level to ensure they are all the same height to guarantee uniform water delivery.

The supply lateral is fed by a larger supply channel and is divided into 'bays' that correspond to 150 furrows in the field. Each bay has a weir structure in the supply lateral to hold and deliver water through the siphons to the furrows. Depending on supply volume a number of bays can be opened at the same time if required. With a flow rate of up to 6 L/s per siphon and the 600 m long runs, each bay takes about eight hours to irrigate.

The team at *Waverley* has learnt that to prevent erosion of the rota bucks on the outlet end, the siphons should be installed 200 mm above the furrow water height. The siphons are installed with a reverse grade of 100 mm so they drain back into the supply lateral.

At around $1000/ha (including automation), with no problems of trash blocking the siphons or erosion of the rota bucks, *Waverley* management is converting another 1600 ha to this system.

Benefits of getting out and about

There is always something to be learnt from others, and this trip was no different. Everybody on the trip learnt something and enjoyed the opportunity to talk with other irrigators, share farming experiences and see how it's done in the north.

Many irrigators are very interested in automating their surface irrigation layouts, thus there was tremendous interest in the two automated siphon systems at *Waverly* and *Red Mill*. Most people saw the potential of the siphon through the bank system at *Waverley*. One attendee is intending to set up two trial sites for next season to understand which systems work best in their farming operation. One site will install the *Waverley* siphon system while the other will trial the larger pipe through the bank/pontoon supply system.

Grain-handling facilities at *Ellematta*, for the supply of high-quality grain, including wheat, chickpeas and faba beans, for the overseas container market.

The automated siphon system developed at *Waverley* is proving successful and a significant area of the property is being converted to the system.

Some of the other lessons learned from the trip included:

- row spacing (30 inch versus 40 inch) doesn't make much of a difference
- 'pipe through the bank' is a viable option with the right soil types
- the need to improve controlled trafficking to prevent compaction
- we know we are on the right track with irrigation on our soils with the bankless channel system.

Another trip is planned for 2018 to attend the Keytah field day and visit Cubbie Station in southern Queensland.

Further information

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The current and potential uses of drones on farm will be highlighted at the Drone and Technology Day in Griffith, in June 2017.

HONING IN ON INNOVATION TO LIFT YIELD AND PROFIT

EVENT SNAPSHOT

What	2017 Drone & Technology Day
Theme	Smart Ag
When	Thursday, 29 June 2017
Where	Griffith, NSW
Topics	Practical use of drones on farm
	Potential of virtual reality technology
	Robotics in farming operations
	Lab on a chip – testing for disease
	Software technology innovation

A *Drone and Technology Day* will bring Murrumbidgee growers a different perspective to on-farm operations, highlighting new ways to raise productivity and profitability.

Lynsey Reilly[1] and John Hornbuckle[2]
[1]Lynsey Reilly Communications, [2]Deakin University

THE one-day event will focus on cutting edge technologies with real-world case studies and applications, across crops and issues, and how they impact on improving productivity and returns. Held in Griffith, NSW on Thursday, 29 June 2017, the interactive agenda will feature evidence and insights of the various technologies and explore how they can be used in your farming business, rather than focusing on the pure theory behind them.

A range of technologies will be featured throughout the day.

The cross-commodity event is a collaboration between IREC, Deakin University and Murrumbidgee Landcare Inc. It is designed as a forum to share new knowledge on drones and technology with irrigators, industry, researchers, educators, agencies and government.

Learn from the experts

The event's keynote speaker, John Sulik, is a remote sensing applications specialist. Hailing from Seattle, USA, John will travel to the Riverina to discuss practical ways to use drones on farm. Dr John Hornbuckle from Deakin University will present case studies that show how drones are used for disease, weed, water and nitrogen management in a variety of crops, as follows:

- disease – powdery mildew in grapes
- weeds – broadacre cereals
- water – irrigation management in cotton and almonds
- nitrogen – nitrogen management in rice.

Case studies will show how the use of drones and specialised agricultural cameras can be used to monitor nitrogen in crops for variable rate technology (VRT) with examples from both the rice and cotton industries being shown.

A case study showing powdery mildew monitoring and management in grapevines will also feature on the day and as well as disease and nutrient monitoring in almonds. Irrigation management will also feature in the case studies with examples of drones being used across these industries to improve water management.

A mix of technology on the agenda

The aim of the Drone and Technology Day is to provide growers and participants with up-to-date information about innovations that can be integrated into on-farm operations. The day will also place the lens on future research — and consider what's in store for growers in the next decade.

The afternoon agenda will highlight a mix of technology currently being developed by Deakin University and explore how it can be used practically, on farm. These technologies include:

- virtual reality
- software technology innovation
- robotic haptics
- lab on a chip – testing for avian influenza.

Program outline

8-9am	Registration and morning tea in exhibition area
9am – 12pm	Murrumbidgee Landcare Drone conference
12 – 1pm	Lunch in exhibition area
1 – 1.30pm	Deakin University presents Virtual Reality
1.30 – 2pm	Deakin Software Technology Innovation Laboratory
2 – 2.30pm	Deakin University presents Robotic Haptics
2.30 – 3pm	Deakin University presents Lab on a Chip – testing for avian influenza
3 – 4pm	Panel/Workshop Session
4pm	Happy hour and drone giveaway in exhibition area

*Program is subject to change without notice

Registrations

Registrations are now open for the 2017 Drone and Technology Day:

IREC Member: $35.00

Non-member: $70.00

Student: $25.00

Where: Yoogali Club, Griffith, NSW

When: Thursday, 29 June 2017

Further information

Please contact Hayley at IREC if you would like to register, or would like more information:

T: 02 6963 0936

E: irec@irec.org.au

Drone giveaway!

All event participants will have the chance to win a new drone, thanks to Rise Above Custom Drone Solutions. Details on how to enter will be explained at registration on the morning of the event. Please note that terms and conditions apply.

Irrigation Research & Extension Committee

DEAKIN UNIVERSITY

MURRUMBIDGEE Landcare INCORPORATED

Plant establishment counts at the irrigated canola trial at Leeton Field Station in 2016.

NITROGEN FOR HIGH-YIELDING IRRIGATED CANOLA

QUICK TAKE

- A total of 200 kg N/ha of applied nitrogen resulted in the highest canola grain yield under irrigation.
- Nitrogen application rates above 200 kg N/ha did not increase yield but did reduce oil content and increase crop lodging.
- Nitrogen application rates below 200 kg N/ha reduced yield but did not affect oil content.
- Pioneer® 45Y88 (CL), Nuseed Diamond and Pioneer® 45Y25 (RR) were the best performing varieties with grain yields over 4.0 t/ha.
- Selection of TT varieties resulted in a 15–20% lower grain yield than the highest yielding Clearfield and conventional varieties.

Research in 2016 showed that nitrogen had a significant effect on crop growth and yield of canola; and the optimum application rate when targeting 4.0 t/ha was 200 kg N/ha.

Tony Napier, Cynthia Podmore, Neroli Graham, Luke Gaynor and Deb Slinger
NSW Department of Primary Industries

IRRIGATED canola trials were conducted for a third season in 2016 as part of the *Southern irrigated cereal and canola varieties achieving target yields* project. The target yields project was instigated in response to irrigators identifying the potential to increase production of irrigated cropping systems.

In 2014, the Grains Research and Development Corporation (GRDC) and NSW Department of Primary Industries (NSW DPI) established the $1.2 million co-funded project for three years to address the needs of the southern irrigation region.

The *Southern irrigated cereal and canola achieving target yields* project aims to increase irrigated cereal and canola production by improving grower and adviser knowledge of:

- high yielding cereal and canola varieties for irrigated systems so growers can select the best variety for their location and irrigation system
- specific agronomy management that will improve production and profitability of cereals and canola under irrigated systems (and increase water use efficiency).

The project has been conducted over six nodes (locations) in the southern irrigation regions. The three core research sites are Murrumbidgee (Yanco Agricultural Institute or Leeton Field Station), Murray Valley (Rice Research Australia Pty Ltd, Jerilderie) and north west Victoria (Kerang). The three satellite research locations are Lachlan, south east South Australia and Tasmania.

An irrigated canola experiment was conducted at NSW DPI's Leeton Field Station in 2016 to evaluate the effect of variety and nitrogen interactions on canola grain yield, grain quality (oil content) and crop lodging (tables 1 and 2).

The experiment was conducted on a self-mulching grey clay soil with barley as the previous crop.

The plots were sown into dry soil on 18 April 2016 and irrigated up the following day.

The plant population target was 40 plants/m^2 but all varieties established better than expected and the average plant population was just over 50 plants/m^2.

The experiment was harvested on 26 November 2016 using a small plot header.

There was a total of 567 mm of rain from sowing until the end of October, which gave the crop adequate moisture during the growing period. The crop received approximately 6.9 ML/ha of water during the growing season (irrigation in April and in-crop rainfall).

Soil testing showed a starting nitrogen level of 56 kg N/ha and there was an estimated 50 kg N/ha of in-crop mineralisation during the growing season.

Prior to sowing, 150 kg/ha of MAP, 150 kg/ha of Gran-AM and 220 kg/ha of urea (providing a total of 150 kg N/ha) was applied 40 mm deep.

Based on trial results, the optimum nitrogen application rate when targeting 4.0 t/ha of canola was 200 kg N/ha.

Table 1. Canola varieties evaluated in the irrigated canola experiment at Leeton in 2016.

Canola variety evaluated under irrigation, Leeton 2016		
Pioneer® 45Y25 RR	AV-Garnet	Hyola® 575CL
Pioneer® 45Y88 (CL)	ATR-Gem	Hyola® 600RR
Pioneer® 44Y89 (CL)	Nuseed GT-50	Hyola® 559TT
ATR-Bonito	Nuseed Diamond	Victory® V3002

Table 2. Nitrogen treatments evaluated in the irrigated canola experiment at Leeton in 2016.

Treatment	Total applied (kg N/ha)	Pre-sowing fertiliser (kg N/ha)	Urea at visible bud (kg N/ha)
Low	150	150	0
Medium	200	150	50
High	250	150	100
Very high	300	150	150

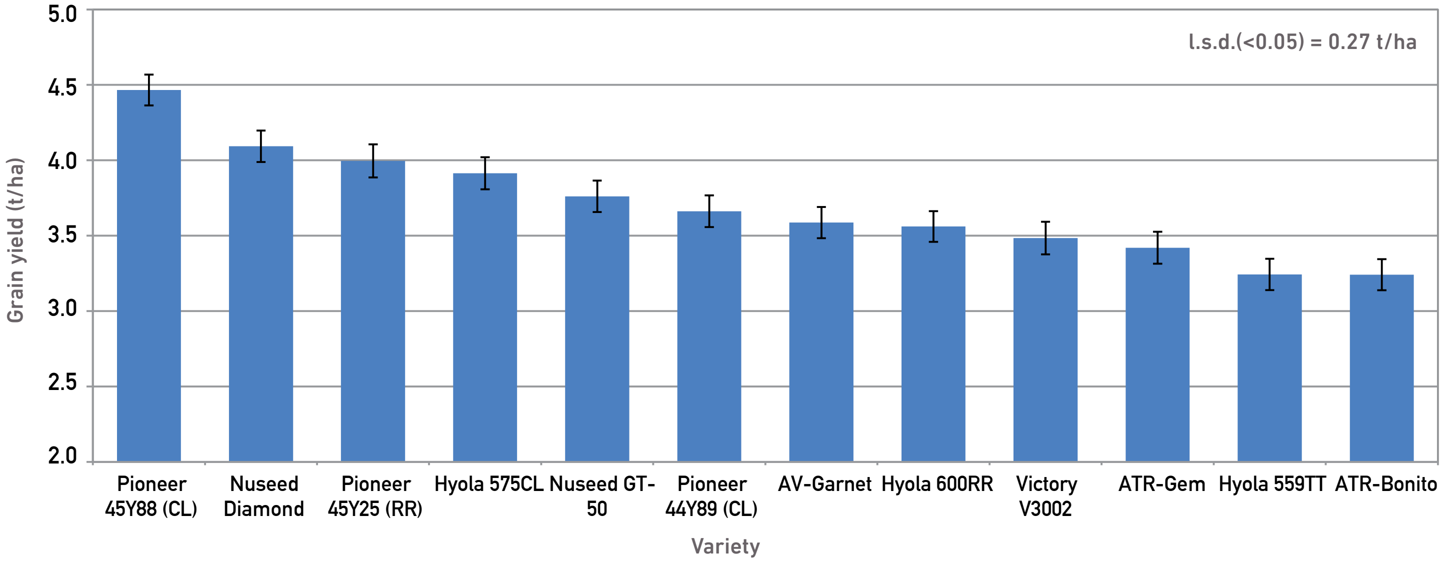

Figure 1. Grain yield of each variety averaged across all nitrogen treatments in the irrigated canola experiment at Leeton in 2016.

