no 191, spring 2014

Irrigation Research & Extension Committee

farmers' newsletter

large area edition

IN THIS EDITION

IREC

Global issues, local lessons

Optimising farming system

New research

Business management

Regular pages

Administration & Advertising

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

Businesses and organisations interested in advertising in the IREC Farmers' Newsletter should contact the office of IREC.

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Editorial

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

Please submit articles for the next edition, Autumn 2015, to the editor by 9 February 2015.

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Design & production

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

Print

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

Photography

Cover: An Australasian bittern's nest in a Riverina rice field in 2013–14. Photo: Matthew Herring, Murray Wildlife.

Unless indicated otherwise, all photographs are attributable to the author of the article in which the photograph appears.

ISSN 0467 – 5282

CHAIRMAN'S REPORT

An era of exciting options

Irrigators in the Murray and Murrumbidgee irrigation valleys have never had so many viable crop options as they have leading into the 2014–15 irrigation season and beyond. Rice, cotton, a resurgence in the soybean market and options in the maize and sorghum markets … it is a great platform from which our broadacre irrigators can prosper. IREC took a field trip to the walnut operation in Leeton in July, which also gave rise to the sense of some great opportunities in horticulture, going forward.

Over the next twelve months it is IREC's intention to develop our farmer subcommittees for both broadacre and horticulture to further pinpoint opportunities for research in these areas. If you would like to nominate yourself or someone else for these committees and this exciting opportunity, please contact our IREC executive officer Iva Quarisa by 30 September, 2014. This is a great opportunity to have input into irrigation R&D as well as learn about the cutting edge technology employed in our current farming systems.

Memberships due

IREC membership subscriptions are now due. Membership is a great way to support IREC to facilitate relevant research opportunities and conduct extension activities (field days, seminars, workshops and issue-gathering sessions). Membership of IREC also includes and supports the *Farmers' Newsletter*. Please give serious consideration to becoming a member, as your membership adds value and purpose to everything we do. For 2014–15, membership costs $55 (GST incl.).

Farmers' Newsletter changes

Due to financial and organisational considerations, IREC is unfortunately no longer able to produce and deliver the *Farmers' Newsletter*, free of charge, to its readership throughout the southern Murray–Darling Basin. For IREC to maintain its cross-commodity approach to its activities, the *Farmers' Newsletter* can only be available through membership of IREC or subscription. Please refer to the explanatory letter enclosed with this magazine and we look forward to your support in maintaining the unique and valuable information source that is the Farmers' Newsletter.

New field trials

The Whitton Field Station will be in full swing this coming season with 40 ha of cotton going in and numerous trials to be conducted. This will be a great opportunity for the cotton industry to demonstrate best practice to Murrumbidgee Valley growers, while trialling things like pix rates, nitrogen rates, thrip control and measuring things like refuge effectiveness, just to name a few.

An advisory group of agronomists has been formed to have input into what projects are needed and help with the methodology being used. They have met once at the field station and will communicate on an 'as needs' basis throughout the summer cropping season. I would like to recognise the Cotton Research and Development Committee (CRDC) and Cotton Seed Distributors (CSD) for their generous support in assisting with funding the field station and its activities.

Outstanding contribution

I am very pleased that IREC has recognised Dr Warren Muirhead with an IREC Lifetime Achievement Award in recognition of his outstanding lifetime contribution to research and extension in the irrigation industry of the Murrumbidgee Valley. It is important to recognise the people behind the success of irrigation and irrigated agriculture in the region. As a contributor to science, industry and IREC, Warren is one of our finest.

IREC committee

John Blackwell has retired from the executive of the IREC after many years of service. His wide-ranging experience both locally and internationally has been invaluable to IREC. On behalf of the entire irrigation community I would like to thank John for his efforts. He will be replaced by Toni Nugent from the EH Graham Centre. We are looking forward to her involvement.

Stay in touch

Please keep informed about field days, farm walks, workshops or single-issue gatherings that IREC will be running over the next twelve months, through our website, Facebook or following us on Twitter. Our commitment to our membership is that IREC events will be relevant, dynamic and succinct; giving participants something that will add value to their business.

I hope you enjoy this spring edition of the IREC Farmers' Newsletter, and have a prosperous summer.

Rob Houghton

Chairman IREC

IREC Website: irec.org.au **Facebook:** irecnsw **Twitter:** IRECNSW

LIFETIME ACHIEVER — WARREN MUIRHEAD

Liz Humphreys
IRRI, Philippines; formerly CSIRO Griffith

QUICK TAKE

- Warren Muirhead, long-time irrigation and agricultural scientist with CSIRO at Griffith, received an IREC Lifetime Achievement Award in August 2014.
- The award recognised his outstanding lifetime contribution to research, extension and training of young scientists in the irrigation industry of the Murrumbidgee Valley.
- Warren earnt respect across the farming and scientific communities, for the careful and practical science he conducted to address issues affecting crop production and irrigaton in the region.
- This article is a very slightly edited version of the tribute speech for Warren Muirhead made by Liz Humphreys at the award dinner held in Griffith.

Thanks both to Warren Muirhead and IREC for providing an excuse for this fantastic reunion — bringing together people from many eras and from many walks of life with one thing in common, that their work and/or lives were touched in some way by Warren.

As I started to jot down a few things about Warren, I quickly realised that this award was a no-brainer! What an outstanding contribution Warren has made in so many ways, and none could be more deserving for this prestigious award. I thank IREC for giving me the honour of making this formal tribute to Warren.

Warren spent his childhood in a horticultural farming family near Maitland, where his father mainly grew potatoes, cabbages and cauliflowers. In his teens, he received a Soil Conservation Service traineeship, which enabled him to do a degree in Agricultural Science at the University of Sydney.

Soil conservation

After graduating in 1954 Warren was posted to the NSW Soil Conservation Service at Condobolin for 12 months to gain some experience before taking over the Hay office. The Condobolin office had an attractive, spirited young secretary called Gwen, who loved dancing and sport. Warren didn't like dancing and wasn't interested in sport, but something must have clicked, because here they are tonight [at the award dinner], together with three daughters and five grandchildren.

Warren and Gwen shifted to Hay where Warren worked on reclamation of scalds — bare patches of degraded land that had lost the topsoil as a result of over-grazing and wind erosion. In the 1950s, the Soil Conservation Service constructed several enclosures in the western Riverina in an attempt to reclaim the land by excluding stock together with various practices such as furrowing, water ponding, seeding with salt bush and natural regeneration. One of Warren's jobs was to study the response to the reclamation measures and evapotranspiration from salt bush. I think you can still see one of the enclosures where Warren used to work just south of Hay on the road to Deniliquin.

Irrigation research

In the late 1950s, Arthur West's father Eric retired as Chief of CSIRO Division of Irrigation Research at Griffith. With the arrival of the new Chief, Eric Hoare, several new positions were created. Warren commenced with CSIRO in 1960 as an Experimental Officer. His first job was to evaluate the potential for crops and pastures planted between rice crops, to help manage the problems of watertables and soil salinisation. He did much of this work on Jim Wilkinson's farm at Murrami, and this was the topic of his Masters Degree, awarded from the University of Adelaide in 1967. The research showed that if the rice straw was retained in the field, the low light levels beneath the straw inhibited crop establishment. However, with a good stubble burn, establishment was satisfactory and led to lowering of the watertable by the crop. More than 40 years later, John Blackwell and his Indian collaborators developed the Happy Seeder technology to the degree that it is now possible to get good establishment of wheat in standing rice residues in the conditions of north west India.

The current version of the Happy Seeder leaves the seed row uncovered, and John asked me to acknowledge both Warren and Evan Christen's encouragement in this work. John has found that the concept is suitable for conditions in the Riverina, but is still working out how to manufacture a machine of suitable quality.

Over the next 36 years with CSIRO, Warren worked on a wide range of problems and opportunities for irrigation farmers, in both broadacre crops and horticulture.

Solving soil problems

In the mid-1960s, Alistair Low appeared on the scene and introduced short-duration cotton varieties and cotton production took off in a small way. However, a major limitation was the poor physical properties of the clay soils, and Warren and colleagues set about investigating soil amelioration options such as gypsum and deep tillage. A lot of this work was done on John Woodside's property at Benerembah, and in 1976 Warren was awarded his PhD with Macquarie University on this topic.

At this stage, farmers were increasingly diversifying to other crops in the rice rotation such as maize and sunflowers, and the problem of "rice stubble disorder" emerged rather spectacularly, with big lush plants on the former contour lines where the rice banks had been, and stunted growth in the former rice bays. This was a very nice example of the use of science to determine the cause of a problem and come up with management practices that went a long way to reducing the problem.

The problem was largely caused by changes in the soil properties as a result of growing flooded rice, which caused phosphorus tie up when the soil was not flooded. The solution was to band the phosphorus fertiliser below the seed instead of broadcasting. Warren and his team were over a decade ahead of the Americans, who "rediscovered" this problem in the 1980s. I understand the problem is again being rediscovered in this region, with funding being sought for further research, probably reflecting the lack of investment in agricultural RD&E and loss of corporate memory in the irrigation areas over the past 20 years.

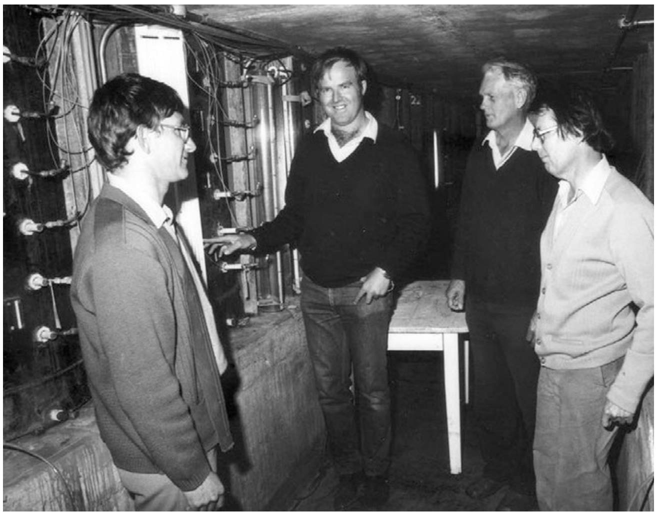
Nitrogen fertiliser efficiency

Around the time I started at CSIRO Griffith, in the early 1980s, Warren was in the midst of a program on improving the efficiency of nitrogen fertilisers applied to row crops, especially maize and sunflowers. At the same time, Barry Steer was doing plant physiological studies on sunflowers. It was around this time that farmers were experimenting with anhydrous ammonia applied in the irrigation water, and Warren, Bob White and John Lockhart did some good science which showed that water run urea was indeed a most efficient and robust method of applying nitrogen fertiliser. They did a lot of this work on Alan Irvin's farm at Benerembah. As a result of this work Warren received a Certificate of Appreciation from the Maize Association of Australia.

Also at Irvin's, Warren and his collaborators from Canberra and Griffith showed that there were huge losses of nitrogen fertiliser applied to rice if it was topdressed into the floodwater before the plant canopy was well developed, and also if it was applied prior to combine sowing rice followed by flush irrigations.

Warren Muirhead commenced his distinguished career with the NSW Soil Conservation Service, working at Condobolin and then Hay.

Warren joined CSIRO in 1960, where he earnt his reputation as the farmer's scientist, finding practical solutions to enhance the productivity of the region's soils.



In the lysimeter at CSIRO Griffith, are, from left, Wayne Meyer, Peter Cull, Warren and Henry Barr

A 1980s field trial where gaseous loss of nitrogen fertiliser was measured. The results have influenced rice nitrogen management since.

From left, Bruce and Marie Smith, and Jean and Graeme Menzies

Irrigation & drainage management

In the 1980s the CSIRO Griffith lab became part of CSIRO Division of Water Resources, and there was a compulsory shift away from an agronomic and production focus to a water management and environmental focus. With a lot of help from Warren and team, John Blackwell managed to get some funds for a lateral move sprinkler irrigator and evaluated it for rice on the Whitton common. The sprinkler irrigated rice performed poorly from early on, and was also hit very hard by cold damage — 1983–84 was a very bad year for cold damage.

In those days, much of the wheat was still grown in rice layouts in which the water came in at the top of the field and flowed from bay to bay to the bottom end, meaning that the upper bays were waterlogged for a long time. Warren initiated some nice research which showed that yield declined as the duration of ponding increased, and the importance of getting the water on and off as quickly as possible.

Warren also initiated CSIRO research on puddling for rice to reduce drainage losses, which brought me back to Griffith again, after a stint in Canberra. Most of this work was done at Coleambally, on the farms of Noel Sutton, Brian Mannes, Keith Burge and Peter Shepheard. We also snuck in a bit of work on nitrogen management for puddled soils, which Lucy Kealey did for her Masters Degree. It was during this era that Brad Fawcett and John Townsend also joined the team. The work on puddling was rather controversial for a couple of reasons. Firstly, it highlighted the problem of large accessions to the watertable from rice culture, which didn't exactly endear us to the rice growing community. Also, we received some pretty harsh criticism from our fellow soil scientists because they were concerned about soil degradation. We didn't find any impacts of puddling on the performance of crops grown in rotation with rice, but we didn't conduct our research for long enough for the usual reasons (short-term funding).

These days there is a big move in parts of Asia to shift from puddling and transplanting of rice to dry seeding with intermittent irrigation and conservation agriculture — especially in the rice-wheat systems of south Asia, where we find that after 2–3 years of puddling rice there are deleterious effects on wheat.