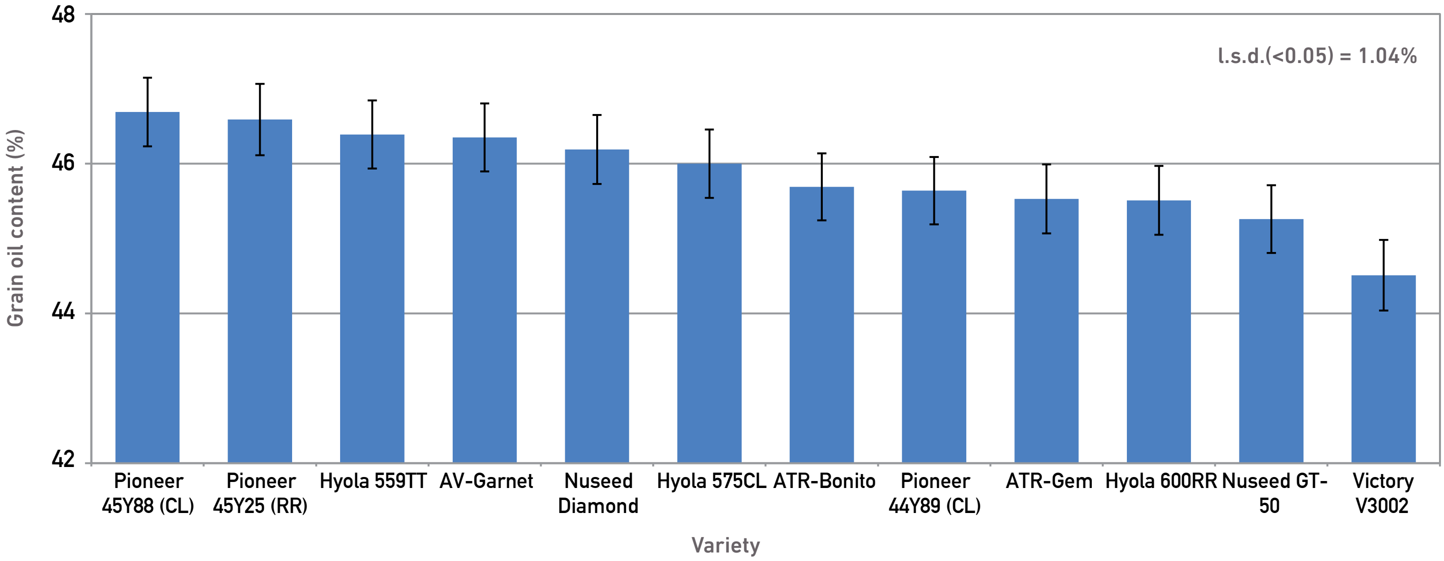

Figure 2. Grain oil content of each variety averaged across all nitrogen treatments in the irrigated canola experiment at Leeton in 2016.

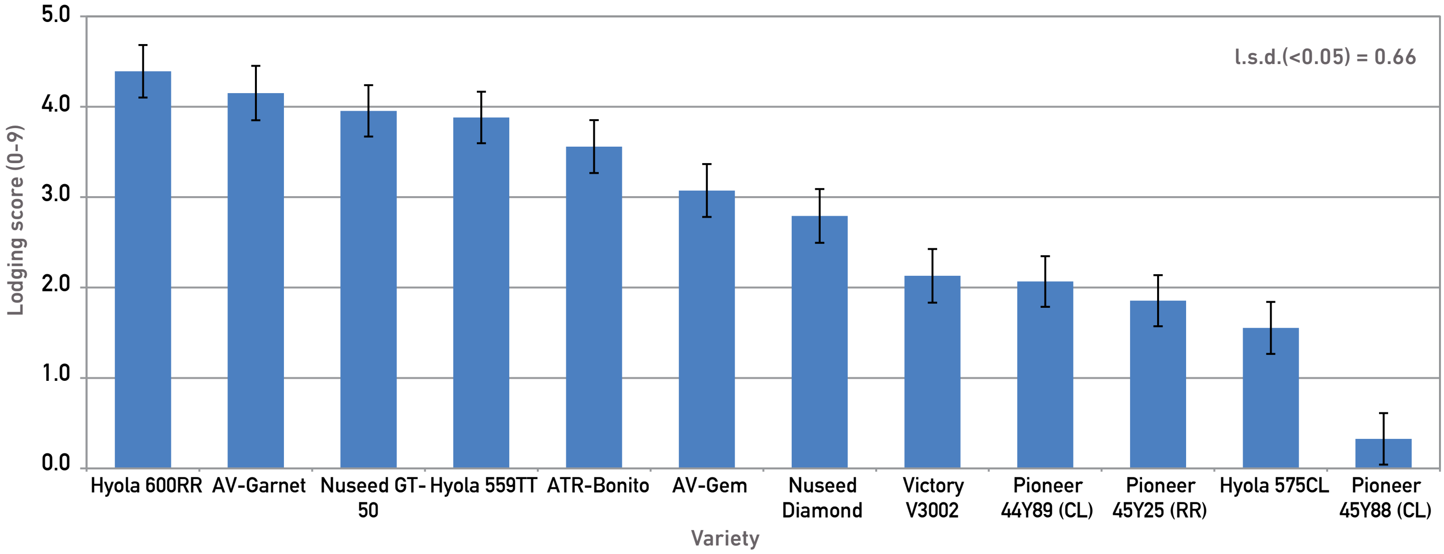

Figure 3. Lodging score of each variety averaged across all nitrogen treatments in the irrigated canola experiment at Leeton in 2016.

The experimental nitrogen treatments (Table 2) included various rates of urea applied at visible buds (as the canola plant begins to elongate before flowering). The topdressed nitrogen treatments were surface applied by hand.

The total nitrogen available varied between treatments and ranged from 150 kg N/ha at the lowest rate to 300 kg N/ha at the highest rate.

Crop performance

Grain yield

Grain yield averaged 3.70 t/ha across all treatments. Pioneer 45Y88 (CL) yielded significantly higher than all other varieties (4.47 t/ha), followed by Nuseed Diamond (4.09 t/ha), which was statistically similar to Pioneer 45Y25 (RR) and Hyola 577CL. ATR-Bonito was the lowest yielding variety (3.24 t/ha) but was statistically similar to Hyola 559TT, ATR-Gem and Victory V3002 (Figure 1).

Oil content

Grain oil content averaged 45.86% across all variety and nitrogen treatments. Pioneer 45Y88 (CL) had the highest oil content (46.69%) but was statistically similar to Pioneer 45Y25 (RR), Hyola 559TT, AV-Garnet, Nuseed Diamond, Hyola 575CL and ATR-Bonito. Victory V3002 had the lowest oil content (44.51%) but was statistically similar to Nuseed GT-50 (Figure 2).

Lodging

Lodging was assessed on 22 November using a scale of 0 to 9, with 0 indicating no lodging and 9 indicating the plants were horizontal. Hyola 600RR had the most severe lodging with an average score of 4.40 but was statistically similar to AV-Garnet, Nuseed GT-50 and Hyola 559TT. Pioneer 45Y88 (CL) had significantly less lodging than all other varieties with a score of 0.33 (Figure 3).

Nitrogen response

The high nitrogen treatment (250 kg N/ha) resulted in the highest average yield (3.85 t/ha) but was statistically similar to the medium (200 kg N/ha) and very high (300 kg N/ha) nitrogen treatments. The low nitrogen treatment (150 kg N/ha) was significantly lower yielding (3.46 t/ha) than all other nitrogen treatments (Table 3).

The low nitrogen treatment gave the highest oil content (46.91%) but was statistically similar to the medium nitrogen treatment. The very high nitrogen treatment was significantly lower in oil content (44.39%) than all other nitrogen treatments (Table 3).

The low nitrogen treatment had significantly less lodging (score of 1.34) than all other nitrogen treatments. The very high nitrogen treatment had significantly more lodging (score of 4.31) than all other nitrogen treatments (Table 3).

Conclusion

The varieties Pioneer 45Y88 (CL), Nuseed Diamond and Pioneer 45Y25 (RR) have high yield potential under irrigation, all yielding over 4.0 t/ha. Nuseed Diamond is a conventional hybrid that has been consistently high yielding in irrigated trials over the last few years. Pioneer 45Y88 (CL) is a Clearfield variety which was added recently to the irrigated canola trials and yielded very well in all 2016 trials. If considering a Roundup ready variety, Pioneer 45Y25 (RR) has also shown high yielding potential. The three TT varieties were the lowest yielding varieties in this experiment suffering a yield penalty of 15–20%.

The higher yielding varieties showed less lodging and higher average oil content than the lower yielding varieties.

Nitrogen treatments had a significant effect on grain yield, grain quality and lodging in this epxeriment. The optimum nitrogen application rate was 200 kg N/ha when targeting 4.0 t/ha. Increasing the nitrogen application rate above 200 kg N/ha did not increase yield but did reduce oil content and increase lodging. Decreasing the nitrogen application rate to 150 kg N/ha decreased yield but did not affect oil content. The lowest nitrogen rate of 150 kg N/ha resulted in the least lodging.

Acknowledgements

This research is part of the *Southern irrigated cereal and canola varieties achieving target yields* project (DAN00198), jointly funded by GRDC and NSW DPI. The support of Daniel Johnston, Glenn Morris, Gabby Napier and Michael Hately for assistance with trial management, field assessments and data collection is gratefully acknowledged.

Further information

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Table 3. Grain yield, oil content and crop lodging response to nitrogen treatments in the irrigated canola experiment at Leeton in 2016.

Treatment	Grain yield (t/ha)	Oil content (%)	Lodging score (0-9)
Low (150 kg N/ha)	3.46 a	46.91 a	1.34 a
Medium (200 kg N/ha)	3.72 b	46.73 a	2.00 b
High (250 kg N/ha)	3.85 b	45.41 b	3.60 c
Very high (300 kg N/ha)	3.79 b	44.39 c	4.31 d
Trial mean	3.70	45.86	1.25
l.s.d. (P<0.05)	0.16	0.60	0.37

Numbers in the same column sharing a common letter are not significantly different.

Irrigated wheat trials at Coleambally in 2016, where the effect of plant population on yield, protein and lodging was investigated.

OPTIMUM PLANT POPULATION FOR IRRIGATED WHEAT

QUICK TAKE

- LongReach Cobra⁽ᴾ⁾ was the stand out variety in 2016 when grown under irrigation with a yield of 9.5 t/ha and protein content of 12%.
- The optimum plant population for irrigated wheat differed between varieties but overall should not exceed 160 plants/m².
- Maximum grain yield can still be achieved at 80 plants/m² for most wheat varieties but varietal response to plant population should be considered when targeting high yields.
- Plant population had a significant effect on grain yield and lodging but no effect on protein content.
- Lodging severity increased as plant population increased.

Plant population had a significant effect on yield and lodging of irrigated wheat, with results showing that optimum plant population was 160 plants/m^2 or less.

Tony Napier, Cynthia Podmore, Neroli Graham, Luke Gaynor and Deb Slinger
NSW Department of Primary Industries

IRRIGATED wheat trials were conducted for a third season in 2016 as part of the *Southern irrigated cereal and canola varieties achieving target yields* project. The target yields project was instigated in response to irrigators identifying the potential to increase production of irrigated cropping systems.

In 2014, the Grains Research and Development Corporation (GRDC) and NSW Department of Primary Industries (NSW DPI) established the $1.2 million co-funded project for three years to address the needs of the southern irrigation region. The project is described in more detail on page 13.

As part of the project, an irrigated wheat experiment was conducted at Coleambally in 2016 to assess the effect of variety and plant population interactions on grain yield, grain quality (protein content) and crop lodging (tables 1 and 2).

The experiment site was on a medium grey clay soil with soybeans as the previous crop.

The plots were sown on 4 May 2016 on permanent beds with six rows per plot and a row spacing of 25 cm.

There was a total of 457 mm of rain during the growing season and the crop was harvested by a small plot harvester on 2 December 2016.

The experiment aimed for maximum grain yield potential with the nitrogen budget calculated on achieving 10 t/ha.

Soil testing showed that the starting nitrogen level of the site was 109 kg N/ha and an estimated 50 kg N/ha became available with in-crop mineralisation during the growing season.

At sowing, 200 kg/ha of MAP was applied under the seed and nitrogen was topdressed at the two leaf, first node and booting stages. The nitrogen topdressing treatments were hand applied on the surface as urea. The total nitrogen applied as fertiliser was 230 kg N/ha.

Crop performance

Grain yield

The average grain yield across all varieties and plant populations was 8.02 t/ha. The highest yielding variety was LongReach Cobra with 9.52 t/ha, which was significantly higher than all other varieties. The second highest was LongReach Trojan (9.12 t/ha), also significantly higher than all remaining varieties. The durum line 280913 had a significantly lower yield (6.36 t/ha) than all other varieties. EGA Gregory was the lowest yielding bread wheat variety (7.06 t/ha) and was significantly lower yielding than all other bread wheat varieties (Figure 1).

Protein content

Grain protein content averaged 12.29% across all varieties and plant populations. The highest average protein content was achieved from the high nitrogen rate that included topdressing at the first node and booting growth stages. Grain protein content decreased as grain yield increased. The durum line 280913 had the highest grain protein (13.50%) but it was statistically similar to the other durum variety, EGA Bellaroi (13.25%).

Based on trial results, the optimum plant population for irrigated wheat differs between varieties but overall should not exceed 160 plants/m².

Table 1. Wheat varieties evaluated in the irrigated wheat experiment at Coleambally in 2016.

Wheat variety evaluated under irrigation, Coleambally 2016		
Corack$^{\phi}$	LongReach Cobra$^{\phi}$	Kiora$^{\phi}$
Suntop$^{\phi}$	EGA Gregory$^{\phi}$	LongReach Lancer$^{\phi}$
Wallup$^{\phi}$	LongReach Trojan$^{\phi}$	EGA Bellaroi$^{\phi}$
Mace$^{\phi}$	Chara$^{\phi}$	280913 (unreleased durum)

Table 2. Plant populations evaluated in the irrigated wheat experiment at Coleambally in 2016.

Treatment	Target plant density (plants/m²)	Actual plant density (plants/m²)
Very low	80	81
Low	120	115
Medium	160	151
High	200	178

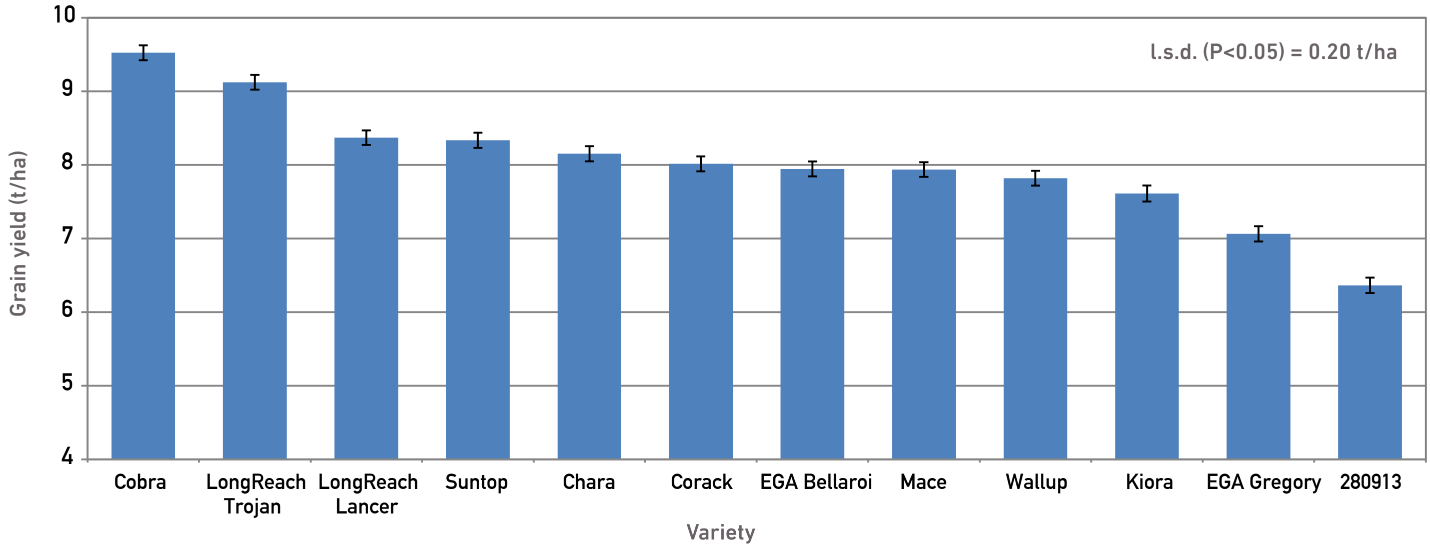

Figure 1. Grain yield of each variety averaged across all plant populations in the irrigated wheat experiment at Coleambally in 2016.

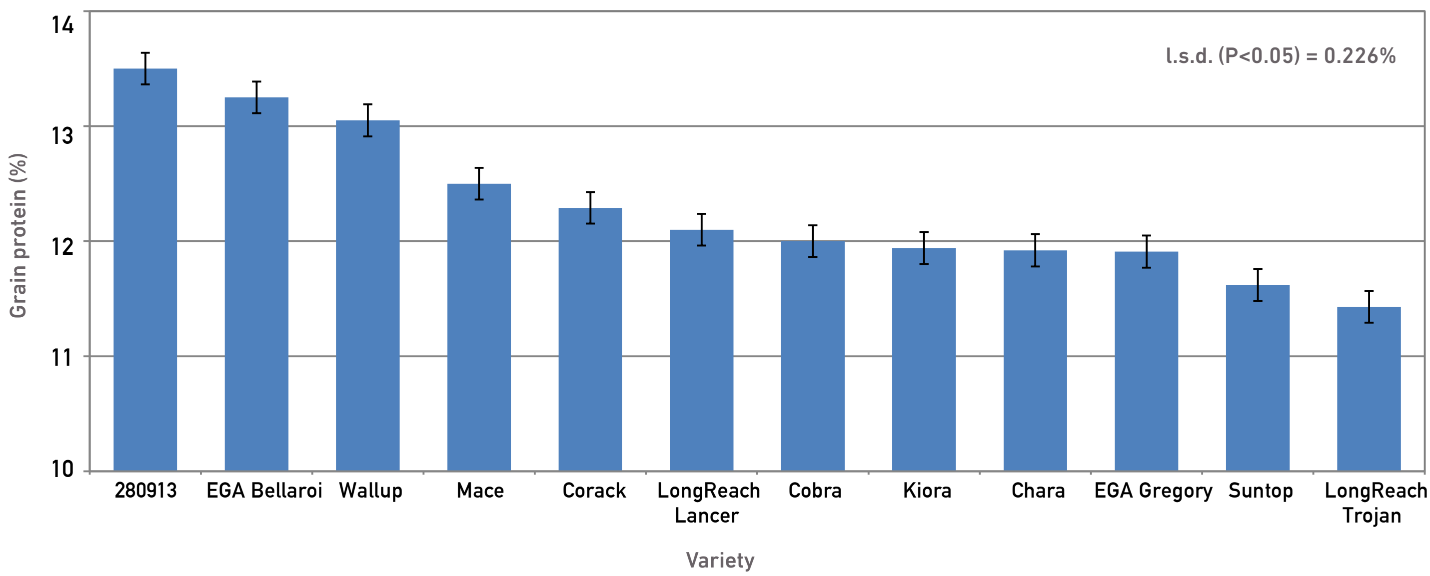

Figure 2. Grain protein content of each variety averaged across all plant populations in the irrigated wheat experiment at Coleambally in 2016.

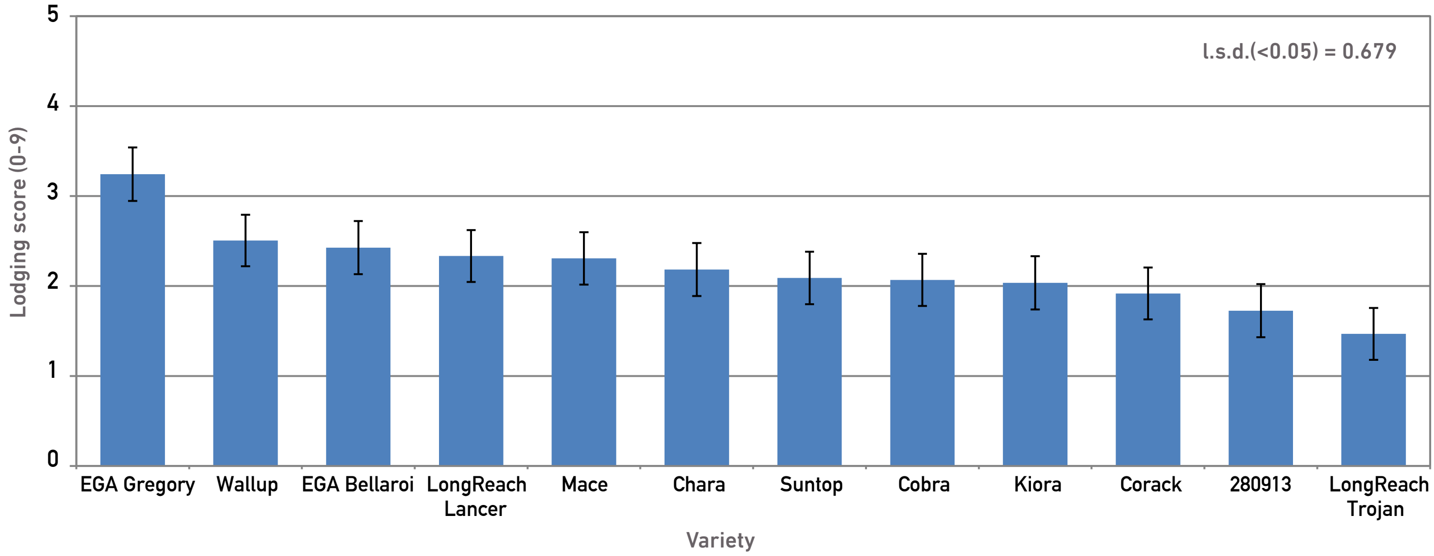

Figure 3. Lodging scores at harvest for each variety averaged across all plant populations in the irrigated wheat experiment at Coleambally in 2016.

Wallup had the highest protein content of the bread wheat varieties with 13.05% and had significantly higher protein than all other bread wheat varieties. Mace had the second highest protein content of the bread wheats with 12.05% and was statistically similar in protein content to Corack with 12.29 %. LongReach Trojan had the lowest protein content with 11.43% and was statistically similar in protein content to Suntop with 11.62%. All varieties (except for LongReach Trojan) met the minimum standard for H2 grade with grain protein content above 11.5% (Figure 2).

Lodging

Lodging was assessed on 30 November using a score of 0 to 9, with 0 indicating no lodging and 9 indicating horizontal plants.

EGA Gregory had the most severe lodging with an average score of 3.24 and had significantly more lodging than all other varieties. LongReach Trojan had the least lodging (1.47) but was statistically similar to line 280913, Corack, Kiora, Cobra and Suntop (Figure 3).

Lodging for most varieties was not much more than a lean in one direction and most likely had no impact on yield. EGA Gregory was the only variety that lodged in a twisted manner that may have had a small impact on yield.

Plant population response

Plant population had a significant effect on yield when averaged across all varieties. The low plant population had the highest average yield (8.08 t/ha) but was statistically similar to the medium and very low plant populations. The high plant population had the lowest average yield (7.96 t/ha) but was statistically similar to the medium and very low plant population (Table 3).

The varieties differed in their grain yield response to plant population with Mace, Corack, EGA Gregory, EGA Bellaroi, LongReach Trojan and LongReach Cobra achieving higher yields at lower plant populations, whilst LongReach Lancer and Suntop achieving higher yields at higher plant populations.

Plant population also had a significant effect on lodging severity. The very low plant population had the lowest incidence of lodging (1.71) but was statistically similar to the low plant population. The high plant population had the highest incidence of lodging (2.62) but was statistically similar to the medium plant population (Table 3).

Plant population had no effect on grain protein content with all treatments resulting in 12.24% to 12.36% protein (Table 3).

Conclusion

LongReach Cobra has the potential to produce high grain yields under irrigation, yielding 9.52 t/ha with an average protein content of 12.0%. LongReach Trojan also achieved a high yield (9.12 t/ha) but had the lowest protein content (below 11.5%) and failed to meet the minimum standard for H2 grade.

Plant population had a significant effect on grain yield and lodging but no effect on protein content. The optimum plant population was between 80 and 160 plants/m^2 for most varieties. Varietal response to plant populations also needs to be considered when targeting high yields. Mace, Corack, EGA Gregory, EGA Bellaroi, LongReach Trojan and LongReach Cobra achieved higher yields at 80–120 plants/m^2, whilst LongReach Lancer and Suntop achieved higher yields at 160–200 plants/m^2. Differing responses to plant population and variety may have been due to differences in crop architecture and plant structure. With an average grain size of 40 g/1000 seeds, a sowing rate of approximately 70 kg/ha is required to achieve a plant population of 160 plants/m^2.

Lodging was affected by variety and plant population. The lowest incidence of lodging occurred in the lowest plant populations and for every increase in plant population there was an increase in lodging. A plant population of 120 plants/m^2 had a higher yield than 200 plants/m^2 whilst reducing the incidence of lodging.

Previous irrigated wheat experiments conducted within this project showed similar results. LongReach Cobra was the highest yielding variety at both Murrumbidgee trial sites in 2015. In the plant population experiments at Leeton in 2014, yield decreased and lodging increased when plant population exceeded 210 plants/m^2.

Acknowledgements

This research is part of the *Southern irrigated cereal and canola varieties achieving target yields* project (DAN00198), jointly funded by GRDC and NSW DPI. We would like to gratefully acknowledge David and Paul Bellato for allowing us to establish the experiment on their property. The support of Daniel Johnston, Glenn Morris, Gabby Napier and Michael Hately for assistance with trial management, field assessments and data collection is also gratefully acknowledged.

Further information

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Table 3. Grain yield, protein content and crop lodging response to plant population in the irrigated wheat experiment at Coleambally in 2016.