Around the same time, Warren initiated research on irrigation and drainage management in horticulture. This included collaboration with a couple of drainage gurus from Silsoe in England, which resulted in Evan Christen coming to CSIRO to conduct his PhD research, initially on mole drainage. A lot of this work was done on Jim Geltch's farm at Whitton, where he was also showing big benefits of raised beds for reducing waterlogging on heavy clay soils. It was at this time that Warren recruited Jim Moll and somehow turned him into an agricultural economist, now his lifetime career.

Busy retirement

Warren retired from CSIRO a little prematurely in 1996, so that he could look after Gwen following a couple of health hiccups. In fact, for the first 10 or more years after he retired, I think that

Gwen saw less of Warren than she had when he was working for CSIRO. Retirement was when his real career began.

In no time, he became leader of the Coleambally Land and Water Management Plan Education Program, and shortly after that he became a director on the board of Coleambally Irrigation, a role which he continued for seven years to 2004. During that period he had a lot of interaction with Arun Tiwari, Environment Manager at CICL.

At the same time, he stayed on as an honorary fellow with CSIRO in an advisory role to various people, and worked with Tony Parle on his vegetable and cucumber crops.

Warren was a passionate advocate for irrigated agriculture, but equally strong on the need for radical changes in on-farm and industry practices if irrigated agriculture was to remain a viable and vibrant industry in the region. He carefully studied many proposals and plans such as the Living Murray, the Murray–Darling Basin plans, and whatever else came along. He wrote strongly-argued submissions on draft plans and to inquiries, not just in relation to water, but also other matters. For example, while I was googling Warren on the internet, I came across a submission to the Productivity Commission's Citrus Industry Inquiry in 2000. In his submission, Warren put the case for value adding, concluding with the following remarks:

> *"The future for irrigated agriculture is likely to depend more on strategies of value adding, niche markets, "new age" cooperatives and sound financial planning, than simply producing a commodity. The Griffith community may well have a new vibrant industry if citrus growers encourage their representatives to spend more time talking to people knowledgeable in agribusiness, food technology and product innovation than to politicians."*

Thoroughly deserved

This brief outline of Warren's career is very incomplete and empty without emphasising several very important characteristics which really highlight why he is so deserving of this Lifetime Achievement Award.

Practical solutions

Warren has always been driven by a very strong desire to find practical solutions to help farmers to improve their production, economic viability and sustainability — in both environmental and political terms.

Being a member of IREC subcommittees was a valuable opportunity for Warren to interact with farmers, agribusiness, consultants and other researchers to identify important barriers to crop production and to assist with the adoption of possible solutions by irrigators.

He was much more driven by practical solutions than by producing scientific publications, at times to his detriment in CSIRO. None the less, he has a healthy publication record in scientific journals, but this is far outweighed by his publications in farmer magazines such as the IREC *Farmers' Newsletter*, the Onion Grower and so on.

Gwen and Warren Muirhead with Jim Geltch, a farmer cooperator with Warren for drainage research in broadacre vegetable crops

From left, Peter Ryrie, Lance Parker, Sue Chittick-Dalton and Adrienne Steer

From left, Evan Christian, Roy Zandona, Warren and Jim Moll

Liz Humphreys congratulates Gwen and Warren on Warren's IREC Lifetime Achievement Award

Devloping and evaluating new technology

As I have already outlined, Warren made a significant contribution to the development and/or evaluation of many technologies to increase yield and efficiency of input use. He did not do this in isolation — he was always talking to farmers, attending farmer meetings and field days, listening, and coming up with ideas that he would try out with farmers on their farms.

In the late 1970s, a new Chief of the CSIRO Division of Irrigation Research banned Warren from going onto farms and attending farmer meetings. He was also evicted from his office in the main CSIRO building to a small building at the other end of the CSIRO site to try and prevent him from spending too much time talking to others — because Warren had many visitors who wanted to sound out ideas, and seek information and suggestions.

So Warren and his team were exiled to Siberia, the building that was eventually taken over by IREC until CSIRO sold out to Murrumbidgee Irrigation over seven years ago. Maybe the idea of his chief at that time was to try and get more scientific papers from Warren, or maybe there were other motives. Anyway, that didn't stop Warren. Whenever he wanted to go on a farm or to farmer meetings he took leave. Fortunately, the new chief didn't last long but that was the beginning of the gradual downgrading of the CSIRO Griffith laboratory and CSIRO's many efforts to close the laboratory since then.

Excellent experimentalist

Warren was a very good field experimentalist — he used thorough and rigourous methods in soil and crop monitoring and processing, and in data analysis and interpretation. He was always alert to the arrival of new monitoring technologies and keen to test and adapt them as they became available. This didn't just apply to scientific monitoring, it also applied to communications technologies of all sorts and continues to this day.

Identifying opportunity

Warren has a great gift for gaining new insights and identifying new opportunities — I often saw this in terms of unexpected findings in field experimentation, organisational changes that were thrust upon us, and in the policy arena. He was quick to move on and grasp the new opportunities, rather than whinge about the changes and losses. It was through Warren that the concept of "out of adversity grows opportunity" first crystallised for me.

Teacher & mentor

Warren has been a great teacher and mentor for many people in this room, and for countless other students and young scientists, all of whom thought he was wonderful. None of them ever had a bad word to say against Warren. Students came from various parts of Australia and from other parts of the world, especially Holland. Sigrid Tijs was one of those students, luckily for Roy Zandona. In my early days at CSIRO I remember a young Brian Freeman dropping in frequently for D&Ms with Warren in his office in Siberia. Brian went on to become head of the school of wine science and viticulture at Charles Sturt University, and Director of the Cooperative Research Centre.

For me personally, Warren's greatest legacies have been the solid foundation that he gave me in the conduct of rigorous field research, data analysis and interpretation, being open to unexpected findings, and willing to question. Equally important was his kindly and helpful approach to the mentoring of young scientists. I remember making a strong mental note very early on — if Warren makes a gentle suggestion, consider it as a bloody good idea to be followed up on immediately! His approach was always about respect and concern for the whole person, active listening and never being dismissive.

Congratulations Warren on your Lifetime Achievement Award, you truly deserve it.

DISCOVER A NEW PROFITABLE SUMMER CROPPING OPTION IN MIA AND CIA

More growers in the Murrumbidgee and Coleambally irrigation areas are considering growing cotton in the 2014/15 season. Not only is cotton a new and profitable summer cropping option, it also provides additional weed control and marketing benefits compared to other summer cropping alternatives.

GET HANDS ON EXPERIENCE WITH WHAT'S INVOLVED IN GROWING COTTON

To get first hand experience with what to expect when growing cotton in your area, give Luke or Jorian a call to find out when the next field walk is being held in your area.

EIGHT STAGES FOR SUCCESS

If you're not sure what's involved in producing high yielding cotton, here's a basic outline of the eight key factors to ensure your cotton crop is successful:

1. **Establishing the crop** *(including variety selection, row spacing and temperature effects, seed quality and soil conditions).*
2. **Nutritional requirements**
3. **Irrigation**
4. **Fruit retention**
5. **Weed and insect control** *With Bollgard II® and Roundup Ready® Flex technology built in, growing cotton has never been easier. Bollgard II reduces the need for insecticide sprays and Roundup Ready Flex allows for over the top applications of Roundup Ready Herbicide with PLANTSHIELD® by Monsanto for broad spectrum weed control.*
6. **Ensuring balanced crop growth**
7. **Impact of plant stress on yield and fibre quality**
8. **Defoliation and picking**

Key contacts to help you get started

Luke Sampson
Monsanto
Regional Business Manager
Lachlan, Macquarie, Bourke & Southern NSW
0427 701 986
luke.sampson@monsanto.com

Jorian Millyard
Cotton Seed Distributors
Extension and Development Agronomist
0428 950 009
jmillyard@csd.net.au

Luke and Jorian are happy to help, give them a call or send them an email. The CSD 'Management Guidelines for Growing High Yielding Cotton Crops' is also a great place to start – download a copy from **www.csd.net.au/resources**

HORTICULTURE RESEARCH PRIORITIES NUTTED OUT

Iva Quarisa
IREC Executive Officer

QUICK TAKE

- Murrumbidgee Valley horticulturalists have identified their top-priority cross-industry R&D issues.
- The highest priority issue is improved biosecurity across the horticultural industries.
- Energy-efficiency, alternative crops, a fruit fly control strategy and water deficit irrigation with no reduction in fruit size were the other top priorities.
- A comprehensive tour of Walnuts Australia's operation at Leeton followed the issues-identification session.

Horticulturalists of the Murrumbidgee Valley have had an opportunity to discuss cross-industry R&D issues, and identify areas that need more attention.

Following on from the successful breakfast meetings that IREC held for broadacre farmers late last year, a breakfast meeting and farm walk planned for horticulture farmers was held in June 2014.

The breakfast meeting and farm walk was generously hosted by Walnuts Australia. The group was given a complete tour of the Walnuts Australia farm at Leeton, including its machinery and processing plant.

Business before nuts

As with past breakfast meetings, the top research priorities were teased out by the growers in attendance, with improved bio-security being the topic of highest concern.

The top five research priorities (in order of importance) were:

- improved bio-security
- energy based efficiency ideas for irrigation
- alternative crops for small, medium and large farms
- fruit fly control strategy for the MIA
- water deficit irrigation with no reduction in fruit size.

IREC will use this list of priorities in discussions with horticulture-research and development organisations to assist secure funds for locally-relevant R&D.

Nuts & bolts of walnuts

After breakfast, the group learnt all about Walnuts Australia's operation and growing walnuts in the region. The Walnuts Australia Leeton site has 765 ha of walnuts ranging from three to eight years old. The trees are grown on mounded free-draining soils, with mounding height dependent upon the depth of topsoil.

Irrigation

The whole property is drip irrigated, with a maximum of 350 ha being irrigated in one shift. At the main pump station there is a variable speed drive pump, four 75 kW motors and a jockey pump to maintain pressure in-line when not pumping. This jockey pump is vital because there is over 900 km of drip line covering the 765 ha. Each row has two drip lines to deliver water, with up to 11 mm/day output. There is 40 metre fall across the farm, so an extra high pressure (800 kPa) pump and main has been installed to deliver water to the high elevation areas. Five screen filters filter the water sourced from the 400 ML storage dam.

Walnuts Australia is in the process of developing a new orchard at Tabbita. It is estimated to cost $25,000/ha to develop the site which includes an 800 ML storage dam and power upgrade.

Water use target is 12 ML/ha depending on the season.

Production & harvest

Once all the trees are at full production, Walnuts Australia will target an average yield of 5–6 t/ha. A small harvest can be expected in Year 4, with trees reaching full production in Year 8. Walnuts Australia is planning a 25-year life span for the trees.

Before harvest, trees are sprayed to induce hull spilt, which enables early harvest and a higher quality kernel. The inter row is kept smooth and as clean as possible to prevent contamination and maintain good harvest conditions. Harvest commences at the end of February and continues until the end of April.

During harvest there are three machines working 16 hours each day. To harvest the walnuts each tree is shaken. After shaking, a sweeping machine sweeps the walnuts into a windrow. This machine also has an air blower which blows any walnuts off the tree line into the windrow.

The windrow of walnuts and other foreign matter (leaves, sticks and small stones) are picked up by the harvester and roughly cleaned. The aim is to remove as much organic material such as leaves, hulls and sticks in the field as possible. A conveyor transports the walnuts to a reservoir cart towed by the harvester. The walnuts are then conveyed into a field bin, which carts the walnuts to a mobile elevator, which is used to fill the waiting trucks.

Post-harvest handling

The walnuts are trucked to the hulling line, which removes the green fleshy hull from around the outside of the shell as well as washes the outside of the shell. The hulling machine runs at around 7.0 t/h with full capacity of 20 t/h. Once the nuts goes through the hulling process, the aim is to bring the moisture content down to 8%, with the nuts having a moisture content of 40–45% at harvest.

After drying, the nuts are augered into a 20 foot shipping container (8–10 t) or a silo (each silo holds 1000 t of nuts) for storage. Once in storage they should be kept at a temperature between 2–4 degrees Celsius to retain the best quality. As quality is also strongly related to moisture content, the aim is to keep moisture below 12%.

Quality is determined by kernel colour, the lighter coloured kernel the better. The kernel has lighter colour early in the season thus the desire for early season harvest. Commodity price is based upon the Chandler variety in California with top quality nuts selling between $5–6/kg.

The Leeton site of Walnuts Australia can now value-add the nuts produced, as a shelling machine has been installed to shell the smaller nuts. Previously, the smaller nuts were transported to Vietnam for hand shelling, before being transported back to Australia for packing.

The shelling line also has a one of a kind, innovative three-stage colour sorter to ensure that maximum quality, and thus price, is received for the nuts.

Nuts are exported as kernels or in-shell to China, Italy, United Kingdom and Spain. In-shell nuts are packed in 20 kg and 10 kg bags, with kernels packed in 5 and 10 kg bags.

All organic matter, manure, waste from hulling line, pruning and leaf litter is mulched and deposited back in the paddock to compost.

Breeding material

All breeding material is obtained from California and it can take up to 17 years to breed new material. To bring bud wood into Australia for breeding, it must remain in quarantine for two years

The tour group is shown through the storage area where walnuts packed in 30 kg bags and stored on pallets.

The tour group learns about growing walnuts as it inspects the Walnuts Australia orchard at Leeton.

A sweeping machine is used to sweep the walnuts into a windrow ready for pickup.

in order to ensure it is disease free. There is a very high risk of Cherry Wood virus, which can stay dormant in the wood.

Growing market

Walnuts are a growth area for Australian horticulture, with Australian production unable to meet the domestic demand. In Australia, there are approximately 3500 ha of walnuts grown, but there is clearly more capacity in the domestic market.