Treatment	Grain yield (t/ha)	Protein content (%)	Lodging score (0-9)
Very low (80 plants/m^2)	8.06 ab	12.24 a	1.71 a
Low (120 plants/m^2)	8.08 a	12.27 a	1.94 a
Medium (160 plants/m^2)	7.98 ab	12.36 a	2.50 b
High (200 plants/m^2)	7.96 b	12.31 a	2.62 b
Trial mean	8.02	12.29	2.19
l.s.d.(P<0.05)	0.113	0.596	0.391

Numbers in the same column sharing a common letter are not significantly different.

Differences between the nitrogen treatments were already visible in mid-August, only eleven days after the application of urea at the tillering stage.

BARLEY SEED RATE AND IRRIGATION FREQUENCY

QUICK TAKE

- In a wet winter like 2016 the decision to irrigate a barley crop increased grain yield and grain quality but resulted in reduced water productivity.
- The average grain yield across the experiment was 6.3 t/ha, with the highest yield of 8.0 t/ha achieved from the 50 kg/ha seed rate with one irrigation and topdressed with 326 kg/ha of urea.
- The lower seed rate of 50 kg/ha improved grain quality and reduced lodging with no negative impact on grain yield.
- The waterlogged treatment (ponded for 48 hours) used an additional 0.41 ML/ha or 55% more water in one irrigation than the treatment that was ponded for only five hours.

One of the more difficult decisions growers have to make each spring is to decide where to use their irrigation water to get the best returns.

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GROWERS often face the dilemma of having an established winter cereal crop in the ground and not knowing whether to give it one or more spring irrigations or to save the water for use elsewhere.

In 2016, an experiment was conducted at NSW DPI's Leeton Field Station to investigate the irrigation water requirements of a barley crop and the impact of plant density, nitrogen, irrigation intensity and waterlogging have on grain yield and quality, water use and productivity. Two seed rates were included to determine the impact of plant density on grain yield and grain quality under different crop moisture stress scenarios.

The barley variety, La Trobe[A] was direct drilled at two seed rates, 50 and 80 kg/ha seed, with 125 kg/ha DAP into a moist uncultivated self-mulching heavy clay soil. The 50 and 80 kg/ha seed rates produced plant populations of 90 and 160 plant/m² respectively.

The field had an intensive cropping history with two consecutive rice crops followed by wheat, canola and wheat, which all had the stubble slashed and burned. A full list of the barley crop's cultural practices, their timing and other details is provided in Table 1.

This research is part of the *Irrigated cereal and canola varieties achieving target yields* project, described on page 13.

Irrigation and nitrogen treatments

There were four replications of each treatment with each irrigation treatment in a separate bay to allow the accurate measurement of water use. It was planned to have four spring irrigation treatments but due to the very wet winter the opportunity only existed for three irrigation treatments:

- T1 – rain fed (no irrigation)
- T2 – one spring irrigation (five hours ponding before draining)
- T3 – waterlogged (one spring irrigation ponded for 48 hours before draining).

The experiment received 402 mm of rain in the growing season, which resulted in a very saturated soil profile during winter and limited opportunity for a range of irrigation treatments. The waterlogging treatment was applied at the same time as the one irrigation treatment (27 October) but the water was held on the bays for 48 hours to simulate a layout with poor drainage.

Each irrigation treatment was split in two for seed rate treatments, and then split again with topdressed urea at rates of zero, 108, 217 and 326 kg/ha urea. Urea was spread onto the soil surface at the stem elongation stage of the barley crop, with the second node visible (Z32) (Table 1).

Grain yield

Average grain yield for the experiment was 6.3 t/ha with 8.0 t/ha the highest grain yield achieved in the experiment from 50 kg/ha seed rate, one irrigation and topdressed with 326 kg/ha of urea.

There was no significant difference in grain yield between the 50 and 80 kg/ha seed rates. The 80 kg/ha seed rate treatment produced a higher dry matter and more tillers but this did not transfer into increased grain yield (Table 2).

The rainfed treatment had a significantly lower grain yield than both the irrigated treatments but the difference was relatively small (0.27 t/ha) due to the large amount of rainfall received during the growing season. The grain yield interaction between irrigation and nitrogen was significant (Figure 1).

Table 1. Cultural practices timing and details for the irrigated barley trial, Leeton 2016.

Practice	Details
Field preparation	Wheat stubble burnt — no cultivation
Sowing	20 May 2016 — disc drill with 18 cm row spacing
Variety and rate	La Trobe barley @ 50 and 80 kg/ha
Sowing fertiliser	DAP @ 125 kg/ha sown with seed
Establishment	50 kg/ha = 90 plants/m² and 80 kg/ha = 160 plants/m²
Herbicides	Ally @ 5 g/ha
Topdressed nitrogen	Z32 — 8 August (week prior to 10 mm rain)
Irrigation date	1 irrigation — 27 October

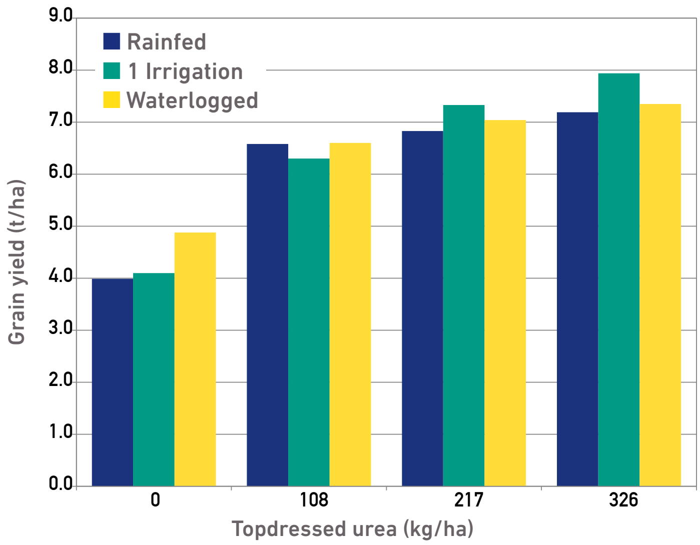

Figure 1. Grain yield (t/ha) for each irrigation and nitrogen treatment interaction, averaged across seed rates. l.s.d. (P<0.05) = 0.49

Table 2. Barley crop production and water productivity for the irrigation, seed rate and nitrogen topdressing treatments (averaged across the other treatments) at Leeton, 2016.

Treatment		Total dry matter (kg/ha)	Tiller number (no./m²)	Grain yield (t/ha)	Grain protein (%)	Retention > 2.5 mm (%)	Screenings < 2.2 mm (%)	Water productivity (t/ML)
Irrigation	Rainfed	1282	813	6.15	9.77	73	9.3	1.53
	1 irrigation	1342	818	6.42	9.65	81	6.0	1.35
	Waterlogged	1373	799	6.47	9.82	80	6.4	1.25
	l.s.d. (P<0.05)	n.s.	n.s.	0.20	n.s.	2	0.6	0.05
Seed rate (kg seed/ha)	50	1315	749	6.33	9.76	80	6.7	1.37
	80	1349	871	6.35	9.74	76	7.7	1.38
	l.s.d. (P<0.05)	30	46	n.s.	n.s.	2	0.9	n.s.
Topdressed nitrogen (kg urea/ha)	0	870	552	4.32	8.26	91	2.3	0.93
	108	1332	777	6.49	8.81	85	4.1	1.41
	217	1505	927	7.06	10.21	72	9.5	1.53
	326	1621	983	7.49	11.71	64	13.0	1.63
	l.s.d. (P<0.05)	51	57	0.31	0.23	2	0.8	0.07

Aerial view of the barley irrigation experiment at Leeton Field Station in 2016, with density and nitrogen treatments within separate bays to allow water measurement.

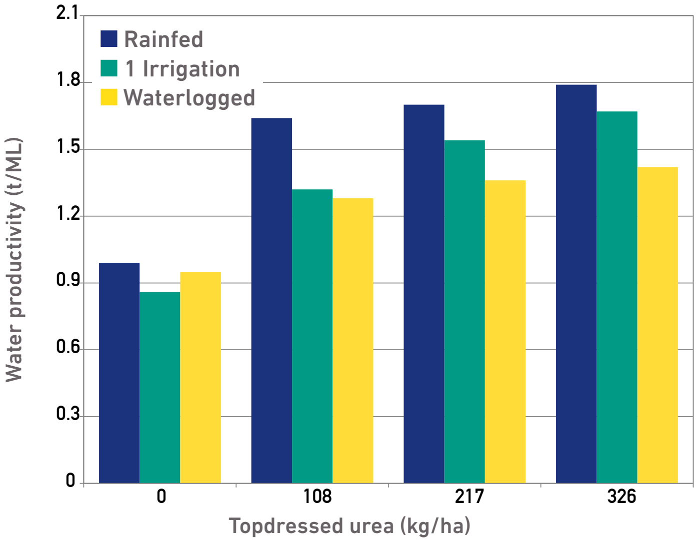

Figure 2. Water productivity (t/ML) for irrigation by nitrogen interaction, averaged across seed rate. l.s.d. (P<0.05) = 0.11

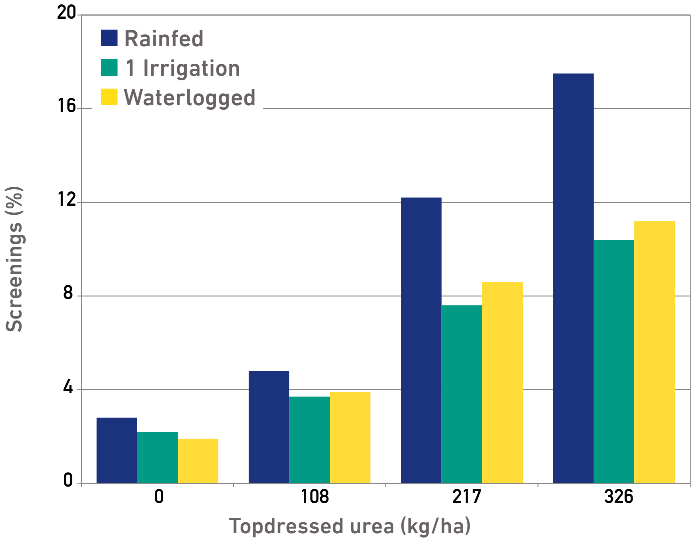

Figure 3. Grain screenings < 2.2 mm (%) for seed rate by nitrogen interaction, averaged across nitrogen treatments. l.s.d. (P<0.05) = 1.33

Despite the extended period of ponding, the waterlogged treatment achieved a high grain yield similar to the non-waterlogged irrigation treatment, which can be attributed to the very good soil structure and internal drainage at the experimental site. On a poorer structured or sodic soil it is likely a larger yield loss would have occurred.

Lodging

Lodging was a significant problem in winter crops in the 2016 season due to the very wet conditions. Although irrigation treatment had no effect on lodging, the higher seed rate (80 kg/ha) resulted in increased severity of lodging compared with the lower seed rate (50 kg/ha). Lodging also increased significantly with increased rate of topdressed nitrogen as often occurs.

Water use and water productivity

The rainfed treatment received 4.0 ML/ha from rainfall during the growing season, while the one irrigation treatment received an additional 0.74 ML/ha and the waterlogged treatment 1.14 ML/ha from irrigation (Table 2). The waterlogged treatment, which was ponded for 48 hours, used an additional 0.41 ML/ha or 55% more water than the one irrigation treatment, which was ponded for five hours.

The rainfed treatment produced the highest water productivity in the experiment with 1.53 t/ML compared with 1.35 and 1.25 t/ML for the one irrigation and waterlogged treatments, respectively (Table 2). As there was little difference in grain yield between the seed rates they both had similar water productivity. The application of topdressed nitrogen increased water productivity due to increased grain yield, as can be seen by the significant interaction between irrigation and nitrogen shown in Figure 2.

Grain quality

Grain protein increased significantly with increased rate of nitrogen topdressing but was not affected by either irrigation treatment or seed rate (Table 2).

The non-irrigated rainfed treatment produced lower grain quality than both the irrigated treatments when averaged across seed rate and nitrogen treatments. The rainfed treatment had significantly lower seed retention (>2.5 mm) and significantly higher screenings (<2.2 mm) than the two irrigated treatments. The 80 kg/ha seed rate produced a reduced grain size compared with the 50 kg/ha seed rate, having lower retention and a higher level of screenings (Table 2).

Increased rates of topdressed nitrogen also significantly reduced grain retention and increased screenings. The interaction between irrigation treatment and nitrogen topdressing (Figure 3) shows that as the nitrogen topdressing rate increased, the percentage of screenings increased considerably more for the rainfed treatment, than the two irrigated treatments.

Grain quality impacts the grade of the grain and therefore its value. At harvest the LA1 grade was paying $165/t and the F1 grade $138/t; but these values were variable with location and dropped soon after harvest and there were limited buyers for LA2 and LA3 grades. All of the rainfed treatments and many of the other treatments achieved the F1 grade. The primary reason for this was low protein levels at the low nitrogen rate treatments and high screenings at high nitrogen rates. Only three of the 24 treatments achieved LA1 grade and they were all close to the limits and the results do not give confidence of continuing to meet this grade.

Seed rates influence the end result

The 2016 winter season was particularly wet with many commercial cereal crops suffering from severe waterlogging during winter. The experimental site has acceptable surface drainage and soil structure, which resulted in little surface water ponding on the plots for any extended period of time, thus high grain yields were still able to be obtained.

The wet winter also resulted in the cereal crops having very shallow root systems, so when evapotranspiration rates started to increase in the spring and rainfall slowed, the crops quickly became moisture stressed. One irrigation (Treatment 2) did not produce a large increase in grain yield, but the benefit was obvious in grain quality, particularly at high nitrogen rates. Grain quality is a very important component in profitability, with poor grain quality often being severely penalised in the marketplace.

Many growers use higher seed rates than required with the current recommended seed rate for barley of 60–90 and 70–110 kg/ha, with partial and full irrigation respectively. The results in this experiment are an example of a lower seed rate producing equivalent grain yield with the added benefits of improved grain quality and reduced lodging. If the winter was drier with the barley becoming more moisture stressed it would be expected that the benefits of the lower seed rate would have been even more pronounced. Seeding rate recommendations for irrigated barley should be reviewed following further research conducted over seasons with a range of irrigation intensities.

Acknowledgements

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Australia's main faba bean market is Egypt, for human consumption; however demand in China is increasing for both human consumption and stock feed.

PROSPECTS AND OPTIONS FOR IRRIGATED PULSES IN 2017

QUICK TAKE

- After a successful season in 2016, it is expected that interest in pulses for the 2017 cropping season will also be strong, particularly with an eye to export markets.
- Paddock selection in 2017 must consider the potential of disease carryover as a result of prolonged wet conditions in the previous winter and spring.
- Chickpea, lentil and faba bean are potentially profitable options for irrigated cropping rotations in 2017.
- Pulses provide benefits to the cropping rotation through nitrogen fixation and a break in cereal crop sequences.

The 2016 winter pulse crop broke records at every turn across Australia, so what are the prospects for pulses for 2017?

Phil Bowden
Industry Development Manager, Pulse Australia

PULSE and canola production totalled 4.0 million and 4.1 million tonnes respectively, in 2016. Lentil production in South Australia and Victoria doubled that of 2015, and chickpea production in northern New South Wales and Queensland increased by 50%.

The buoyant global prices on offer for pulses were driven by increased demand from India, Pakistan and Bangladesh following crop failures due to the lack of monsoon rains. Pulse Australia expects interest in pulses to again be significant in 2017 and that a similar area to 2016 will be planted as lentil and chickpea prices remain attractive, particularly in comparison with depressed cereal prices.

This forecast is tempered with some uncertainty regarding the likely demand following a larger crop harvest on the sub-continent that is in the final stages of harvest (at the time of publication). A deficit in supply in India is still expected later in 2017, which will see buyers looking to import more grain.

Pulse Australia recommends growers take a prudent approach to budgets for irrigated pulses as both production and price risk are likely to influence the 2017 crop.

At a farm level, paddock selection will be an important factor. In particular, growers are advised to take into account the higher disease pressure experienced in many broadleaf crops in 2016, due to prolonged wet conditions in winter and spring.

Chickpea

Chickpea was first produced in the Middle East about 7000 years ago and is now produced in over 50 countries and on all continents. Globally, the marketed volume is only 5–8% of the total production as most chickpeas are consumed in the countries where they are produced. In contrast, about 95% of the Australian chickpea crop is exported.

The price of chickpeas as a commodity is relatively volatile, rising and falling in line with supply and demand. In recent years the price of chickpeas has generally shown a rising trend as production in the traditional countries has fluctuated with often-reduced production for a number of reasons. This situation is connected with insufficient expansion of production in the importing countries to meet their domestic demand.

Full or supplementary irrigation of Australian chickpea crops is common in districts where chickpea is grown in rotation with other irrigated crops. Management requirements for irrigated chickpea are the same as for dryland crops but their sensitivity to waterlogging, for even a short time, can result in severe losses, particularly if the crop is also under stress from herbicides or disease.

With the larger planted area in 2016, and being such a wet season, disease management was a problem for growers and it is expected that disease inoculum will be at high levels in soils and on retained stubble for the 2017 season. Ascochyta, botrytis and sclerotinia all caused yield losses in 2016 and will need to be managed carefully in 2017. Ascochyta and botrytis spores can be carried on seed so be careful to source planting seed for planting from a disease-free crop and use a suitable fungicide seed dressing.

Botrytis and sclerotinia both have wide host ranges, enabling a build-up of inoculum in paddocks. Fungicide treatments during the season need to give continuous protection to new growth, especially as the crop gets into the danger period in spring. Budget for 4 or 5 protective sprays around 2–3 weeks apart and be prepared to apply additional sprays, depending on the seasonal conditions.

An important aspect of growing chickpeas to get the full nitrogen benefit for future rotation crops is proper rhizobia inoculation. Seed needs to be inoculated for every crop (Group N) and there is a variety of inoculum types available, such as granular, freeze dried or the standard peat types, that will suit different situations. Rhizobia bacteria are very sensitive to heat, acid soils and fungicidal seed treatments. Seed needs to be inoculated immediately prior to sowing, after applying the fungicide treatment to the seed.

Using sprinkler irrigation equipment reduces the risk of waterlogging, even during flowering and pod-fill, however there may be a higher risk of foliar disease, e.g. botrytis grey mould and ascochyta blight, due to the increased irrigation frequency and leaf wetness.

Pre-irrigate to fill the moisture profile prior to planting chickpea crops, unless there has already been sufficient rainfall. Watering up is most effective in bed, row and sprinkler systems, but is not recommended for border check layout unless soil moisture is insufficient to achieve a uniform germination.

Risk of sclerotinia stem rot

Sclerotinia stem rot, a common fungal disease of broadleaf crops such as canola, has become more prevalent in chickpeas and lentils. The disease had an impact on crop yields in many regions in 2016 and must be considered when selecting paddocks for broadleaf crops in the 2017 season and beyond.

Sclerotinia sclerotiorum, the fungus that causes sclerotinia stem rot, has a wide host range including many common broadleaf weed species and nearly all of the broadleaf crops. Ideal conditions last season will have boosted inoculum levels in paddocks growing these crops and weeds. The main drivers of disease severity are the frequency and amount of late winter and spring rainfall, the length of crop flowering and how frequently a broadleaf crop has been grown in each paddock.

The survival structures of the pathogen are known as 'sclerotes' and can remain viable in the soil for as long as ten years. Many foliar pathogens of pulse crops such as *Ascochyta* and *Botrytis*, also survive in old stubble residue, ready to release spores the following year to infect emerging crops.

When planning the pulse crop, select paddocks that are coming out of cereal crops and preferably not adjacent to last season's pulse stubble.

About 95% of the Australian chickpea crop is exported. The price of chickpeas as a commodity is relatively volatile, rising and falling in line with supply and demand.

As a general rule, irrigation of the emerged crop should start early when there is a deficit of between 30–40 mm and around 60–70% field capacity. Schedule irrigation using soil moisture indicators rather than the crop growth stage.

Time irrigation to prevent moisture stress during flowering and podding and to reduce the impact of high temperatures on yield, quality and grain size. This is particularly important with large kabuli types. Chickpea is very sensitive to waterlogging during flowering and podding, so great care is required to provide adequate soil moisture without causing waterlogging.

Pulse Australia expects interest in pulses to again be significant in 2017 and that a similar area to 2016 will be planted.

In furrow irrigation systems, water every second row to avoid waterlogging. Doubling up the number of siphons can increase water flow and reduce irrigation time. Aim to have watering completed in less than eight hours, and have good tail water drainage to avoid any waterlogging in the crop area.

If in doubt, do not water.

Lentil

There has been a massive increase in lentil production in southern Australia due to increased demand and higher prices. Grown mainly on alkaline soils in South Australia and Victoria, there has also been success in NSW on some acid soil types. Growers are more confident with the new herbicide-tolerant lentil varieties that increase the weed management options in lentil crops, however it is a crop that needs careful management. The main market is for human consumption in the Middle East and the sub-continent, so delivery standards are very tight and there are no secondary markets for lower quality grain. Lentil is generally considered a higher risk crop, compared with other pulses.

Control foliar diseases through careful paddock selection (avoiding recent pathogen inoculum), crop canopy management and strategic fungicide applications as required. High humidity and excessive rainfall during the growing season encourages vegetative growth, which limits yield and can reduce seed quality. High temperatures during flowering and pod-fill also reduce yields.

Irrigation of lentil is possible but good drainage is essential because lentil plants do not tolerate waterlogging, particularly during early flowering. Even short periods of waterlogging can result in severe losses. Management requirements for irrigated lentil are the same as for dryland crops, with a greater emphasis on disease control as irrigated crops are more prone to the spread of foliar diseases due to the dense canopy and potentially prolonged leaf wetness after irrigation.

Salinity levels in irrigation water or the soil must be low. Lentil is one of the more sensitive field crops to salinity—almost as sensitive as green beans (*Phaseolus vulgaris*), which require irrigation water < 0.7 dS/m for nil yield reduction. A 10% yield reduction is expected if the irrigation water measures 1.0 dS/m.

Irrigation may be economical if the system allows adequate drainage, there is good quality water available and the rotation with other winter and summer crops is managed well to reduce the risk of disease pressure. Some experienced lentil growers in the eastern Mallee regions of Victoria successfully use overhead irrigation however flood irrigation of lentil crops is not widely practiced in Australia because the risk of yield loss to waterlogging is considered to be high.

Harvest as soon as the crop is mature, as lentil crops can turn brittle once fully matured and can be prone to shattering, especially following summer rainfall. Desiccation or windrowing can help avoid these harvest problems.

To maximise grain quality, handle the seed carefully and avoid equipment blockages. Harvest during cooler conditions to improve harvest efficiency and reduce the risk of fire.

Faba bean

Faba bean originated in the Middle East and is now an important food crop in China and many Mediterranean and African countries. Australia's main market is Egypt for human consumption, but the demand in China for beans used as both human and stock food in increasing. As faba bean receives greater attention in the western world, because of the value in livestock nutrition and crop rotation, there will be increasing export potential for Australian grain.

Market prospects depend on the Egyptian crop as well as supplies from Europe, particularly France. Domestic market is stock feed, but increasing use for aquaculture pellets is expanding the market size. Prices are down at present due to the large crop in 2016 and good harvests in Europe, the preferred supplier into Egypt due to lower freight costs.

The major risks to faba bean are ascochyta blight, chocolate spot, plant viruses and occasionally, rust. No varieties are resistant to all fungal and virus diseases. The impact of fungal diseases on yield can be reduced through the strategic selection and use of fungicides and following best practice crop management, including maintaining a 500 metre buffer between new crops and the previous year's faba bean stubble, and eradicating volunteer plants over summer and autumn.

Faba bean crops respond well to irrigation in dry areas. Furrow irrigation is successful in southern irrigation areas with either pre-water and sow, or dry-sow and water-up, following similar guidelines to those recommended for chickpea crops. Sprinkler irrigation is ideal to minimise waterlogging, however there may be a need for greater disease control against chocolate spot, rust or ascochyta blight due to more frequent wet conditions.

To maximise yield potential, crops should be watered to produce maximum biomass, and not allowed to stress during flowering and pod-fill. The additional risk of foliar disease under irrigation must be taken into account, along with the risks associated with waterlogging, particularly after the commencement of flowering. Faba and broad beans are more sensitive to waterlogging during their reproductive stage (flowering and podding) so, if in doubt, do not water.

Note that faba bean is one of the more sensitive field crops to salinity, but not as sensitive as field beans.

Harvest on time, with a properly set up header. Start harvest when nearly all pods are black but before stems become completely dry and black. If the header settings are correct, pods will thresh easily to yield clean, whole seeds with a minimum of splits and cracks.

Further information

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PULSE AUSTRALIA

Limited options for weed management along irrigation infrastructure is putting additional pressure on the longevity of knockdown herbicides in irrigated farming systems.

RISK OF RESISTANCE TO KNOCKDOWN HERBICIDES

QUICK TAKE

- Non-cropped areas of irrigation farms are high risk areas for the build-up of herbicide resistant weeds, particularly resistance to glyphosate.
- A survey of cotton farms in 2016–17 showed glyphosate resistance in a high proportion of fleabane, feathertop Rhodes grass, windmill grass and sowthistle samples.
- With widespread areas of zero and minimum tillage, knockdown herbicides provide effective weed control but weed management tactics must be diversified to preserve the longevity of these useful herbicides in cropping systems.
- Individual plants that survive a spray application may be a sign of resistance in the plant population. A second warning sign is the need for higher rates of herbicide to achieve the same results as in previous years.

Herbicide resistance is frequently identified first along fence lines, roadways and irrigation channels where herbicide use tends to be the same year in, year out.

Cindy Benjamin
WeedSmart

OFTEN less attention is paid to herbicide efficacy or survivor weeds in non-productive areas of the farm compared with cropped areas. This can be a high risk practice unless survivors are removed after every spray application as there is no crop competition to restrict weed growth, resulting in production of large volumes of seed.