Further information

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ONCE BITTERN, NOT SHY OF RICE

By Matt Herring[1], Neil Bull[2], Andrew Silcocks[3] and Mark Robb[4]

[1] Murray Wildlife, [2] Ricegrowers Association of Australia, [3] Birdlife Australia, [4] Coleambally Irrigation Cooperative Limited

This article is based on an article published in the September 2014 edition of Australian Birdlife, *the magazine of Birdlife Australia*

QUICK TAKE

- The large numbers of bitterns found in rice fields is a strong case that food production and nature conservation can be potential partners.
- Several key factors had pointed toward widespread and regular breeding, but until January 2014, there had been no conclusive evidence of any bittern breeding in rice crops.
- Bitterns show a strong preference for aerial sown rice, probably because earlier inundation is important so that potential prey, such as frogs, can establish populations sooner.
- While there are clear environmental costs of extracting water from rivers for irrigation, the surrogate habitat values of rice fields are not widely appreciated in Australia.

This is an unusual situation. Here we have one of Australia's most threatened birds and it turns out that their stronghold explicitly comprises agriculture — in the form of rice crops. Nowhere else in the country can we find such large numbers of the globally endangered Australasian bittern.

These new insights, fresh from the Riverina of New South Wales, could be likened to finding unprecedented numbers of southern cassowaries in Queensland's cane fields or discovering widespread breeding of plains wanderers in wheat crops. Odd as it is, this situation compels us to re-imagine food production and nature conservation, not as separate, competing human pursuits, but as potential partners.

Sneaky & rare

The Australasian bittern is right up there among Australia's most poorly-known birds. They're sneaky and they're rare. Often the only clue to their presence is the stirring sound of a booming male at sunrise or sunset during the breeding season. Even the birdiest of birdwatchers typically only logs a handful of sightings in their lifetime. Nationally, Australasian bitterns are listed as Endangered under the Environment Protection and Biodiversity Conservation Act, and the IUCN (International Union for Conservation of Nature) also considers them Endangered at the global level. Only one other Australian waterbird is equally threatened — the Australian painted snipe. Much more unexpectedly, we've found significant numbers of these snipes in rice fields as well, but that's another story (see box on next page).

The total population of the Australasian bittern in Australia has traditionally been estimated at around 2500 mature individuals, though at the end of the decade-long millennium drought in 2010, the lowest estimate on record of just 250–800 birds emerged. In New Zealand, there are between 500 and 1000, and they may persist (or occur as vagrants) in very small numbers in New Caledonia, including the Loyalty Islands.

Significant numbers

The Riverina has long been known as a stronghold for the Australasian bittern, and the bird has used the region's rice crops for at least forty years. Only now have we begun to understand just how important these agricultural wetlands might be. In late November 2012, as *The Bitterns in Rice Project* gained momentum in its first season, some late-afternoon field days signalled what was to come, with one field day yielding four bitterns sighted and another producing six. By mid-December, sightings from rice growers and targeted surveys made it clear that we were dealing with very significant numbers.

There was, of course, a substantial number of misidentified Nankeen night-herons to deal with!

"I'm not sure what all the fuss is about; I've got 20-odd bitterns roosting in my trees, and then fly down on dusk each day to feed in the rice."

Australasian bitterns never roost in trees and they don't occur in flocks!

By the end of the 2012–13 season, we had confirmed a whopping 70 bitterns in rice crops, avoiding double counting and employing a strict verification process. Our coverage of the 113,500 hectare crop was tiny. Bitterns were unevenly distributed across the rice-growing region, with the Coleambally and Barren Box areas supporting relatively high densities, while much of the Murray Valley supported relatively few. It also became evident how easily bitterns could be overlooked and that a key survey window existed from about two months after sowing when bitterns arrive in crops, until late summer when the rice height can make observation prohibitively difficult and booming males quieten.

As the numbers grew toward the 70 mark, we wondered how representative the sightings were. We trialled a random sampling approach in one of the key areas. The results were staggering. We now fully realised we were talking about a population in the rice fields of the Riverina that extended well into the hundreds. In the following season (2013–14), we refined this approach as the foundation for further work and long-term population monitoring. We found bitterns on one quarter of those rice farms and inevitably, birds were missed.

Anecdotes from rice growers and birdwatchers suggest there is nothing particularly new about this phenomenon of bitterns in rice, such as a post-millennium-drought response or because natural wetlands are more degraded than ever. The importance of rice fields as novel bittern habitat and the significance of the population simply appear to have been overlooked. If these birds are breeding successfully and the population is sustainable, then these food production wetlands may support the global stronghold for the species.

Eggs of the Australasian bittern in a rice crop. Until January 2014, there had not been any conclusive evidence of any bittern breeding in rice crops.

The breeding cycle of Australasian bitterns is well timed with the rice crop. Incubation takes just over three weeks, and chicks can fly after seven or eight weeks, allowing ample time before harvest.

More than just bitterns in the rice …

It's not unusual to see dozens of herons, egrets, spoonbills and cormorants using a rice field. There are also the not-so-welcome flocks of common ducks, which can wreak havoc at the start of some seasons. Keen observers of Riverina rice fields are also familiar with the large numbers of glossy ibis and whiskered tern. Less obvious is the significance of the golden-headed cisticola and Baillon's crake populations. There are migratory shorebirds like the sharp-tailed sandpiper to be found as well, especially early in the season when water depths and rice height are low. In the 2013–14 season, we were amazed to stumble across several eastern grass owls roosting in rice fields. In New South Wales, this threatened wetland owl is normally restricted to the north coast region. One was roosting so close to a bittern nest that we feared bittern chicks might be on the menu. What a conundrum! Fortunately, our fears were allayed.

The most significant additional species though, is the globally endangered Australian painted snipe, whose total population estimates are similarly low as the Australasian bittern. During the 2012–13 season, and much to our surprise, they began appearing at some of our bittern sites. In total, there were 44 birds at five sites, and an additional 43 birds seen by observers at three other rice fields. The sites were spread across the rice-growing region. Again, our survey effort and coverage was miniscule, and the total of 87 birds was highly likely to be indicative of at least several hundred using Riverina rice fields during that summer. It might have been a particularly good season for them, but, like the Australasian bittern, the extent of their use of rice fields as novel habitat has probably just been overlooked. With potentially conflicting habitat requirements (snipe avoid vegetation that is too tall and dense), there is a new challenge for managing rice fields to benefit both the Australasian bittern and the Australian painted snipe.

It's not just about waterbirds either. Our surveys have reaffirmed the significance of Riverina rice fields for the nationally threatened southern bell frog (also widely known as the growling grass frog), and considering Peter Menkhorst observed an Australasian bittern at Werribee eat 17 of them, it's reasonable to suggest they're an important food source in rice crops.

Breeding & harvest

Several key factors had pointed toward there being widespread and regular breeding, but until January 2014, we'd been unable to find conclusive evidence of any bittern breeding in rice crops.

Eventually we managed our first glimpse into the very secret reproductive life of the Australasian bittern. The initial nest for the 2013–14 season was a glowing beacon of bittern reproduction: three chicks and two eggs. All up, we found four nests, three of which were from randomly selected rice farms, giving us some confidence in extrapolating our results. Trials using a small drone helped find one nest and showed promise for complementing existing methods in the future.

We have learnt that chicks leave the nest and begin roaming within about two weeks of hatching. We found two chicks, about 18 days old, dubbed 'Bazza' and 'Beatrice', a good 50 metres from their nest. They were hiding in the tall, thick barnyard grass on a bank between two rice bays. With such mobile chicks and so many places to hide in a rice field, it makes it difficult to determine breeding success, although all indications so far are positive. So, what about the impending harvest? Incubation takes just over three weeks, and the chicks then need seven or eight weeks before they can fly. All four breeding sites had ample time before harvest, although one was close.

This leaves us with a burning question. Where do all of these bitterns go when fields are drained and the rice is harvested? We have begun targeted surveys of key wetland areas in the Riverina in the hope of finding some of their non-breeding, post-harvest haunts, but we may well be better off searching near the coast. Monitoring data from the Edithvale–Seaford Wetlands near Melbourne indicate relatively large numbers of bitterns arrive in autumn (when rice harvest occurs). They remain present throughout winter and depart before summer.

Are these bitterns from the rice fields? Time will tell.

Food production & nature conservation

Paradoxes are plenty in this unusual situation. One of the primary threats to the Australasian bittern and apparent causes of its decline — the diversion of water for irrigation — is, in the case of Riverina rice fields, ultimately providing important surrogate habitat. The familiar narrative of a threatened species clinging to the 'best bits', the least disturbed, last remaining chunks of their customary habitat doesn't apply. The traditional story of habitat loss, where animals are left homeless, doesn't fit here either. Understandably, for some it's rather sad and confronting that species might be increasingly reliant on such modified environments. Pragmatically, situations like the bitterns in rice may well be just the sort of opportunities that conservationists need to seize.

Protected areas like national parks are central to nature conservation, yet alone they'll be vastly inadequate to wave off the forecast mass-extinction due to human impact on global ecosystems. With over 200,000 additional mouths around the world to feed each day, and a mid-century forecast of 9–10 billion people, there is an inevitable need for increased agricultural production. A recent report from the United Nations Food and Agriculture Organisation insists efforts to reduce both food waste and meat consumption will only partly fill the gap. Somehow we need to reconcile the need for more food with a desire to avoid extinctions. Wildlife-friendly farming is one of the most promising solutions.

Chicks begin roaming from the nest within about two weeks of hatching. Two 18-day old chicks were found about 50 metres from their nest, hiding in tall, thick barnyard grass on a bank between bays.

Working with the industry to improve habitat

Rice farmers could take the lead on bittern conservation. Many of them are chuffed to be providing habitat for such a special bird and are keen to benefit them further. They can tweak their rice-growing methods to suit bitterns, especially where there is little or no effect on the hip pocket. Where there is a significant cost or loss of production, support could be made available from a range of potential sources. Demonstrating how farming and threatened species conservation can work together is an appealing outcome. Perhaps consumers would pay a premium for bittern-friendly rice. There is a small market already willing to do so for organically grown rice.

The *Bitterns in Rice Project* is slowly but surely uncovering the characteristics of rice crops and their management that bitterns like most. Bitterns show a strong preference for aerially-sown crops, rather than drill-sown or combine-sown crops. It appears that the earlier inundation of aerially-sown crops is important. Potential prey, such as frogs, can establish their populations sooner. In yet another paradox, the key motivations for growers to move away from aerially-sown crops are to save water and avoid duck damage early in the season. New varieties with shorter growing periods are also likely to be bad news for bitterns.

The rice season means bittern breeding is delayed and the earlier crops are sown, the better their chances of supporting bitterns. We've also noted the value of cumbungi (*Typha* spp.) patches in and around rice fields. They are frequently used by bitterns for feeding and roosting. As explained earlier, weedy banks (e.g. barnyard grass, *Echinochloa* spp.) are important as cover for roaming chicks, and the control of foxes and cats should also improve the likelihood of chick survival.

Bitterns seem to go for the biggest bays, but because the open edges around each bay are often used for feeding and smaller bays mean more edges, a combination is likely best. Reduced pesticide use is also likely to increase bittern prey populations. In future seasons, we are planning to trial some alternative rice field designs with dedicated bittern habitat bays, and test the effectiveness of our bittern-friendly rice-growing techniques. Outside of the rice–growing season, the management of bittern habitat in natural wetlands, farm dams, channels and other areas are all practical measures rice farmers can make to benefit Australia's 'bunyip' bird.

Closing remarks

There is an increasing number of rice farmers keeping their eyes and ears peeled for this elusive species, which helps us to learn more about them, and enhance conservation efforts. They feel they have been unjustly vilified as environmental vandals and that the habitat values of rice growing are too often ignored. Images of severe drought in the Murray–Darling Basin, of dying river red gums and thirsty floodplains have often led the proverbial finger to be pointed at the water used by irrigators. While there are clear environmental costs of extracting water from rivers for irrigation, the surrogate habitat values of rice fields are not widely appreciated in Australia.

A common misconception is that if a rice farmer doesn't grow rice then they use less water and there is more for the environment. The amount of water available to an irrigator and used on their farm each year is determined by regional allocations and individual property entitlements. If not rice, then something else will be grown. As far as we can see, no practical alternative agricultural use of the water would provide the same benefit to waterbirds and other biodiversity that rice does.

Nothing beats natural wetlands and they should always be our priority for conservation. The delivery of environmental water to natural wetlands on public and private land has been a godsend for conservation. The current Australian Government has indicated a strategic shift in environmental water recovery, from water buybacks to infrastructure upgrades. Instead of buying the entitlements from landholders willing to sell or buying entire properties and the water that comes with them, it will be looking more to water saving measures like the replacement of channels with pipelines. This approach will likely mean less rice fields are lost. In the season just prior to the drought, with 100% water allocations, there was approximately 180,000 hectares of rice. The 2012–13 season, also with 100% allocations, was down to 113,500 hectares, the reduction largely attributable to buybacks.

Deciding how much water should be made available for food production and how much should be spared for environmental flows is difficult and value-laden. There is also much uncertainty ahead for the Murray–Darling Basin's wetlands, including its rice fields. Climate change, increasing competition and demand for water, and changes in global markets are but a few of the key challenges. Perhaps the current separation of food production and nature conservation is just part of the same false dichotomy of the economy versus the environment. Maybe we really ought to be on the lookout for 'win-wins'. This unusual situation of bitterns thriving in rice fields presents such a potential partnership. It's one where bitterns, other waterbirds and biodiversity generally would be the beneficiaries alongside the production of food.

About the authors

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Bitterns in Rice Project

The *Bitterns in Rice Project* is a collaboration between Birdlife Australia and RGA, with key support from the Norman Wettenhall Foundation, the Riverina and Murray Local Land Services, RIRDC, Coleambally Irrigation, Murrumbidgee Irrigation, Murray Irrigation, Murrumbidgee and Coleambally Landcare, the Murrumbidgee Field Naturalists Club, and the NSW Office of Heritage and Environment.

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SUPERSIZED HERBICIDE RESISTANCE IN THE STATES

Kieran O'Keeffe

CottonInfo, Regional Development Officer, Southern NSW

QUICK TAKE

- Australian cotton industry representatives visited the southern areas of the United States of America in July 2014 to understand, first hand, the glyphosate resistance issues facing American cotton growers.
- The first glyphosate-resistant Palmer amaranth weed was identified in 2004 in the southern US and by 2007, these fields were considered unmanageable. In Australia, the immediate threat is a glyphosate-resistant grass species.
- The tour experience was a stark reminder that herbicide resistance is inevitable if we rely on just one tactic for weed control.
- Australian farmers need to have an integrated focus on weed management and zero tolerance to weed set.

Currently there is an estimated 60 million hectares of herbicide resistant weeds in the United States of America and this area is increasing by 25% each year.

Representatives of the Australian cotton industry visited the southern areas of the US in July 2014 to understand, first hand, the glyphosate resistance issues American cotton growers are facing in their production systems.

The group was made up of eight cotton growers, three consultants and three industry representatives. The trip was sponsored by Monsanto and organised through Cotton Australia and Cotton Research & Development Corporation (CRDC).

Situation in the US

Palmer amaranth (*Amaranthus palmeri*) has caused major disruption to summer cropping in the southern states of the US. Known locally as pigweed (different to Australian pigweed), Palmer amaranth is a very competitive weed that is dominating cropping and non-cropping ground in the southern states. Major problems have now existed for ten years in cotton, maize and soybean cropping programs. All these crops have one thing in common — market dominance of the Roundup Ready trait.

The first resistant Palmer amaranth weed was identified in 2004 in the southern US and by 2007 these fields were considered unmanageable. By 2012 glyphosate resistant Palmer amaranth had occurred in all southern states. We don't have this species of amaranth in Australia but if we "push the easy button" with weed control tactics, we will eventually select a herbicide-resistant weed in our summer cropping systems.

In Australia, the immediate threat is a glyphosate-resistant grass species if we don't have diversity in weed management programs. Glyphosate-resistant ryegrass is already widespread in southern NSW.

Are they winning the weed war in the US?

In cotton production systems, US growers are using a combination of glyphosate and pre-emergent residuals plus residuals through shielded sprayers and laybys in crop, every two weeks until canopy closure. This has added up to $125/ha in herbicide costs to already very tight margins. A rebate system to growers is in place to encourage the use of different modes of herbicide action. This rebate system has increased residual use from 43% in 2010 to currently 85% of the cotton area. For weed escapes, growers are back to chipping and removing the chipped weeds from the field, at a cost of up to $300/ha.

More herbicide-resistance traits in cotton are becoming available in the US with a three-way stack in cotton of glyphosate/glufosinate/dicamba undergoing approval for the next cotton season.

Key messages for Australian cotton

As one American consultant said, "The cat's out of the bag and it's not going back!".

It was a stark reminder that herbicide resistance is inevitable if we rely on just one tactic. We need an integrated focus on weed management and zero tolerance to weed seed set.

Fourteen representatives of the Australian cotton industry visited the United States to understand first hand, glyphosate resistance issues in US cotton production systems.

John "Cowboy "Cameron holding a Palmer amaranth (Amaranthus palmeri) plant. The weed has caused major disruption to summer cropping in the southern states of the US.

A strip of crop was not treated with residual herbicide and Palmer amaranth dominates at the expense of cotton. This demonstrates the need for growers to have a zero tolerance to weed set on their whole farm.

Graham Charles, NSW DPI Narrabri, looking at Palmer amaranth in a cotton crop, which has developed into a super weed in US cropping systems. It is very competitive and super-resistant to glyphosate herbicides.

The top five key messages, in priority order, from the tour group back to the Australian industry were:

- Integrated Weed Management (IWM)
  - area-wide management
  - encourage all tactics to be used
  - crop rotations
  - new potential chemical and non-chemical tactics be investigated
  - reinforce total farm hygiene
- strong on-going extension campaign — WeedSmart website and catchy message
- incentives to increase the use of pre- and post-emergent residuals be investigated
- risk/reward for the different chemical programs — an economic/biological model be developed
- strengthen the current cross-sector CRDC/GRDC approach to resistance management.

The cotton industry has just released its Herbicide Resistance Management Plan for 2014–15, which is based on using multiple tactics to extend the useful life of glyphosate. The plan will be published in the Cotton Pest Management Guide, due for release spring 2014, and available from the Publications page of the CRDC website: www.crdc.com.au/publications.

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A grower's reflections on the trip — John Cameron, cotton grower of the year 2013

For their cropping system, US farmers have successfully developed a super weed, Palmer amaranth, that is very competitive, and super-resistant to glyphosate herbicides. The vision of all the farmers we visited was purely focused on this weed and ways to control it, and thoughts of crop yield or input efficiencies were not front of mind. There were many comments from growers that they were selecting crop varieties according to the herbicide traits they possessed, rather than according to crop production (yield and/or quality). The market is awash with seed companies (who just happen to be the multi-national trait providers as well) selling their varieties with a mix of backgrounds and traits and the ensuring commercial programs to go with them.

The US farmer appears to have an obsession with zero till at all costs, weed control can only be achieved with herbicides, and crop rotation is something that you only do if commodity prices change. Granted that the soils we saw were very fragile and erosion prone, that may be the correct management approach, but they appear to have not learnt from past mistakes. Prior to Roundup Ready type crops, control of weeds seemed to be achieved by a number of means, including pre- and post-emergent knockdown and residual herbicides, cultural practices and some crop mixes.

With the arrival of in-crop use of Roundup®, there seemed to be a bulk shift to that technique, and a total reliance on just that one technology! Other herbicide groups were forgotten, and residuals abandoned. This worked for about 8–10 seasons, at which time at a number of locations around the country, growers noticed surviving plants. Their approach was to treat them again with the same herbicide, then shrug their shoulders! Of course, after marching their cotton pickers or harvesters straight through these patches, they become a little larger, and a little more widespread!

Not until whole fields and districts were infested did growers start to believe that perhaps Roundup wasn't going to control this weed! So aggressive and competitive is Palmer amaranth as a weed (growth rate of 5 cm height per day) that farmers have reported that it has replaced all their other weed species.

Their reaction now is a cropping program dominated by a multitude of residual herbicides, with farmers and advisors reporting up to three or four different modes of action and several applications to the same crop each year to try and control Palmer amaranth, and hand-rogueing of survivors if labour can be found! Many times we heard the call for "new chemistry" or multiple traits as necessary, as the war really isn't being won!

Does any of this sound familiar for our cropping situation?

Messages for Australian growers

- Herbicide resistance is real! The better the product, and the larger the percentage of crop area that is treated in a similar way, the greater the risk! The cost of herbicide resistance is borne by the farmer.
- Vigilance is essential. Whole fields don't suddenly become resistant. In the US it started with patches, and a poor response to them.
- Seed banks are the link from one generation to the next, and the severity of the problem. If plants are prevented from seeding, the problem is much reduced. Your weeds don't just grow within your fields — look at your total environment.
- Simply substituting one chemical mechanism for another may work today! Will it work tomorrow?
- Do the cost/benefit analysis of all tactics available to the weed manager. We may need to look at tactics other than just chemical intervention for weed control — cultivation does still work, crop rotations and using the environment to manipulate the total weed population may be viable options.

Further information

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CAN AUSTRALIAN RICE BE HEALTHIER?

Leigh Vial

Head, Experiment Station, International Rice Research Institute & absent rice grower, Moulamein

QUICK TAKE

- As people become more sedentary, dietary requirements should change and demand for low GI food should increase.
- Glycaemic index is becoming an important food characteristic in the Australian food market and so far, Doongara and brown rice are the only low GI options for Australian rice.
- Developing Australian japonica rice with low GI may meet market demand but there is a threat that indica rices from tropical regions could be developed to also meet the same market.

Obesity and type 2 diabetes continue their march across much of the world. Australians are becoming obese quicker than most. To help fight obesity and diabetes, we need low glycaemic index (GI) food.

As people are becoming more sedentary, dietary requirements in Australia and many of its traditional rice markets are changing. If people keep eating the types and quantities of foods they needed when they lived more active lives, there is plenty of glucose entering the blood that is not used at the time. The pancreas has to work hard to make the insulin that stores that glucose as fat. The result is that people get fatter (obesity) and their pancreases get worn-out (type 2 diabetes). They need foods that deliver glucose to their blood slowly — they need low GI food. To help meet these dietary needs, Australian rice probably needs to become lower GI, while still filling its market niche of being soft and sticky.

Can Australia produce a soft, low-GI rice?

A food is low GI when it slowly releases glucose into the blood after eating. For rice, that generally means having a high amylose, and hence a low amylopectin content. Amylose comes in long chains with few ends that enzymes can work on, so it slowly breaks down into simple sugars. Amylopectin has lots of branches, so it breaks down quickly. Australian rice generally has low amylose and high amylopectin, as this gives it the soft-cooking characteristic that means so much to our markets. Hence, Australian rice is generally high GI.

Glycaemic index is becoming an important food characteristic in the Australian food market. It is now used as a point of differentiation in at least some of the packaged-food market place. So far, either Doongara (which is a harder-textured, higher-amylose distant cousin of our main varieties, with GI of 54%) or brown rice (GI of 53%) have been our only low GI options; less than 55% is generally regarded as low GI. SunRice has exploited them well, selling a lot of retort brown rice and selling Doongara as low GI rice, but this is probably not enough to satisfy the market in future. Doongara does not have the soft texture for which the main Australian varieties are known (Figure 1).

We will probably need Australia's main soft-cooking varieties to also be as low GI as white rice to command the niche we now have. To do that, we need to defy one or both of two well-accepted relationships.

First, we could create a rice variety that is intermediate-amylose but also low GI. Lower amylose content generally means high GI, but because type 2 diabetes is a worldwide issue, IRRI researchers have looked closely at this relationship and found it weakens a lot once amylose content reaches about 15%; a mid-amylose rice (Figure 1). There are many low GI lines of rice with only intermediate amylose content. Genomics studies will help to understand why this is the case, and breed a mid-amylose rice that is low GI (follow the gold line in Figure 1).

Second, we could create a variety that is soft but has intermediate amylose content. It was believed that the gel consistency, or softness of cooked rice is strongly influenced by amylose content. IRRI researchers have trawled through 63,700 lines to find outliers: soft, higher amylose rice (Figure 2). They have found outliers aplenty, and intend using these outliers in genomic studies to unravel the genetics of this relationship. Once the genetics of these outliers are understood, breeders will be able to deliberately breed soft, intermediate-amylose rice (follow the gold line on Figure 2).

Hence, we can breed a variety or two with intermediate amylose content that is both soft and low GI. To my knowledge, no one is trying to do that with a japonica rice ... yet.

What is happening currently?

Currently the Australian rice breeding program is trying to select low GI lines using a genetic marker that measures amylose content. The low GI parent plants that the breeders have used produce a whole grain that is high amylose, hard and inedible, so they want to break the link between high amylose and low GI with backcrossing. Unfortunately the GI tests cost a lot: $8000 per sample for tests on living plants (*in vivo*) and $700 per sample for laboratory tests (*in vitro*). Thousand of lines need to be screened to achieve this, hence the breeders are presently looking at partnerships with universities to develop cheaper *in vitro* methods.

This is a great opportunity for Australia to fill a growing niche. However, this is also a threat. If varieties can be bred that are intermediate amylose and also soft-cooking, it will enable indica rice (grown in the tropics and generally higher amylose) to better satisfy markets now held by japonica. Softness and stickiness are the main characteristics that define the japonica market, along with the classic shorter grain length; the believed strength of the amylose-softness relationship means that the japonica market is mostly a separate market. If a variety can be intermediate amylose and soft, indica rices will be able to provide those characteristics; it is easy to reduce grain length if desired. Of course, some japonica markets will always be japonica markets; they are not interested in a substitute. Other markets, such as PNG and the Pacific Islands and perhaps the Middle East, may more readily accept substitutes.

Australia should invest in developing a soft, low-GI, mid-amylose rice. That will be an important part of serving many of our markets in the future, our domestic markets in particular. But beware, the same innovation may bring new competitors for us.