Eric Koetz, NSW DPI weeds research agronomist, said the limited options for managing weeds along irrigation infrastructure and other non-crop areas is a problem, and is putting additional pressure on the longevity of knockdown herbicides in irrigated farming systems.

Build-up of resistance on cotton farms

"A recent survey of cotton fields in Queensland and NSW showed that cotton paddocks were generally relatively weed free, however the incidence of resistance to glyphosate is quite high in fleabane and

Weed researcher Eric Koetz said the limited options for managing weeds along irrigation infrastructure and other non-crop areas is a problem and is putting additional pressure on knockdown herbicides in irrigated farming systems.

Mark Congreve, ICAN senior consultant, says growers need to be looking for survivor weeds after every herbicide application and responding to 'rate creep' by changing how they use herbicides across their cropping system.

windmill grass samples collected mainly from non-crop areas on cotton farms," he said.

"Preliminary results from the samples collected across cotton farming systems in 2016–17 show 95% of fleabane samples, 60% of feathertop Rhodes grass samples, 80–90% of windmill grass samples and 20% of sowthistle samples tested as resistant to glyphosate."

"Keep in mind that flaxleaf fleabane, feathertop Rhodes grass and windmill grass are not registered for control with Roundup Ready® Herbicide with PLANTSHIELD (used with Roundup Ready® technology crops). Control of these species is generally poor because of naturally tolerant plants within these species, so there is further selection for resistance which only exacerbates the problem," he said.

"Although still lower compared with other weeds, the level of resistance to glyphosate emerging in sowthistle is very concerning, given that this species is listed on the herbicide label. According to a recent attitudinal study by Monsanto, growers also identify annual ryegrass and barnyard grass as showing signs of glyphosate resistance in the field."

To date there have been no recorded cases of paraquat resistance in weeds on cotton farms, however with rising glyphosate resistance, and increased use of paraquat products, there is a high risk that paraquat resistance will also be found, leaving growers with few options to control these weeds. Mr Koetz now has additional funding available to test the seed collected in the survey for resistance to paraquat and diquat products — Gramoxone® and Spray.Seed®.

Mr Koetz said the lack of diversity in herbicide use in many cotton systems is likely to contribute to the increased incidence of herbicide resistance.

"The attitudinal study by Monsanto indicates that less than 50% of growers are applying a pre-emergent herbicide and only 25% of growers apply a post-emergent herbicide in addition to their applications of glyphosate in cotton," he said.

"The label for Roundup Ready® Herbicide with PLANTSHIELD states that this product must not be the only form of weed control used in Roundup Ready Flex cotton varieties."

"In the next five to 10 years there will need to be a shift towards non-herbicide controls such as robotic cultivation and microwave technologies, which are well suited to summer cropping on rows or beds," he said.

"Until then, optical spray technology is a good option for growers to keep weed numbers low in the fallow."

The timing of fallow sprays is presenting itself as a critical issue on cotton production areas. Spray drift of Group I herbicides (e.g. 2,4-D products) applied late in the summer fallow to control large fleabane is causing considerable damage to neighbouring cotton crops. Mr Koetz recommends growers change their fallow weed management program to target small plants earlier in the spring, before cotton emergence, using a double knock of glyphosate followed with cultivation or paraquat plus a residual herbicide as the second knock.

Protecting knockdown herbicide options

Most cropping systems in the irrigation regions (and dryland areas) rely fairly heavily on a small group of non-selective or 'knockdown' herbicides. Since the widespread adoption of zero and minimum tillage, these herbicides have provided effective control of many grass and broadleaf weeds but these useful herbicides could be lost to the industry if steps are not taken to increase the diversity of weed management tactics used.

Mark Congreve, senior consultant with Independent Consultants Australia Network (ICAN), said that the highly effective double knock tactic, which combines an application of glyphosate followed by paraquat, is at risk if growers don't remain vigilant and ensure removal of any surviving plants.

"The double knock strategy of glyphosate, plus a Group I herbicide for weeds such as flaxleaf fleabane, followed by paraquat has provided excellent control of weeds that are difficult to kill with glyphosate alone," he said.

"Recent confirmation of a fleabane population that is resistant to paraquat, found in a New South Wales vineyard, is a clear warning to

The recent discovery of flaxleaf fleabane resistance to paraquat is a clear warning to crop producers that there is no room for complacency with double knock operations.

grain producers that there is no room for complacency following a double knock operation. In addition to this recent discovery, an annual ryegrass population from a Western Australian vineyard was confirmed in 2013 to have resistance to both glyphosate and paraquat. This shows that a single plant can develop resistance to both of the main non-selective knockdown herbicides used in Australian grain production."

Paraquat is a widely-used herbicide, being an active ingredient in over 100 herbicide products registered for use in broadacre cropping. It is a group L herbicide and as such is considered a 'moderate risk' for herbicide resistance. Having a moderate risk rating means that resistance generally takes longer to occur, not that it won't occur.

"Paraquat resistance typically takes over 15 years of consistent use before resistant weeds are noticeable in the field," said Mark.

"This critical period has now elapsed on many farms where paraquat is used in cereals and broadleaf crops, and for general weed control around the farm."

Paraquat resistance has been present and widespread in barley grass in lucerne production systems for many years in southern NSW and Victoria (Table 1). While paraquat resistance is still relatively rare in other systems, very high level resistance was confirmed in three weed species (crowsfoot grass, blackberry nightshade and cudweed) taken from sugarcane and tomato blocks around Bundaberg in 2015 (Table 1).

In the event of widespread resistance to paraquat, Mark is concerned that there are no new herbicide modes of action likely to be commercialised within the next 10 years or more, so we need to protect what we have.

Table 1. Weeds with confirmed resistance to paraquat in Australia.

Species	Common name	Year	State	Crop
Hordeum glaucum	Northern barley grass	1983	Victoria	lucerne
Arctotheca calendula	Capeweed	1984	Victoria	lucerne
Hordeum leporinum	Barley grass	1988	Victoria	lucerne
Vulpia bromoides	Silver grass	1990	Victoria	lucerne
Mitracarpus hirtus	Small square weed	2007	Queensland	mangoes
Lolium rigidum	Annual ryegrass	2010	South Australia	pasture seed
Gamochaeta pensylvanica	Cudweed	2015	Queensland	tomatoes sugar cane
Solanum nigrum	Blackberry nightshade	2015	Queensland	tomatoes sugar cane
Eleusine indica	Crowsfoot grass	2015	Queensland	tomatoes sugar cane
Conyza bonariensis	Flaxleaf fleabane	2016	NSW	grape vines

Source: www.glyphosateresistance.org.au/paraquat_resistance.html

"It is essential that farmers do everything in their power to preserve the effectiveness of the herbicide groups currently available," he said.

"The key is to take a diverse approach to weed management and, most importantly, remove weeds that survive herbicide applications. This is the best way to keep weed numbers low and when numbers are low, resistant weeds can be controlled more effectively. It's a numbers game!"

Mark suggests that growers check the results of every spray application, looking for individual plants 'surviving' or 're-growing' after a spray application that has killed adjacent weeds. This may be a sign that the surviving plants carry the genetic mutation that 'protects' them from the herbicide's mode of action.

"If this is observed, the first step is to remove those individual plants before they shed seed," he said.

"It is recommended to have the plants, or their seed, tested to confirm resistance and determine what herbicides those individuals are still susceptible to."

A second warning sign is when a higher rate of herbicide is needed to have the same effect as achieved on the target weed in previous years. Mark called this 'rate (or dose) creep' and said that it is the most common sign of resistance to herbicides like paraquat.

"Paraquat resistance primarily occurs as a result of a plant having the ability to re-direct the herbicide molecules away from the chloroplasts in the cell and into the cell vacuole, where the herbicide has no effect," he said.

"If you are finding that you now need to use a higher rate of a herbicide such as paraquat, it is time to change how you manage those weeds."

Currently there are 10 weed species with confirmed resistance to paraquat (Group L) and 13 species resistant to glyphosate (Group M) in Australia.

The WeedSmart website provides many practical tools for farmers wanting to make their weed control program more diverse and robust to delay herbicide resistance on their farms.

Useful websites

WeedSmart

Australian Herbicide Resistance Initiative

Australian Glyphosate Sustainability Working Group

Further information

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WeedSmart

WeedSmart is an industry-led initiative aimed at enhancing on-farm practices and promoting the long term sustainability of herbicide use in Australian agriculture. Australian research partners, commercial entities, Government, advisers and growers have joined forces to ensure weed management remains at the forefront of global farming practice. Viable herbicide use will help secure the weed control productivity gains made by the current generation of Australian farmers.

A smoke demonstration showing air movement under early morning inversion conditions.

SPRAY DRIFT – WHY IS IT STILL HAPPENING?

QUICK TAKE

- Most incidents of spray drift result from 'inversion drift', i.e. not drift from an adjacent sprayed area but from one or more sources some distance from the affected site.
- Applicators need to understand the difference between 'day wind' and 'inversion wind', and how these affect the movement of spray droplets.
- Spraying should occur when there is 'day wind', which has a turbulent motion and is much more likely to pull any fine droplets to the ground within a reasonable distance.
- Spraying under inversion conditions is extremely high risk and prohibited on many product labels *— that means it is illegal.*

Despite an abundance of information on spray application being available, we continue to see widespread incidents of crop damage each year. A key to avoiding spray drift is understanding the difference between 'day wind' and 'inversion wind'.

Mary O'Brien
Educator, chemical use best practice
Mary O'Brien Rural Enterprises P/L, Dalby, Queensland

MANY factors contribute to the number and severity of spray drift incidents that occur across agricultural areas each year, with the most obvious being the nature of the season. Less rain and therefore less weed pressure directly translates into less spraying, we know this. Regardless of the season, the fact that drift is occurring at all should be our major concern and certainly it is, for those affected by drift on an annual basis.

Group I herbicides are synthetic auxins (growth regulators) and symptoms will be observed in the growing points of plants.

'Witches' hand' is a typical symptom of more severe damage on cotton caused by Group I herbicides.

Puckering of leaf margins and 'bubbling' of the leaves are less severe symptoms of damage by Group I herbicide on cotton.

Drift of Group I herbicides

Let's just consider herbicide drift, and more specifically Group I herbicides such as 2,4-D. This gains plenty of media coverage every year for its impact on cotton crops. Some may say the main problem is that cotton is very sensitive to 2,4-D and this is true. For me, the issue is that we are clearly doing something wrong with the application to get the product into the air to start with.

It is now twelve years since specific drift warnings were included on the labels of Group I herbicides and it would appear that it has made no difference to the incidence of spray drift. So what are we missing?

What is the problem?

In my experience, the vast majority of spray drift cases (probably 90% or more) is the result of 'inversion drift'. That means the drift has not come from an adjacent sprayed area, it has come from one or more sources that are some distance from the site of damage. The distance between the sprayed site and the location of the damage may vary dramatically, from a few kilometres to tens of kilometres.

Why is there so much inversion drift when Group I labels specifically prohibit use of the products under surface temperature inversions?

Many may argue that it is a blatant disregard of the label by a few applicators. I do not agree this is the main problem.

I believe the problem is a lack of understanding about how to tell when there is an inversion and particularly not knowing how 'day wind' moves differently to 'inversion wind'. I continue to see good farmers/applicators doing what they believe to be the right thing but it is not. These are people very concerned about minimising spray drift — they honestly do not think they are doing anything wrong.

What is 'day wind'?

After sunrise, the sun begins to heat the ground, the warm ground then heats the air close to the surface, and this air then rises. As that warm air rises, cold air from above sinks down to replace it. The ground then warms this cold air and it rises. This cycling of warm air rising and cold air sinking creates turbulence and then wind. This is a good thing; turbulent wind movement is much safer for spraying. 'Day wind' has a turbulent motion and is much more likely to pull any fine droplets to the ground within a reasonable distance.

During the day, we can predict which direction and how far fine droplets will travel.

What is 'inversion wind'?

As the sun sets, the ground begins to cool quickly and this in turn cools the air next to the ground. As we all know, cold air does not rise and warm air does not sink. This means there is a layer of cold air trapped close to the surface and a layer of warm air above it. The result is no turbulent movement or mixing of the air. The air may become quite still and this is often observed around sunset when the daytime wind ceases or drops off.

What happens next is where the real danger occurs for spraying.

As the night progresses and the ground cools more, the cool air close to the surface becomes colder and therefore denser, particularly from midnight onwards. This cold dense air then begins to move across the landscape, often down slope and in very unpredictable directions. Remember this air is not turbulent, there is no mixing, it has layers of air, something like layers in plywood, and it flows parallel to the ground. Any fine droplets released into these layers of cold non-turbulent air will simply move sideways across the surface until the sun rises and heats the ground again. This is when the fine droplets are released from the layers and they come to ground, often in the lower parts of the catchment and a long way from the site of application.

It is impossible to predict what direction this 'inversion wind' will go. For this reason, spraying in this type of wind is extremely high risk for spray drift.