Further information

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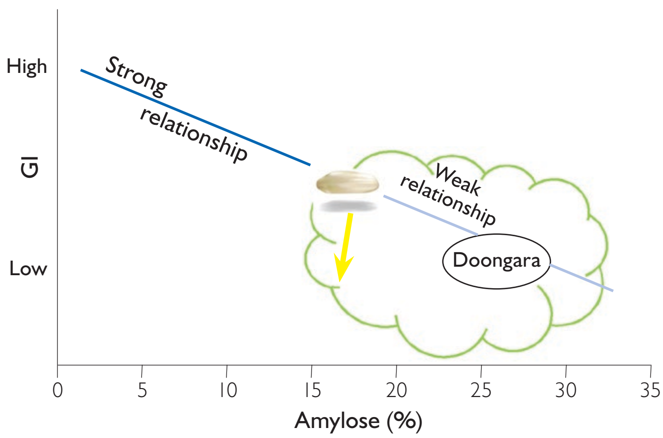

***Figure 1**: There are mid-amylose lines with low GI (gold star)*

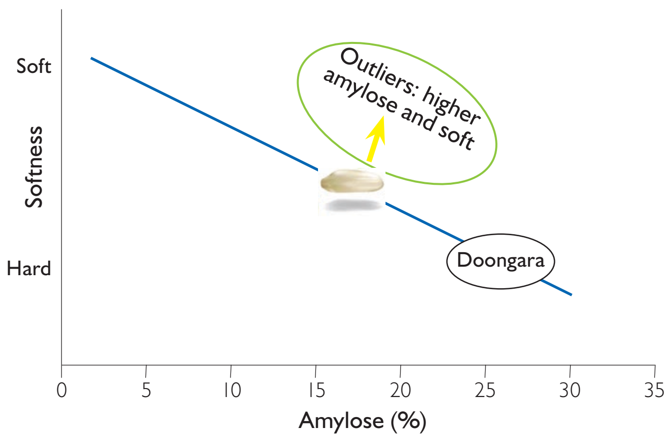

***Figure 2**: There are higher amylose lines that are still soft*

IRRI is scanning across tens of thousands of lines to spot outliers that break the rules about the genetic relationship between texture and GI.

Close inspection of trials is one way for the author to counteract the risks of an increasingly sedentary lifestyle.

FACTORS AFFECTING RICE ESTABLISHMENT AT FINLEY

John Lacy
John Lacy Consulting, Finley

QUICK TAKE

- Some factors affecting the establishment of rice crops have not changed much, while others have changed a lot, for the sowing seasons of 2010 to 2013.
- Wind, cold and ibis continue to cause problems for aerial sowing and dry broadcasting.
- Snails, ducks, melted fine soil and muddy water have been bigger problems since 2010.
- Recent factors affecting drill sowing were over-deep sowing and uneven sowing depth, too slow drainage and weed control compared with the 2010 season factors of locusts, ducks and slime.

Although establishment success of aerial and dry broadcast sowing and drill sowing is improving, there are still a number of factors affecting establishment.

Survey results of the Finley Discussion Group growers for 2010 through to 2013, show that poor establishment affected 3000–6000 ha of aerial sown and dry broadcasted rice, and 300–800 ha of drill sown rice. The two main factors affecting aerial sowing and dry broadcasting were weather related, i.e. wind and cold; while the main factors affecting drill sowing were over-deep and uneven sowing depth.

This article presents the results of the Finley Discussion Group grower surveys about the factors affecting rice establishment for the 2010–13 sowing years. The key messages are summarised and Table 1 presents the relative importance of each factor on crop establishment. Since more drill sowing commenced in 2010, the factors are divided between aerial and dry broadcast, and drill. The percentages are based on the number of times the factor is mentioned.

Aerial & dry broadcasting

The key factors affecting aerial and dry broadcast sown rice are summarised as follows.

Wind — remains a major problem and in the 2013 season, wind speed was 25% above average. Although most farmers manage wind with low water, the water can end up at either end of the bay and if the soil melts and covers seed, establishment is hampered.

Cold weather — was rated the worst in 2013. It meant more water management adjustment was needed as rice growth was slow, which in turn meant less vigour to compete with weeds.

Snails — most rice in 2010 was on fresh ground so snails were not an issue. With better water allocations enabling closer-to-average rice areas, more rice was grown on stubbles in 2011, which led to significant snail damage in 2012. Earlier control with bluestone applied to rice fields within one week of sowing reduced damage in 2013.

Ducks — are still a major problem for farmers near watercourses and swamps, particularly when rice crops are isolated. Many farmers in these areas have changed to drill sowing. In 2013 the new Deniliquin siren and rotating lights duck deterrent has been a great aid and made a difference. For farmers in dense rice areas and away from watercourses, ducks were not an issue. Galahs got some dry broadcast seed – these fields crops need to be filled quickly.

Ibis — are often a problem as they are harder to scare than ducks.

Other — problems of slime, bloodworms, deep water and muddy water reduced over the four years.

Drill sowing

The key factors affecting drill sown rice are summarised as follows.

Ducks & locusts — the very wet weather in 2010 even led to ducks and locusts grazing drill crops but rice recovery was mostly good although odd bays did not recover.

Sowing — as the drill area increased, sowing factors such as over-deep sowing, uneven sowing depth, lack of ridge roller use and layout factors (poor layout and slow drainage) have affected establishment.

Weeds — with more rotations being rice on rice, weed control has become more difficult and affects establishment. Some farmers with a lot of barnyard grass have rotated back to aerial or dry broadcasting where control is easier.

Holes at panicle initiation

In the 2013–14 season, farmers recorded the percentage of holes in their crops at panicle initiation (PI) — this is a new check. The average for holes was only 4%, which demonstrates the known ability of rice to compensate for poor establishment. The hot weather after PI also allowed many thinner and variable crops to compensate.

Sowing rates

As Table 1 shows, because there are still many factors affecting establishment farmers have tended to use higher sowing rates as insurance for loss of plants and to reduce holes in crops, with the aim of achieving 150–300 plants/m^2. This recommendation was changed to 180–250 plants/m^2 in 2013 based on a forgotten RIRDC-funded Rice Field Study of the top 50 yielding farmers in the 1991 season.

The Ricecheck discussion group results indicate farmers have slowly increased sowing rates to a high of 170 kg/ha in 2013. For the top 10 yields in each of the years from 2011 to 2013, averaging 12.3 t/ha, the aerial pre-germination sowing rate was 169 kg/ha, dry broadcast 185 kg/ha and direct drill 150 kg/ha.

Although the discussion group yields are high, it seems amazing that 170kg/ha is needed as this is about 550 seeds/m^2 for Reiziq and 644 seeds/m^2 for Sherpa. For 200 plants/m^2 this indicates a seed rate establishment efficiency of 36% for Reiziq and 31% for Sherpa.

Further information

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Survey results from Finley indicate that the main factors affecting aerial sowing and dry broadcasting for the 2010–13 sowing years, were weather related, i.e. wind and cold; and the main factors affecting drill sowing were over-deep and uneven sowing depth.

Table 1. Factors reducing rice establishment, as recorded in surveys of the Finley Discussion Groups 2010–13. Each number is the percentage of total factors listed for that year.

	2010	2011	2012	2013
Aerial/dry broadcasting				
Wind	8	18	7	23
Early cold weather	9	4	13	27
Snails	2	12	20	11
Ducks	13	20	9	1
Ibis	4	10	9	4
Melted fine soil	0	4	4	10
Muddy water	4	8	2	3
Weeds	1	1	5	6
Fill up too long	0	0	7	4
Magister® toxicity	0	2	8	0
Slime	11	2	4	2
Bloodworms	11	3	2	2
Deep water	14	3	2	2
Poor layout	0	5	1	1
Water hens	0	5	1	0
Stubble/organic matter residue	4	1	3	1
Cut area/recent lasering	4	1	3	1
Galahs	0	0	0	1
Aquatic worms	0	0	0	1
Drill sowing				
Too deep sowing	6		17	23
Drainage too slow	0		32	8
Weed control	0		14	16
Uneven sowing depth	0		2	17
Did not use ridge roller	0		8	10
Poor layout	0		8	8
Vegetation/organic matter	3		1	12
Delayed flushing	0		12	0
Poor establishment	0		6	0
Needed to flush after sow	0		0	6
Locusts	30		0	0
Ducks	16		2	0
Slime	10		0	0

RICE NITROGEN TIMING

Brian Dunn and Tina Dunn

NSW Department of Primary Industries, Yanco

QUICK TAKE

- Sufficient nitrogen must be supplied to the rice crop from the soil and pre-permanent water fertiliser applications for adequate growth to be achieved by panicle initiation, or grain yield will be reduced regardless of how much nitrogen is applied at panicle initiation.
- When sufficient nitrogen was supplied pre-permanent water, there was no difference in grain yield between applying all the fertiliser nitrogen prior to permanent water or a split application with nitrogen also applied at panicle initiation.
- Due to increased potential for cold damage at high crop nitrogen levels, we recommend using the split nitrogen strategy. The majority of the expected required nitrogen should be applied prior to permanent water with a top-up at PI once soil nitrogen supply has been defined by crop growth.
- Gross margins are more sensitive to grain yield changes than changes in costs from variable nitrogen application timings.

There is often debate amongst rice growers about the timing and amount of nitrogen fertiliser to apply to their rice crops. Considerable scientific research over several decades has proven that applying nitrogen prior to permanent water for both aerial and drill sown rice is the most efficient practice, with panicle initiation applications running a close second. As we don't have a rice soil nitrogen test and can't predict seasonal temperatures, a split application between both timings is often the safest option, but what split is the best for yield and profitability?

In the 2013–14 rice season, four experiments were established to investigate the timing of nitrogen application on rice grain yield and profitability. Two experiments were located at Leeton Field Station (Leeton 1 and Leeton 2) and one each at Yanco Agricultural Institute (Yanco) and *Old Coree* near Jerilderie. All the experiments were drill sown with excellent establishment.

Nitrogen rates and application timings

The Old Coree and Leeton 1 experiments both had a total urea application rate of 300 kg/ha with this rate split between application timings at pre-permanent water and panicle initiation. The Leeton 1 experiment also included some splits with nitrogen applications at mid-tillering (Table 1).

The Yanco and Leeton 2 experiments both received a total urea application rate of 390 kg/ha with this being split between timings at pre-permanent water and panicle initiation. At all sites a zero nitrogen control treatment was included (Table 1).

The pre-permanent water nitrogen was applied as urea spread onto the dry soil surface within 24 hours of permanent water being applied. The mid-tillering and panicle initiation nitrogen treatments were applied as urea spread into the flood water. The panicle initiation applications were applied within four to six days of panicle initiation occurring.

Leeton Field Station, Experiment 1, prior to sampling at panicle initation

Collection of 1 m² plant samples from Leeton Field Station, Experiment 1, at panicle initiation

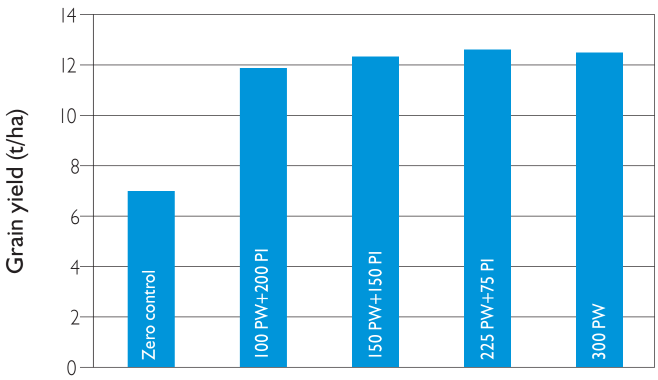

Figure 1. *Grain yield (t/ha) for nitrogen treatments in the Old Coree experiment (l.s.d. (P=0.05) = 0.3)*

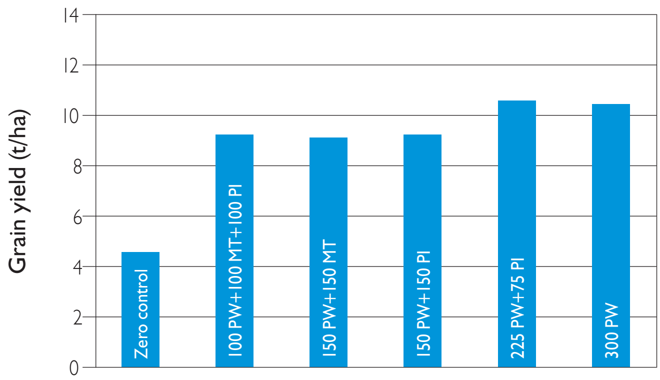

Figure 2. *Grain yield (t/ha) for nitrogen treatments in the Leeton Field Station 1 experiment (mean of varieties) (l.s.d. (P=0.05) = 0.6)*

Table 1. The varieties and nitrogen application timings and rates investigated at each experimental site in the 2013–14 rice season

Experiment	Old Coree	Leeton 1	Yanco	Leeton 2
Variety	Sherpa	Sherpa & Reiziq	Sherpa & Reiziq	Sherpa & Reiziq
Treatments (timing & rate)	Zero control	Zero control	Zero control	Zero control
	PW 100, PI 200	PW 100, MT 100, PI 100	PW 130, PI 260	PW 130, PI 260
	PW 150, PI 150	PW 150, MT 150	PW 260, PI 130	PW 260, PI 130
	PW 225, PI 75	PW 150, PI 150	PW 390	PW 390
	PW 300	PW 225, PI 75		
		PW 300		

Application timings: PW = pre-permanent water, MT = mid-tillering and PI = panicle initiation
The numbers represent the kg/ha of urea applied at each application time

Chris Dawe, Craig Hodges and Tina Dunn collecting tiller samples at harvest

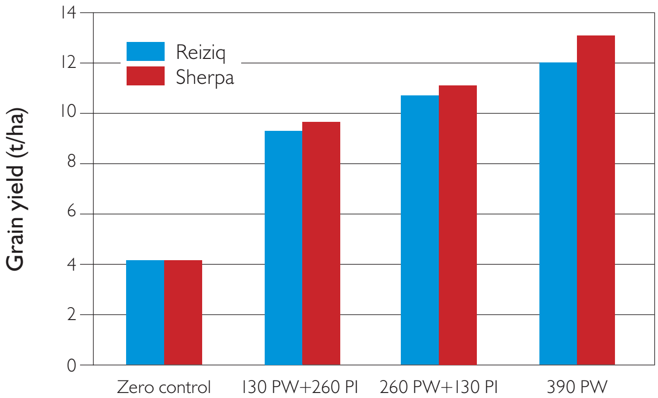

Figure 3*. Grain yield (t/ha) for nitrogen treatments in the Leeton Field Station 2 experiment (l.s.d. (P=0.05) = 0.7)*

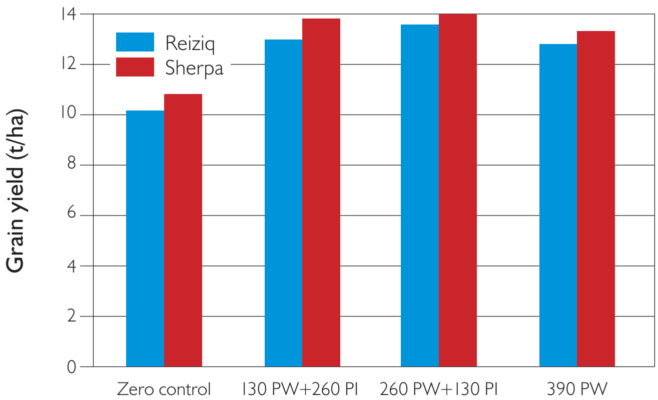

Figure 4*. Grain yield (t/ha) for nitrogen treatments in the Yanco Agricultural Institute experiment (l.s.d. (P=0.05) = n.s.)*

Grain yield

At Old Coree there was no significant difference in grain yield between the 150 PW + 150 PI (12.4 t/ha), 225 PW + 75 PI (12.7 t/ha) and PW 300 (12.6 t/ha) treatments, but the yield of the 100 PW + 200 PI (11.9 t/ha) treatment was significantly lower (Figure 1). A grain yield of 7.1 t/ha was achieved with no added nitrogen fertiliser.