Key indicators that indicate an inversion is unlikely

We should always expect that a surface temperature inversion has formed at sunset and will persist until sometime after sunrise unless we have one or more of the following:

- continuous overcast weather, with low and heavy cloud
- continuous rain
- wind speed remains consistently above 11 km/h for the ***whole time*** between sunset and sunrise
- after a clear night, cumulus clouds begin to form.

For more detailed information on inversions, refer to the suggested viewing and reading list at the end of this article.

Conclusion

Many factors affect the potential for spray to drift but the main ones are:

- the timing of the application
- weather conditions
- nozzle selection
- products/tank mix used
- actual spray quality achieved
- speed of rig
- boom height.

The common denominator is that all of these factors are within the control of the spray operator.

Spraying under inversion conditions is extremely high risk and prohibited on many product labels — ***that means it is illegal.***

If we are serious about preventing drift, then we must learn how to identify when an inversion is likely to be present and more importantly when it has broken.

All agricultural chemicals have the potential to drift; it is how we use them that increases or decreases that potential. Therefore, the problem is a human one, not a chemical one. There is a suite of information available but if you are still unsure or need any assistance, please seek advice from an expert. Maintaining long-term access to chemical products depends on us reducing spray drift.

Suggested video

Inversion YouTube video showing air movement under inversion conditions

Suggested reading

- Best Practice Guide for Summer Weed Control (Cotton Australia)
- GRDC Surface Temperature Inversion Factsheet (GRDC)
- Weather Essentials for Pesticide Application by Graeme Tepper (GRDC)

Further information

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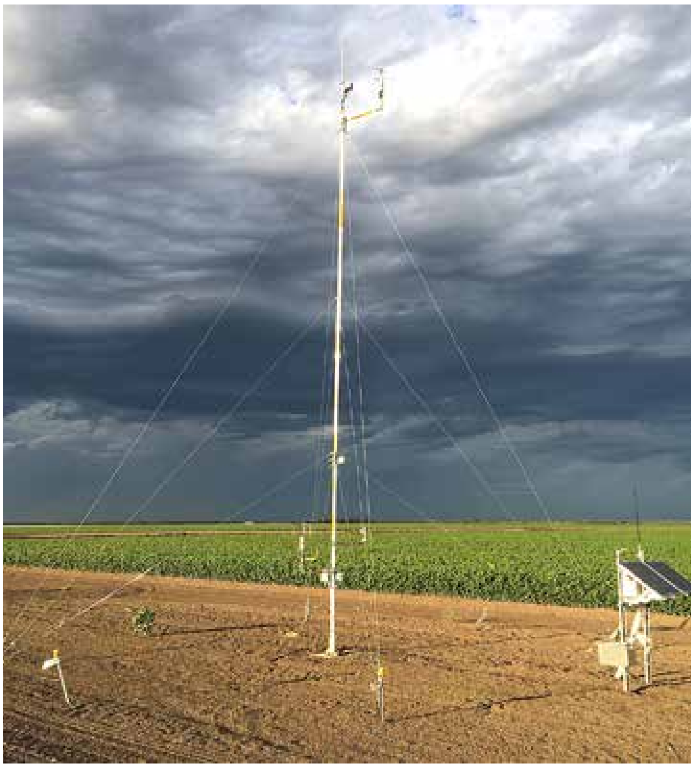

A series of 10-metre inversion towers is being trialed in northern NSW to help identify when inversion conditions occur.
PHOTO: Jon Welsh, CottonInfo Carbon Technical Specialist

ALL FARMERS AND APPLICATORS HAVE A DUTY OF CARE

Kieran O'Keeffe
Southern NSW CottonInfo Regional Extension Officer

In southern NSW, we live and farm in one of the most diverse farming communities in Australia and all our crops (fruit, nuts, pastures, and winter and summer broadacre crops, both irrigated and dryland) can be impacted by spray drift. However, all these crops can be the source of spray drift as well. We all have a duty of care not to impact on others in our community.

A recent survey asked 60 consultants across Australia what would help to reduce the incidence of spray drift and herbicide damage. Over 60% suggested that continued education, better communication and awareness were the best path forward. Spray drift management workshops for next spring in southern NSW are in the initial stages of planning.

It is the responsibility of all spray applicators to use all tools available to them to be aware of what is nearby, by talking to neighbours, and spraying in the right conditions with attention to spray set-up to minimise drift. Cotton map is produced each season to indicate where cotton is being grown in each region.

Rice$cenario is a decision support tool that will assist irrigators to enhance the productivity and economic sustainability of their irrigated farming businesses.

IMPROVE THE BUSINESS OF RICE GROWING WITH RICE$CENARIO

QUICK TAKE

- Rice$cenario is a simple, user-friendly, web-based decision support tool designed to assist irrigators analyse water costs within the farming business.
- To assist irrigators with water budgeting, the tool uses an average purchased water cost to guide decisions for water use across enterprises and it calculates the fixed and variable water charges for predicted or known allocation.
- Users of Rice$cenario have reported a greater understanding of their water costs, resulting in increased confidence to make a decision on growing a crop using allocated water only, selling water, or purchasing additional water to maximise business profit.

A new web-based tool will help irrigators understand irrigation needs and costs and gross margins, so that they can determine the most productive use of water in their farming business.

Leah Garnett, Gae Plunkett and Troy Mauger
Rice Extension

EACH season, irrigators make decisions around what crops to grow, the area of each crop, how much water is required and how much the water costs. Understanding how to calculate the price of water, crop gross margins and sensitivity analysis to determine risk are essential steps for making the best decision to improve the business.

Every rice farming business is different. They vary in size, enterprise mix, location, structure, resource availability, equity and capital. Therefore, it is important that each grower understands their own numbers. Rice$cenario is a web-based tool that can be used to enter individual data for guidance in making water purchase, crop mix and risk management decisions.

Water costs are the major driver of profitability in irrigated farming systems and to undertake a useful gross margin analysis it is necessary to calculate with accuracy the variable cost of water.

Rice Extension developed Rice$cenario after identifying the need for a simple, user-friendly decision support tool to assist growers to analyse water costs within the farming business to ensure the most productive use of water available. There was no 'free of charge' tool in the marketplace that could meet this need. Growers using this tool will better understand irrigation needs and costs and the gross margin of all crops and livestock enterprises within the farming business.

Rice$cenario allows growers to determine:

- water budget — how much water is needed for an irrigation program or how much rice can be grow with the water available
- fixed and variable costs of allocated and purchased water
- average price for irrigation water (purchased, allocated and other)
- what price a grower can afford to purchase temporary water
- gross margin of farm enterprises, such as rice, winter crops, other summer crops and livestock
- sensitivity analyses on yield, crop price and purchased water price
- income and input costs to use in farm budgets.

Rice$cenario stores scenarios electronically for future use or reference, and the information is protected by a user's unique email address. Individual scenarios can also be printed out for a hard copy or emailed to an advisor or family members.

When planning for the coming season, growers can assess different scenarios including crop size, variety, sowing methods and crop management to maximise their profitability.

Rice$cenario has default charges for inputs in the templates however growers are encouraged to input their own information to obtain gross margins of enterprises and sensitivity analyses on yield, price and purchased water of the given scenario.

Rice$cenario was released in July 2015 and a number of workshops and training days were held to promote the tool. The uptake has been healthy with 30% of growers having used Rice$cenario and created at least two scenarios each. Rice$cenario is continually being improved taking into account feedback from users and updates have included new gross margin templates for common winter crops and livestock operations. Irrigation fees and charges and default input costs are updated in July of each year.

Water budgeting

Calculating the cost of water in a gross margin is important to help determine the enterprise mix. Many growers will use the temporary water price only in their gross margin. Others will decide which crops they are assigning their purchased and allocated water to. Some advisors and growers think an average purchased water cost is a better indicator. What is most important is that a consistent process is used from crop to crop or between years. The advantage of the average purchased water cost, which is the method used in Rice$cenario, is that it assigns the cost of the water purchased and the water allocated consistently across all cropping enterprises grown within the irrigation year.

An example from the Water Budgeting Calculator from the tool is shown in Figure 1.

Fixed and variable costs of water

Since the separation of land and water titles and the maturing of the water trade market, budgeting for fixed and variable charges for irrigation water has become more complex and difficult—even to calculate an accurate cost of the variable charges.

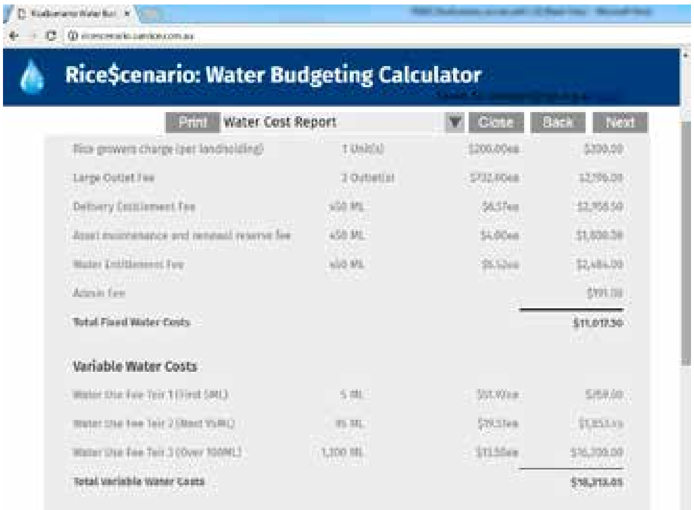

Figure 1. An example of a water cost report prepared Rice$cenario.

These complexities have evolved as irrigation companies have adjusted to the changes described above and as their customer base becomes more diverse. An example of the complexity is one irrigation company has 13 line items on the account received by growers including outlet fees, landholding fees, S&D outlet fees, fixed and variable charges on delivery entitlements and government charges, to mention a few. In addition, a lot of growers trade water in from the temporary market or in some instances sell water rather than growing a crop, which will have an impact on irrigation costs.

The Rice$cenario water budgeting tool allows growers to calculate the fixed and variable charges from predicted or known allocation. Charges under a number of different scenarios can be calculated, such as purchasing extra water or selling water.

Fixed and variable fees and charges are updated in July of each year.

Gross margins

Gross margins are used to compare the relative profitability of different farm management practices and similar enterprises. Consequently, they provide a starting point for understanding the farm's management practices or overall enterprise mix. A gross margin can be defined as the gross income from an enterprise less the variable costs incurred in achieving that income.

A gross margin includes only the variable costs of a farm business. Variable costs are costs directly attributable to an enterprise and vary in proportion to the size of an enterprise. For example, if double the area of rice is sown, then the variable costs associated with growing the extra area, such as seed, chemicals and fertiliser will also roughly double.

A gross margin is not net profit because it does not include fixed or overhead costs such as fixed water costs, depreciation, interest payments, rates or permanent labour, which are paid regardless of enterprise size or mix.

Gross margins are generally quoted per unit of the most limiting resource, e.g. land (per ha) or irrigation water (per ML).

Gross margins need to be used carefully. As overhead costs are excluded, it is advisable to only make comparisons of gross margins between enterprises that use similar resources. If major changes are being considered, more comprehensive budgeting techniques such as capital costs, cash flow budgeting, profit and loss statements cost of production and balance sheets are required. Gross margins are a valuable aid in farm planning but they should be by no means the sole determinant of enterprise mix.