Both of the Leeton experiments were grown on a return rice field, which had very low levels of soil nitrogen. Grain yields of only 4.6 and 4.1 t/ha were obtained from the zero nitrogen controls for the Leeton 1 and Leeton 2 experiments respectively, thus little nitrogen was supplied from the soil.

In Leeton 1 experiment a total of only 300 kg/ha of urea was applied, which was not sufficient to achieve a satisfactory grain yield (i.e. 12 t/ha) regardless of application timing (Figure 2). The highest yields of 10.6 and 10.5 t/ha were achieved by the 225 PW + 75 PI and 300 PW treatments respectively. All other treatments that had less nitrogen applied pre-permanent water yielded significantly lower. The treatments that included mid-tiller nitrogen applications yielded significantly less than the pre-permanent water and panicle initiation treatments.

The second Leeton experiment received a total of 390 kg/ha of urea. Sherpa yielded significantly more than Reiziq and the highest yield (13.0 t/ha) was achieved when all of the 390 kg/ha urea was applied pre-permanent water (Figure 3). Yield significantly decreased as the amount of nitrogen applied pre-permanent water was reduced.

The Yanco site had a high level of soil nitrogen with grain yields of over 10 t/ha achieved without the addition of urea (Figure 4). With such a high level of soil nitrogen all of the added nitrogen treatments, regardless of the application time, yielded more than the zero control. The added nitrogen treatments were not significantly different to each other, but Sherpa yielded significantly more than Reiziq. There were no cold events during microspore which allowed all yields to remain high.

To achieve high grain yields (i.e. > 12 t/ha) nitrogen supplied from the soil, combined with nitrogen from the urea applied pre-permanent water, must be sufficient for the crop to reach an adequate level of growth by panicle initiation. Once this level

Table 2. Grain yield (t/ha) and gross margin analysis ($/ha) of three nitrogen timing/rate treatments from each experiment

Experiment	Grain yield (t/ha)	Gross margin ($/ha)	Grain yield (t/ha)	Gross margin ($/ha)	Grain yield (t/ha)	Gross margin ($/ha)
	PW 150 + PI 150		PW 225 + PI 75		PW 300	
Old Coree	12.44	2418	12.68	2483	12.56	2479
Leeton 1	9.23	1590	10.57	1939	10.46	1937
	PW 130 + PI 260		PW 260 + PI 130		PW 390	
Leeton 2	9.43	1573	10.83	1944	12.53	2412
Yanco	13.43	2612	13.73	2699	13.16	2582

Yield is average of variety for the Leeton Field Station 2 and Yanco Agricultural Institute experiments
Rice price of $300/t and urea price of $544/t used in gross margin analysis

is reached the application of recommended rates of nitrogen at panicle initiation, after doing a NIR Tissue Test, will fine tune the optimum rate to achieve maximum yield with reduced risk of cold damage.

The recommended target nitrogen uptake level required at panicle initiation is 100 to 140 kg N/ha. This target range allows high grain yields to be achieved with economical nitrogen fertiliser applications at panicle initiation with reduced risk of excessive crop nitrogen levels which can lead increased risk of cold induced sterility.

Gross margin analysis

The gross margin analysis results are highly dependent on grain yield (Table 2) with the cost of aerially applying nitrogen at panicle initiation having a relatively small impact in comparison with the profit from increased grain yield.

The highest gross margins were achieved at the Yanco site where the grain yields were above 13 t/ha and the gross margins ranged from $2582/ha to $2699/ha (Table 2). At Old Coree the grain yields were over 12 t/ha and the gross margins ranged from $2418/ha to $2483/ha. The only treatment that reached a gross margin over $2400/ha in the Leeton 2 experiment was when all the 390 kg/ha of urea was applied pre-permanent water ($2412/ha), all other gross margins at Leeton 2 and Leeton 1 sites were below $2000/ha.

Conclusions

When soil nitrogen levels are low, sufficient fertiliser nitrogen must be applied pre-permanent water, or a satisfactory grain yield cannot be achieved. On soil with very low nitrogen levels, 400 kg/ha of urea or more may be required pre-permanent water to achieve a satisfactory grain yield and profit.

In all four experiments, no yield decline was experienced by applying all the required nitrogen pre-permanent water. This may have been different in a season with cool temperatures during microspore, especially in the Yanco experiment which had a high level of soil nitrogen.

As we don't have a rice soil nitrogen test and can't predict seasonal temperatures it is recommended that best practice is to apply the majority of the crops expected nitrogen requirements pre-permanent water and then top-up at panicle initiation. Grower knowledge of adequate nitrogen rates applied to previous rice crops, paddock history, landforming cut and fills and soil type are necessary to determine expected pre-permanent water nitrogen rates.

Mid-tiller nitrogen applications are less efficient than pre-permanent water and panicle initiation application timings and should only be used when it is obvious insufficient nitrogen was applied pre-permanent water to achieve the growth required by panicle initiation.

Grain yield has a much larger impact on gross margin returns than the cost of aerial applying nitrogen at panicle initiation.

Acknowledgements

This research was funded by the Rural Industries Research & Development Corporation (RIRDC) and NSW Department of Primary Industries. Competent technical support by Craig Hodges and Chris Dawe has contributed significantly to the success of this project.

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Old Coree experiment at harvest

RICE PI NITROGEN – HOW MUCH YIELD CAN I GAIN?

Brian Dunn

NSW Department of Primary Industries, Yanco

QUICK TAKE

- The maximum grain yield increase obtained from PI nitrogen topdressing was 2.8 t/ha and this was at a very low PI nitrogen uptake.
- At a PI nitrogen uptake of 100 kg N/ha, grain yield was only increased by 0.7 and 1.0 t/ha when 60 and 120 kg N/ha (130 and 260 kg/ha urea) was applied respectively.
- Sufficient nitrogen must be supplied from the soil and pre-permanent water applied nitrogen to reach a PI nitrogen uptake of 100 kg N/ha or grain yield potential will be reduced.
- If a PI nitrogen uptake of 100 kg N/ha is not going to be reached by PI it may be necessary to apply nitrogen at mid to late tillering to ensure a satisfactory grain yield is achieved.

We apply nitrogen fertiliser to rice at panicle initiation (PI) as a top up for any shortfall from soil nitrogen supply and pre-permanent water applied nitrogen fertiliser. Applying nitrogen at PI is relatively efficient and you can adjust the amount required depending on the crop's growth, but how much can grain yield be increased by applying nitrogen at PI?

In the 2012–13 and 2013–14 seasons, several drill sown rice x nitrogen experiments were established. The experiments were located on the self-mulching clay soil at Leeton Field Station and the red-brown earth at Yanco Agricultural Institute.

Treatments

The experiments comprised four replications with the rice varieties Reiziq and Sherpa.

The experimental treatments included a combination of nitrogen applications applied at both pre-permanent water and panicle initiation.

Nitrogen was applied as urea spread onto the dry soil surface prior to the application of permanent water when the rice was at the 3-leaf stage with rates of 0, 30, 60, 90, 120, 150, 180 and 210 kg N/ha. All plots were then split into three with urea spread into the water at panicle initiation (PI) with nitrogen applications rates of 0, 60 and 120 kg N/ha. All the experiments had excellent plant establishment.

Grain yield

Grain yield increased as more nitrogen was applied pre-permanent water until a PI nitrogen uptake of approximately 140 kg N/ha was achieved, after which grain yield started to plateau (Figure 1). When high PI nitrogen uptake levels are combined with cold temperatures during the reproduction period, you can expect grain yield to start to decline due to cold induced floret sterility. Temperatures during the reproductive period in both the 2012–13 and 2013–14 seasons were warm, so cold temperature damage was not experienced in these experiments.

All the PI topdressed treatments yielded higher than the non-topdressed plots (Figure 1); but at higher PI nitrogen uptake levels the topdressing may not have provided an economic benefit. It can be seen in Figure 2 that as PI nitrogen uptake levels increase, the yield gain from PI topdressed nitrogen decreases, and the difference in yield between the 60 and 120 kg N/ha topdressing rates come together.

The maximum grain yield increase achieved in all the experiments by topdressing with nitrogen at PI was 2.8 t/ha (Figure 2). This was achieved at a very low PI nitrogen uptake with a total yield of only 7.0 t/ha achieved.

At a PI nitrogen uptake of 50 kg N/ha grain yield was increased by 1.1 and 1.7 t/ha when 60 and 120 kg N/ha respectively was applied at PI (Figure 2). When the PI nitrogen uptake was 100 kg N/ha grain yield was increased by 0.7 and 1.0 t/ha for the 60 and 120 kg N/ha topdressing rates and 0.5 and 0.6 t/ha when the PI nitrogen uptake was 150 kg N/ha.

Conclusions

In the past when we considered grain yields of 10 t/ha to be satisfactory and non-semi dwarf rice varieties were more sensitive to high levels of nitrogen, applications of nitrogen at PI where a large component of the total nitrogen applied. The PI nitrogen topdressing was often enough to increase grain yields to 10 t/ha when insufficient nitrogen was supplied from the soil or pre-permanent water nitrogen fertiliser.

But now we require yields of 12–14 t/ha so extra nitrogen must be applied pre-permanent water as nitrogen applications at PI will not increase grain yield enough to compensate for nitrogen deficiency during tillering.

To achieve a high grain yield (12–14 t/ha) sufficient nitrogen must be applied pre-permanent water to reach a PI nitrogen uptake of 100 kg N/ha or grain yield potential will be reduced.

If the crop didn't receive sufficient nitrogen at pre-permanent water for a nitrogen uptake of 100 kg N/ha to be reached by PI then it may be beneficial for the crop to be topdressed with nitrogen at mid to late tillering.

Do not topdress nitrogen into the water when the rice plants are small, as nitrogen losses are large.

Acknowledgements

This research was funded by the Rural Industries Research & Development Corporation (RIRDC) and NSW Department of Primary Industries. Competent technical support by Tina Dunn, Craig Hodges and Chris Dawe has contributed significantly to the success of this project.

Further information

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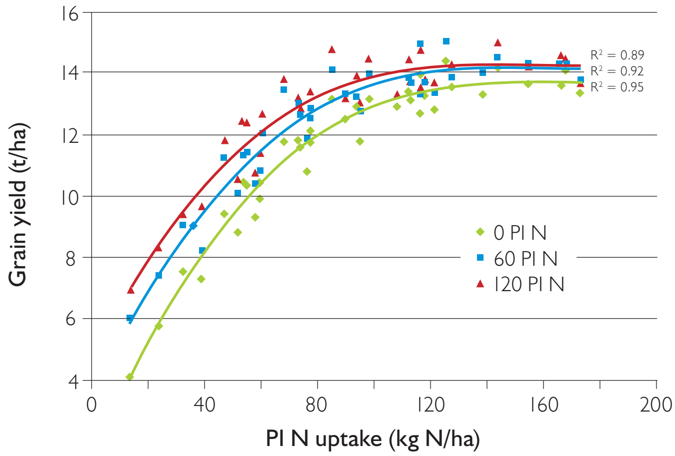


Figure 1. *Grain yield (t/ha) when 0, 60 and 120 kg N/ha is applied at PI to plots with a range of PI nitrogen uptakes. Each symbol represents the mean of varieties Reiziq and Sherpa and four replicates.*

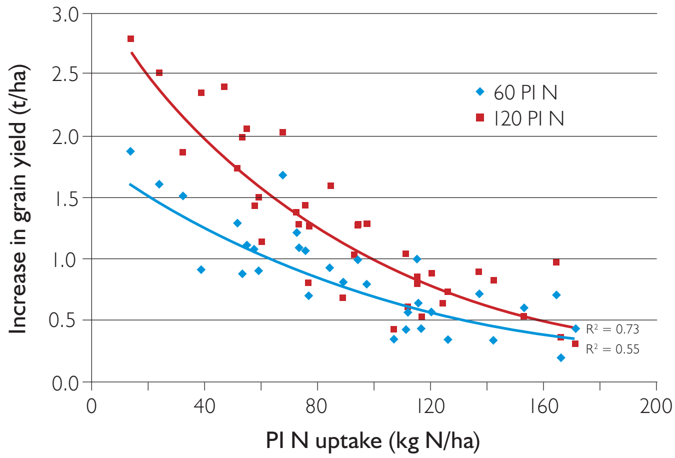
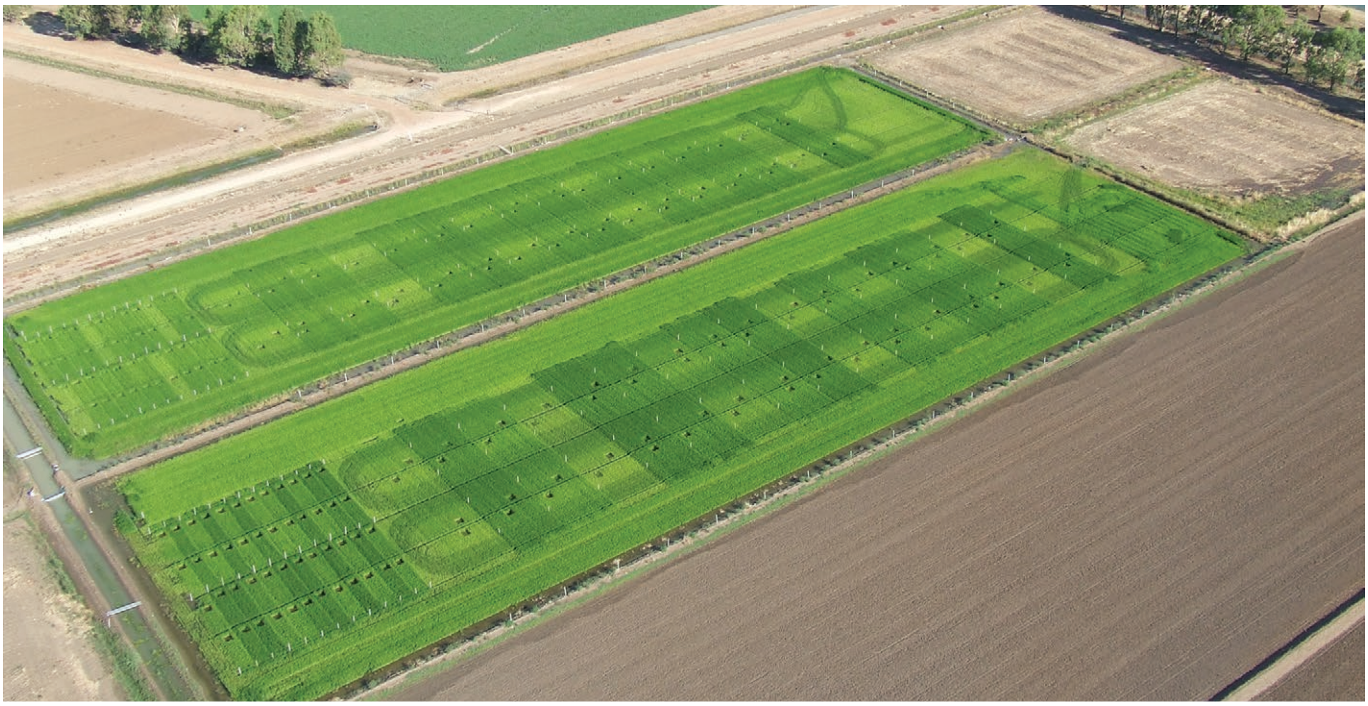


Figure 2. *Increase in grain yield (t/ha) with the addition of 60 and 120 kg N/ha applied at panicle initiation. Each symbol represents the mean of varieties Reiziq and Sherpa and four replicates.*



Aerial photograph of the Leeton Field Station nitrogen experiments in the 2013–14 season

SOIL AND CROP BENEFITS FROM FABAS

Tim Weaver & Cindy Benjamin
Pulse Australia

QUICK TAKE

- Legumes, particularly faba bean and vetch, reduce nitrogen fertiliser costs and improve soil fertility.
- Faba beans can supply most of the nitrogen requirements for a following cotton crop, as well as improve subsoil structure.
- Faba bean and cotton crops benefit from subsoil applications of phosphorus.
- One or two irrigations are required in most years for faba beans to achieve maximum grain yield and biomass.

Faba beans are proving to be a valuable part of irrigated cropping rotations. In northern NSW, faba bean crops grown in rotation with cotton, on average, yield 2.3 t/ha and return 131 kg N/ha to the soil after grain harvest each year.

For almost 20 years Dr Ian Rochester and the crop nutrition team at the Australia Cotton Research Institute (ACRI) at Narrabri, NSW, have been monitoring the effect of a variety of crop rotations on soil health and cotton crop performance.

Early results indicated that including a legume in an irrigated cotton rotation was beneficial on several fronts. The legumes that fit best in rotation with cotton and contribute the most fixed nitrogen are vetch, grown as a green manure crop in the winter between cotton crops, and faba beans, sown the winter after cotton harvest then fallowed for 10–12 months before planting cotton again.

Legumes have consistently provided greater soil benefits than wheat crops sown between cotton crops. Dr Rochester's earlier trials have shown that both these legume crop options can eliminate the need to apply nitrogen fertiliser for the following cotton crop. The added economic advantage of faba beans is the value of the harvested grain, which can be removed while still leaving sufficient nitrogen in crop residue (stubble and roots) to supply most of the requirements of the following cotton crop.

Good nitrogen return

The 16 irrigated faba bean crops grown at ACRI, Narrabri between 1995 and 2012 yielded 2.3 t/ha on average (up to 4.4 t/ha) and returned an average 131 kg N/ha after grain harvest. In addition, the root systems of faba bean plants exude organic acids that improve subsoil structure, feed the microbes and add 10% more carbon to the soil than wheat crops did in the trial. Dr Rochester's research has demonstrated that including faba beans in the rotation can lower the subsoil sodium levels, which also improves the soil structure and encourages cotton plant roots to explore further down the soil profile.

Recent research indicates that faba beans have benefited from phosphorus fertiliser placed deeper than 15 cm, especially when Colwell P levels are less than 10 mg P/kg soil. The phosphorus fertiliser is used more efficiently and the residual phosphorus fulfills the needs of the following cotton crop.

To grow high biomass faba bean crops of about 5.0 t biomass per hectare requires one or two irrigations most years in the cotton districts of northern NSW. Rain-fed faba beans grown in rotation with irrigated cotton will still make significant contributions to the nitrogen budget and provide subsoil fertility benefits, although their contribution to farm income is likely to be less than an irrigated crop. Crops that produce 2–7 tonnes dry matter per hectare above ground can fix 37 kg N per tonne DM, or 75–260 kg N/ha, before grain removal.

When irrigation water is limited, as it has been for 15 years or more, many growers have chosen not to irrigate their rotation crops and some have opted to grow wheat rather than legumes. This has increased the reliance on nitrogen fertiliser and many cotton fields have not benefitted from the soil conditioning effects of faba beans.

About 231,500 ha of cotton was sown in NSW for the 2013–14 cotton season, producing approximately 2.2 million bales. It is estimated that 5% of cotton country, approximately 11,000 hectares, was sown to faba beans following the good rain that fell in March in most districts.

Permanent in the rotation

Faba beans have found a permanent place in the crop rotation on Findley Farms west of Wee Waa. They are a valuable cash crop that provide additional nitrogen for the following cotton crop.

Farm manager, Todd Farrer, said they have had good results with Doza faba beans over the last six or more years.

"This season has started well with six inches of rain falling around planting time that will see the crop through to flowering," he said.

"Some follow-up rain or one irrigation should be enough to finish the crop."

Findley Farms is primarily in the cotton business. Other winter crops grown on the farms include wheat and chickpea to spread production and price risks. Mr Farrer said that care is required to reduce the risk of verticillium wilt affecting cotton crops on the farms. With both chickpeas and faba beans hosting the disease, wheat is grown to provide a disease break.

"Average faba bean yield from the farms is 3.5 t/ha and we expect this year's crop to perform well on stored soil moisture."

Mr Farrer has applied one mancozeb spray to protect the crop from foliar fungal diseases such as chocolate spot. The crop has also been treated for cut worms and aphids. Insect monitoring will continue to track population size and assess any leaf damage by helicoverpa but faba beans can tolerate significant foliar damage with minimal yield loss.

"We control heliothis grubs at podding if necessary as they can cause economic damage to the pods and the developing grain," he said.

"Late application is a softer environmental option and gives the beneficials the best chance of suppressing insect pests."

A well-grown faba bean crop is expected to contribute a significant amount of nitrogen to the next crop. Mr Farrer said discing the stubble in at the end of the season releases the nutrients, including nitrogen, into the soil ready for the following cotton crop that is planted four to five months after the faba bean harvest.

"This year we have forward sold about half the expected crop and will sell the rest straight off the header," he said.

Faba information

PBA Rana is the latest release from Pulse Breeding Australia that is suited to southern NSW. The current industry standard varieties for southern NSW are Nura and Farah.

Variety Management Packages (VMPs) for PBA Rana, Nura and Farah provide specific management recommendations and can be found on the Pulse Australia website: www.pulseaus.com.au

A recent publication 'Faba bean (irrigated) marketing guide' provides information specific to southern NSW and can also be found on the Pulse Australia website.

Long-term crop rotation trials at the Australian Cotton Research Institute, Narrabri, have demonstrated the soil conditioning and nitrogen fixing benefits of faba beans for over 20 years.

Tim Weaver, Pulse Australia and NSW DPI industry development manager (left), Todd Farrer, manager Findley Farms Pty Ltd, and James Pursehouse sales agronomist, Cotton Growers Services, inspect a promising crop of faba beans on Findley Farms' Wee Waa property.

Pulse Australia coordinates the presentation of Best Practice Management workshops for pulse growers and advisors. Faba bean workshops planned for early 2015 will provide participants with access to the latest research and field experience. Growers are encouraged to attend these workshops themselves or engage agronomists who completed the workshop.

To register your interest in these or future workshops please contact:

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Pulse Australia's flagship publication, *Pulse Update Annual 2014*, is available online and provides information about new pulse varieties and recent research findings. To access, please follow this link:

issuu.com/cabenjamin/docs/pulseupdateannual2014_744879fcd75e56

Acknowledgement

The authors wish to thank Dr Ian Rochester, CSIRO and Todd Farrer, Findley Farms, for their contribution to this article.

RICE WATER USE & EFFICIENCY AT FINLEY

John Lacy
John Lacy Consulting, Finley

QUICK TAKE

- Rice water use efficiency (WUE) increased from 0.7 t/ML in 2011 and 2012, to 0.8 t/ML in 2013 and 2014.
- Increasing yields, helped by good seasons in 2013–14, higher adoption of Sherpa, drill sowing and stable water use have led to an increase in rice WUE.
- The top 10 yielding rice crops averaged 0.95 t/ML WUE each year.
- Irrigation water use increased in 2013 and 2014, to 13.5 and 12.7 ML/ha respectively, compared with 10.1 ML/ha in 2011 and 11.4 ML/ha in 2012, as a result of lower rainfall.
- High summer rainfall after the drought led to high rainfall water use of 4.3 ML/ha in 2011 and 2.4 ML/ha in 2012, compared with the low rainfall water use in the drier summers of 0.8 ML/ha in 2013 and 0.9 ML/ha in 2014.

Four years of farmer data, collected by the Ricecheck system, shows that rice water use efficiency can be increased at the planning stage of the rice crop with paddock and variety selection, as well as by drill sowing the crop.

The Finley Discussion Groups use Ricecheck records to benchmark and improve rice water use and water use efficiency. Farmers can compare their rice crop water use with other rice crops, to assist making decisions to choose paddocks, rotations, varieties and sowing methods to lower water use. Lifting water use efficiency keeps rice crop water use competitive with the water use efficiency of other enterprises, such as winter crop and lamb systems.

Rice yields, irrigation & total water use

Average rice yields (t/ha), irrigation water use (ML/ha) and total water use (irrigation + rainfall) (ML/ha) for the four harvest years, 2011–14, are shown in Figure 1.

Most of the 116–119 crops in the Ricecheck system for the last three years were the varieties Sherpa and Reiziq, and there were 14 Opus crops in 2014.

The data shows that yields improved each season.

Irrigation water use has risen in the last two years, 13.5 and 12.7 ML/ha respectively, compared with 10.1 ML/ha in 2011 and 11.4 ML/ha in 2012, as a result of lower rainfall.

The high summer rainfall after the drought, resulted in rainfall water use of 4.3 ML/ha in 2011 and 2.4 ML/ha in 2012, compared with rainfall water use in drier summers of 0.8 ML/ha in 2013 and 0.9 ML/ha in 2014.

The total water use was relatively similar over the four years, from a minimum of 13.6 ML/ha in 2014 to a maximum of 14.4 ML/ha in 2011.

The combination of increased yields helped by good seasons in 2013–14, higher adoption of the high-yielding variety Sherpa and stable water use led to an increase in WUE from 0.7 t/ML in 2011 and 2012 to 0.8 t/ML in 2013 and 2014.

The top 10 yielding crops, which were mainly Sherpa from 2012 onward, had WUE of 0.9, 1.0, 0.9 and 1 t/ML in the years 2011through to14, respectively.