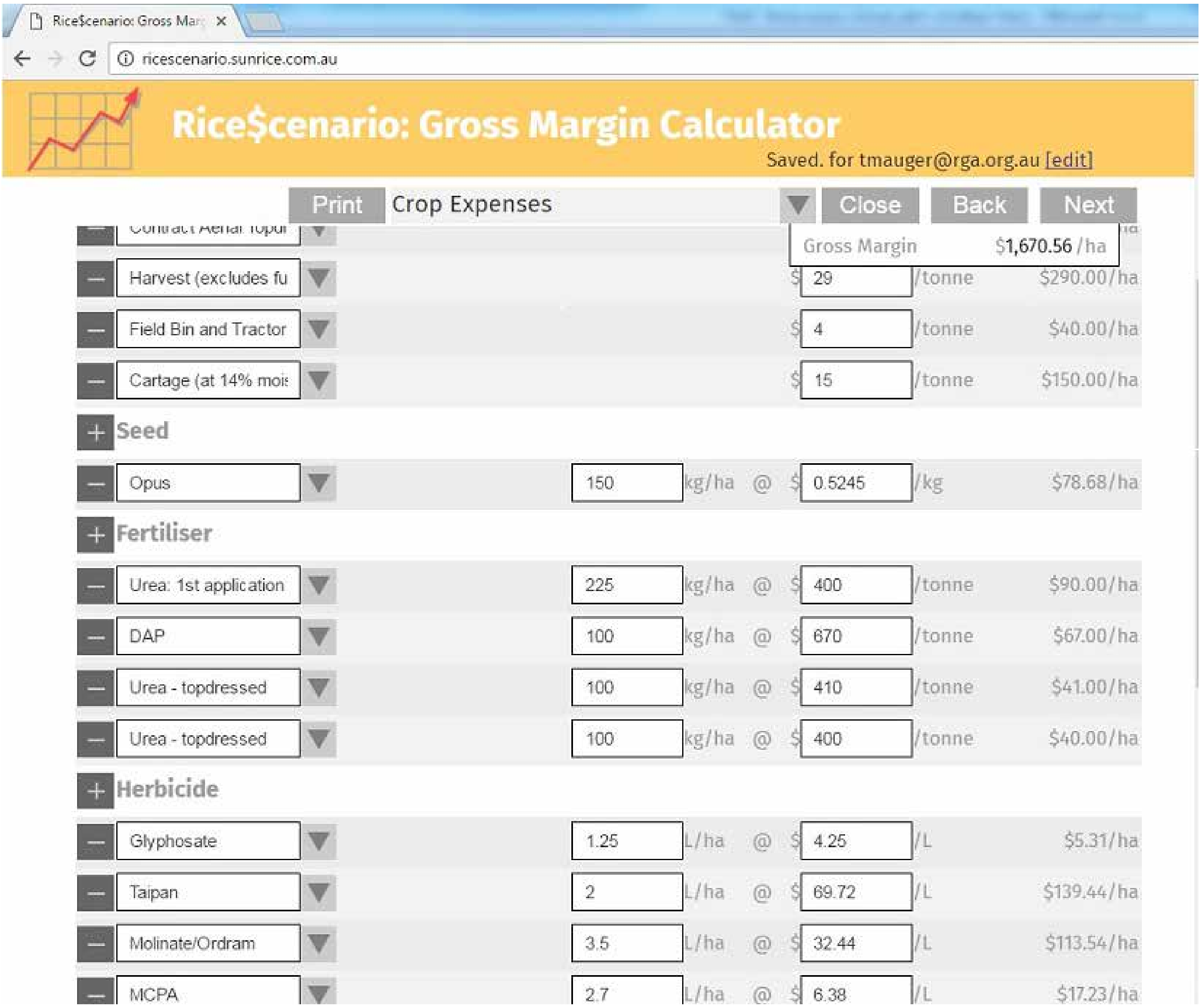

Figure 2. An example of a gross margin report prepared Rice$cenario.

Table 1. A sensitivity table showing gross margin per hectare for dry broadcast Reiziq rice production as affected by variation in yield and rice price.

Yield (t/ha)	Rice price ($/t) 300	320	340	360	380
9.3	1,190	1,376	1,562	1,748	1,934
9.8	1,339	1,535	1,731	1,927	2,123
10.3	1,488	1,694	1,900	2,106	2,312
10.8	1,637	1,853	2,069	2,285	2,501
11.3	1,787	2,013	2,239	2,465	2,691
11.8	1,936	2,172	2,408	2,644	2,880
12.3	2,085	2,331	2,577	2,823	3,069
12.8	2,234	2,490	2,746	3,002	3,258
13.3	2,383	2,649	2,915	3,181	3,447

Sensitivity tables

A sensitivity table presents the effect of variations in yield and price on gross margin as a result of seasonal and market conditions on gross margin. Table 1 shows a sensitivity budget that has been calculated using Rice$cenario for gross margin per hectare for a dry broadcast Reiziq crop. The gross margin figure enclosed in the darkest shaded box ($2,069) represents the original gross margin under the base yield, variable costs and price assumptions. All other gross margin figures in the table are based on the same cost of inputs and management operations but show the effect if yield and price varies from the original budgets. When yield increases the gross margin is improved. Increases in rice price also improve the gross margin.

Outcomes

Users of Rice$cenario have reported a greater understanding of their water costs, resulting in increased confidence to make a decision on growing a crop using allocated water only, selling water or purchasing additional water to maximise business profit. The Rice Extension team has used the tool extensively to promote innovative best rice growing practices using gross margin comparisons and sensitivity analyses from Rice$cenario in case studies and at field walks. The continued promotion of the decision support tool among irrigators will enhance productivity and economic sustainability of irrigated farming businesses.

To use Rice$cenario, go to ricescenario.sunrice.com.au

Future work

Rice Extension has commissioned a computer programmer to enhance Rice$cenario by adding the ability for variable costs and income to be transferred to a monthly cash flow budget. To complete the monthly cash flow budget, fixed and capital expenses will be required. This addition will be huge time saver for growers, as it will show cash flow implications of the scenario that they are testing. The monthly cash flow would be in a format that is 'bank ready' and another tool to assist with business management.

Further information

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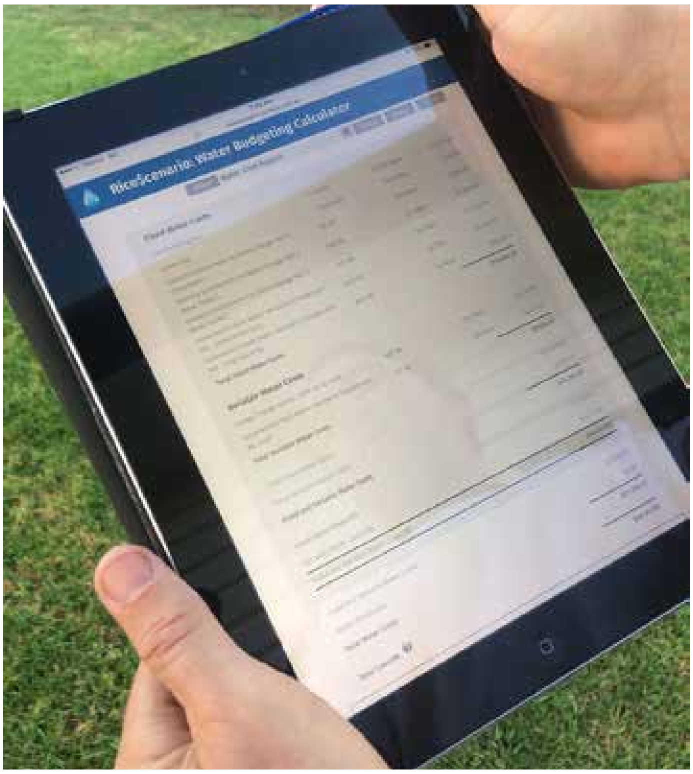

Rice$cenario gives users increased confidence when making decisions about using allocated water only, selling water or purchasing additional water for the coming season's cropping program.

Coleambally rice grower, Peter Sheppard, photographed seven brolgas in his rice field with a drone-mounted camera, in mid-March.

HI-TECH TWITCHING IN COLEAMBALLY RICE FIELD

It's hard to think of a more iconic Australian waterbird than the brolga. Their dances, trumpeting calls and graceful flight are in equal parts unmistakable and captivating.

Matthew Herring
Wildlife Ecologist, Murray Wildlife

BROLGAS have been embedded in Aboriginal culture for 50,000 years. Fortunately, they are still a common species across northern Australia and central Queensland, but down south they are now quite rare and considered a threatened species. There are about 1000 remaining in south-western Victoria and the far south-east of South Australia, and less than 250 in northern Victoria and southern New South Wales.

Peter Sheppard, a Coleambally rice grower, managed to get some stunning images from his drone of seven brolgas during March 2017. It's the most he has ever seen on his farm. Mark Robb from Coleambally Irrigation has been keeping tabs on brolga numbers in the area for almost 20 years and although he's seen up to ten together in the broader region, he's never had that many within the core irrigation area. Three of Peter's seven brolgas are young birds, without the full red head, indicating an excellent breeding season consistent with many other waterbird species in 2016–17.

After the winter–spring breeding season, brolgas congregate in non-breeding flocks, with the most important site in the Riverina being the Tuckerbil and Fivebough Swamps at Leeton. In 2003, I recorded 123 brolgas there but not a single one was a young bird. It is thought these flocking sites are where young birds meet and partner for life; a bit like a B&S Ball perhaps?

During our Bitterns in Rice Project surveys we have recorded the odd pair of brolgas in rice around Coleambally and in the Murray Valley, including a rare breeding event near Deniliquin in 2013, but the best areas to see brolgas in southern NSW are on the plains around Urana, Boree Creek, Lockhart, Oaklands, Savernake and Balldale.

Unlike the Australasian bittern, whiskered tern, glossy ibis, Baillon's crake golden-headed cisticola and various other wetland birds, brolgas are not strongly associated with rice fields and irrigation areas.

So why don't brolgas use rice crops more often? It's likely that by the time there's sufficient material to build a nest (December), it is too late in their season. The lack of native water plants with the tubers that they love to eat might also be important.

However, there are still many things that rice growers and other irrigators can do to encourage brolgas on their farms. The most important is to maintain any natural, treeless, shallow swamps, like those with canegrass (*Eragrostis australasica*) and spike rushes (*Eleocharis* spp.), as well as creating similar habitat in constructed wetlands that is available in winter and spring. They also love feeding on the grain in corn stubble and will use it extensively during the flocking season, providing they have a large, shallow wetland nearby to roost on at night.

Long live the iconic southern brolga!

Further information

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In 2013, a rare breeding event near rice fields occurred at Deniliquin. The young bird is in front of the adult bird, as indicated by the arrow.

Breakfast meetings across the MIA attracted a good number of irrigators and IREC was able to determine priority R&D issues.

TOAST, TEA AND TOP PRIORITY R&D ISSUES

QUICK TAKE

- A series of breakfast meetings conducted by IREC in February asked irrigators to nominate their top issues for research for the benefit of all industry sectors in the Murrumbidgee Valley.
- Spray drift, herbicide resistance and crop rotations were amongst the priority issues at four different meetings. Interestingly, crop rotations and herbicide resistance were top issues arising from the 2014 meetings.
- IREC was able to report on projects that had been instigated as a result of the 2014 breakfast meetings, namely the *Maximising Irrigation Profitability* and *Optimising the Management of Manures in Southern NSW Cotton Production* projects.

Spray drift, herbicide resistance and crop rotations were among high priority research issues identified by irrigators at a recent round of breakfast meetings conducted by IREC.

Iva Quarisa
Executive Officer, IREC

BREAKFAST meetings were conducted across the Murrumbidgee Irrigation Area in February to find out from growers and advisors what issues they saw as vital and requiring research, and ranking these issues in priority order. The research ideas were framed around what research would have benefit across the range of industry sectors in irrigated cropping in the Murrumbidgee Valley.

The meetings, held at Gogeldrie, Yenda, Coleambally and Benerembah, were similar to those run in 2014. As with the last round, meetings were held at drawcard sites so attendees could look at current research or innovations in irrigated farming. This year the meetings featured use of drones, new varieties and an automated supply irrigation layout.

The Whitton breakfast meeting inspected the new layout and automated supply system at the IREC Field Station before discussing priority R&D issues.

The Coleambally breakfast meeting inspected a cotton crop and heard about projects instigated from priorities raised at the last round of meetings in 2014.

Growers were firstly asked to write down their ideas on paper, with each person then sharing their best idea. These were written up on butcher's paper. Once all the ideas were listed, each person got to vote on the five ideas that were most important to them. This process ultimately showed what the top issues for the group were.

The top issues from each of the meetings are listed as follows.

Gogeldrie meeting

1. Herbicide resistance
2. Soil moisture monitoring and irrigation scheduling
3. Spray drift
4. Fertiliser efficiency (losses in different forms)
5. Soil quality — improving microbes

Yenda meeting

1. Crop rotations — cotton/rice/pulses
2. Spray drift awareness
3. Profitability of cropping enterprises
4. Incorporating stubble after rice
5. Water use efficiency
6. Field layouts and design — t/ML = $/ML

Coleambally meeting

1. Amelioration of cut areas
2. Understanding soils — sodicity, impact of irrigation systems and compaction
3. Shorter-season summer crops
4. High-yielding short-season rice

Benerembah meeting

1. Beds versus hills in cotton, especially early season irrigation looking at waterlogging/soil temperatures
2. Cut/fill nutrient management
3. Spray drift — education 2,4-D, ppm thresholds to cause damage and lessons from north
4. Compaction
5. Benefits of wheat stubble incorporation for cotton
6. Herbicide resistance, alternative weed management

It was interesting to see the number of common research areas that was of highest priority across the groups, as groups were not told how other groups had voted.

The issues of spray drift, herbicide resistance and crop rotations were raised at each of the meetings. This is remarkable as crop rotations and herbicide resistance were top issues for a number of groups in the 2014 meetings.

The priorities raised at the 2014 meetings led to the establishment of a number of projects, including:

- **Maximising On-farm Irrigation Profitability**

In the Murrumbidgee Valley, this project is examining the effect of reduced deficit irrigation on nitrogen use efficiency and water use efficiency in irrigated cotton. In the Murray Valley the project is investigating what crop and management regime will allow continuous double cropping in the rice farming system. While the northern Victoria site at Numurkah site is exploring the productivity and profitability of maize through better nitrogen and water management.

- **Optimising the Management of Manures in Southern NSW Cotton Production**

This Cotton Research and Development Corporation funded project is investigating the benefits of using animal manure in cotton production systems.

The priorities generated from the breakfast meetings are valuable information as RDCs, research institutions and funding bodies are keen to fund projects that are relevant to irrigators, who are the levy payers. IREC will work with other farmer groups with aim of establishing projects to address some of these priority issues.

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