A factor helping irrigation water use in 2013 and 2014 was that 51% and 52% of the crops, respectively, were sown following a previous rice crop, compared with 33% in 2012, which means the surplus subsoil moisture after the first rice crop helped reduce water use for the second crop.

Lowest & highest water use

Although farmers aim to have average or below-average water use, the range in each year is surprisingly high, as Figure 2 shows. The figure is based on the average of the five lowest and five highest irrigation water use rice crops in each year.

In 2011, the lowest irrigation water use was only 7.7 ML/ha, offset by rainfall water use of 4.6 ML/ha and total water use of 12.3 ML/ha. However, in the same season, the highest irrigation water use was 12.9 ML/ha and rainfall of 3.6 ML/ha totalling water use of 16.5 ML/ha.

In 2012, the lowest irrigation water use was 9.3 ML/ha with 3.1 ML/ha rainfall totalling water use of 12.4 ML/ha and in the same season the highest irrigation water use was 14.5 ML/ha and rainfall of 2.2 ML/ha and total water use of 16.7 ML/ha.

In the drier 2013 summer, the lowest irrigation water use was 10.5 ML/ha with only 0.8 ML/ha rainfall totalling 11.3 ML/ha. In the same season, the highest irrigation water use was 16 ML/ha and rainfall of 0.8 ML/ha, and total water use of 16.8 ML/ha.

Similarly in 2014, the lowest irrigation water use was 10.2 ML/ha with only 0.9 ML/ha rainfall totalling 11.1 ML/ha. In the same season the highest irrigation water use was 15.6 ML/ha with rainfall of 1.0 ML/ha and total water use of 16.6 ML/ha.

Other factors

Variety had an influence on water use, with water use of Sherpa 0.5 ML/ha less than that of Reiziq in 2012 and 2013, and 0.2 ML/ha less in 2014. Water use of 24 drill sown crops in 2013 and 2014 was, respectively, 1.9 and 1.0 ML/ha less than pre-germinated aerial sown crops, which averaged 1.5 ML/ha over the two years.

Conclusion

These results show that farmers can lower rice water use and improve water use efficiency by choosing one, a combination or all of the following options:

- lower water use paddocks
- management for higher yields
- selection of the variety Sherpa
- drill sowing
- sowing into rice stubble.

Lowering water use helps rice compete for water with winter crops and lambs water use.

Acknowledgements

These results were derived from the Finley Discussion Group farmer records, so thanks to all the discussion group farmers for participating in the groups and completing the records, which most farmers find, is an arduous task.

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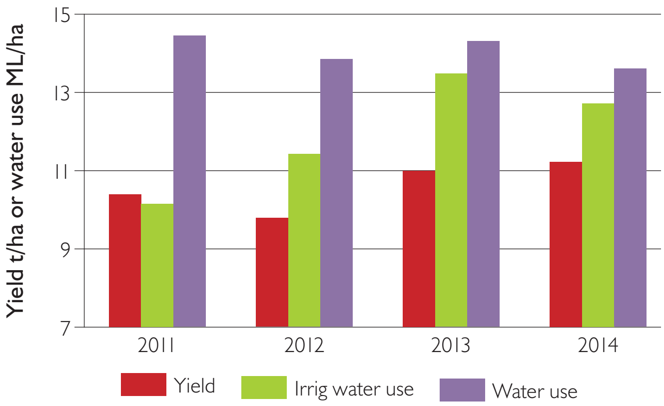

Figure 1. *Average yield (t/ha), irrigation and total water use of rice crops participating in Ricecheck in the Finley district*

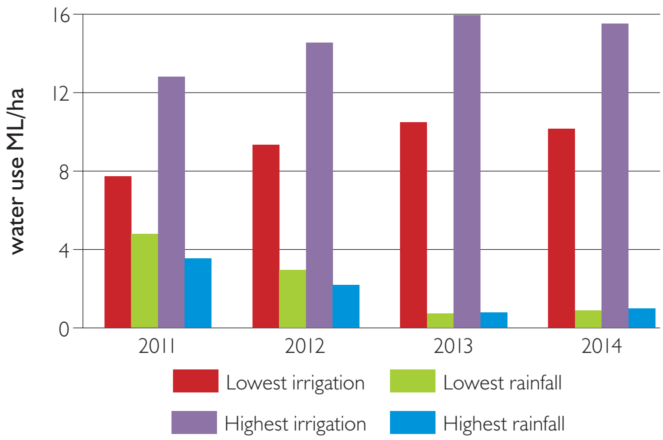

Figure 2. *Lowest and highest irrigation and rainfall water use*

$1.2 MILLION BOOST TO IRRIGATED CEREAL & CANOLA RESEARCH

Cynthia Podmore & Tony Napier
NSW Department of Primary Industries

QUICK TAKE

- It is estimated that if current yields of irrigated crops increased to best trial levels, the farm gate value of cereals and canola would double to $347 million.
- The *Southern Irrigated Cereal and Canola Achieving Target Yields* project aims to increase irrigated cereal and canola production by improving grower and adviser knowledge.
- High-yielding cereal and canola varieties for irrigated systems will be trialled so that growers can select the best variety for their location and irrigation system
- Specific agronomy practices that improve production and profitability of irrigated cereals and canola (and increase water use efficiency) will be identified and defined.

Recent industry research identified significant potential for increased production and profitability of irrigated cereal and canola. It is estimated that if current yields increased to best trial levels, the farm gate value of cereals and canola almost doubles to $347 million.

Cereals and canola have a sound fit in southern irrigated rotations, particularly as an alternative 'key crop' to rice, when water allocations are low. They also provide the additional benefit of being a break crop for weed, disease and pest management. Cutbacks in water allocations have created urgency for irrigated industries to grow 'more crop per drop'.

New research for southern irrigators

In response to irrigators identifying potential increased production, the Grains Research and Development Corporation (GRDC) and NSW Department of Primary Industries (NSW DPI) have instigated a new $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 is aiming to increase irrigated cereal and canola production in the GRDC southern region 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 will be conducted over six nodes (locations) in the southern GRDC region. The three core research sites are Murrumbidgee (Yanco Agricultural Institute), 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.

The project area covers five agro-ecological zones:

- NSW Central
- NSW Vic Slopes
- SA Vic Mallee
- SA Vic Bordertown Wimmera
- Tas grain growing regions.

Locally-defined priorities

At each node, a group of growers and researchers identified priority research questions and the trials in that node will address some of those questions.

Issues in the Murrumbidgee research node include:

- what varieties of wheat and canola to use under irrigation
- decision or support systems/tools to make the second fertiliser and/or irrigation
- best bet guide for situations of low/medium and full allocations to maximise yields when water is limiting.

Issues in the Murray Valley node include:

- varieties suited to full and partially irrigated canola
- varieties suited to full and partially irrigated wheat
- optimum sowing times for grain and grazing/grain irrigated canola
- optimum spring irrigation timing for canola
- irrigated canola nitrogen timing and rate
- factors preventing 4.0 t/ha canola yields.

Products for irrigators

The research outcomes of the project will assist with the development of three tools for growers and advisers to be completed in 2017.

1. 'Irrigated Wheat: Best Practice Guidelines in Southern Irrigated Cropping Systems' — a manual
2. Irrigated Canola: Best Practice Guidelines in Southern Irrigated Cropping Systems' — a manual
3. Variety Specific Agronomy Packages (VSAPs) for each node.

IREC has an important role in the project, providing extension and communication services to ensure that all information about the research and new knowledge from the project reaches irrigators.

Chairman of IREC and Gogeldrie irrigator, Rob Houghton, said IREC is delighted to be involved in the extension of this project to irrigators over the next three years and beyond.

"There are so many questions that this project will provide answers for in terms of water and nutrient efficiency, as well as improved varietal choice," Rob said.

"As an irrigator, the value of the "three tools for growers" will be invaluable in our winter cropping enterprises. Winter cropping was a very poor cousin to summer cropping in our farming system, even ten years ago, however now we depend on this vital part of our income stream. It takes advantage of residual moisture left in the soil profile from our summer crop, and also our winter dominant rainfall."

A new project will establish trials across the southern irrigation areas to increase growers' knowledge to achieve target yields in irrigated cereal and canola production. This photo is taken at a satellite trial site at Coleambally.

Project personnel

The project is co-funded by GRDC and NSW Department of Primary Industries. Several subcontractors will be engaged to manage the satellite research nodes.

The NSW DPI project team includes:

- Deb Slinger, Manager Southern Cropping Systems
- Luke Gaynor, Leader Southern Cropping Systems
- Tony Napier, Research & Development Agronomist (Irrigated)
- Cynthia Podmore, Project Officer
- Neroli Graham, Research Officer
- Brian Dunn, Research Agronomist.

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BENCHMARKS AND BUSINESS PERFORMANCE

Michael Ryan
Booth Associates

QUICK TAKE

- Benchmarking is a familiar tool for measuring business and farm performance, and a range of different benchmarks can be used.
- Focussing on one benchmark in particular may have a negative impact on overall business performance.
- Use business benchmarks to assist with measuring business performance and testing the merits of business and enterprise expansion or other expenditure.

Agriculture is a capital-intensive and long-haul industry with a lumpy cash flow pattern. Cash management problems are exacerbated by seasonal and market fluctuations.

Benchmarks are commonly used to measure performance. To be of value, benchmarks for farming businesses must be able to accommodate the challenges in agriculture of capital and cash management.

There are different types of benchmarks relevant to agriculture:

- **technical benchmarks** to measure crop input efficiency, such as kilograms of grain per unit of nitrogen fertiliser
- **enterprise benchmarks** such as gross margin ($/ML)
- **business benchmarks** to assess the overall business performance such as return on capital.

Technical & enterprise benchmarks

Technical benchmarks can be useful tools in assessing crop production and/or input efficiency, but they need to be considered in the context of overall business performance.

Enterprise benchmarks such as gross margins can be useful but have limitations. Gross margin (such as $/ML) is only relevant when comparing two crops which can be grown in the same system with no capital expenditure required. For example, comparing the gross margin of rice with cotton can be misleading for a rice farmer who is considering growing cotton, as gross margins do not address the cost of converting irrigation layout from rice to cotton and changes in farm equipment required.

System gross margins are an extension of the enterprise gross margin concept and are more relevant than individual crop gross margins as they take into account the synergies between crops, such as growing a winter crop on the residual moisture of a rice crop. The gross margin ($/ML) for an enterprise could be compared with the temporary water market to make decisions about buying or selling water.

All gross margins have limitations as they do not recognise risk, cash flow, operating funds, overheads, build costs and capital expenditure requirements. In addition, a continual focus on technical and enterprise benchmarks can lead to a loss of business direction and a reduction in overall business performance. The key reason is that the inevitable decline in the terms of trade (cost/price squeeze) will undermine the capacity of the business to grow if the usually unavoidable inefficiencies associated with growth are not addressed and understood.

The best way to assess the merits of different crop regimes is to look at whole farm profit, using a budget. Budgets can be time consuming to prepare and are very sensitive to the assumptions of yield, price and costs used within. But budgets are business, people and situation specific, and are the best means of comparing different options for that business. For example, for a rice grower, the whole farm profitability of producing rice should be compared with the whole farm profitability of producing cotton, including the cost and timing issues of converting irrigation layout and purchasing cotton specific equipment. Prepare budgets thoroughly as the merits of one system versus another will be highly dependent on the assumptions made about yield, price and costs used within the budgets.

Business benchmarks

Business benchmarks arising from whole farm budgets and performance reviews are the best way to assess your business. The most common business benchmark is **earnings before interest and tax (EBIT)**, which can then be used to measure **EBIT yield**.

Also referred to as **return on capital**, EBIT yield is a measure of the debt-free profit of a business divided by the total business value. EBIT yield is not agriculture specific and is used across all industries from mining to retail. The risk-free return (interest rates on fixed deposits) is currently between 3.5% and 4% (zero risk). With inflation ranging between 2% and 3% the real return on deposits is actually closer to 1%.

Any agricultural business must, in order to justify the risks involved, earn significantly more than the risk free rate on a long term basis to provide a fair return to the business owners. The target EBIT yield should be more than the risk free rate, aim for 1.5 to 2 times as a minimum.

Some other business benchmarks used are described as follows.

Interest cover — which is EBIT (debt-free profit) divided by annual interest commitments. At a ratio of 1:1 this would indicate the business has the ability to service interest only and no buffer. The preference is for a ratio of 2 or greater.

Peak debt to income — simply, peak liabilities divided by annual revenue. Ideally this would be 1:1 but it is not uncommon to see businesses which have continued to perform solidly at ratios of 2:1 and even 3:1.

Equity — ABARES farm surveys indicate average equity for all farms is 80% or higher, but there is a significant variation from < 50% to > 90%. Businesses with low equity lack the strength in their balance sheet to buffer against challenging circumstances or take on new opportunities when they arise. Tight equity positions for many arise from their business going through a rapid growth phase. Whilst these circumstances are often unavoidable and well planned, and in cases advisable in order to improve long-term business performance, all debt including equipment finance should be approached with caution as high debt reduces business resilience.

Loan to security — most banks consider their clients' positions in terms of peak debt to securable assets (land and water). There is a range of 'loan to security' upper limits between the banks ranging from 50% to 70%. Loan to security ratios provide a guide as to a business' ability to security additional borrowings, but not the business' ability to service additional borrowings.

Gross margin divided by revenue — this ratio should be > 40%. In other words, total direct enterprise profit should be more than 40% of total revenue, and if not, it suggests that business operating costs are out of sync with the enterprise's performance potential.

Overheads divided by revenue — ideally this should be 5% (or less) and provides a guide as to the efficiency of fixed business costs.

These ratios are objective measures of the business' structure and performance and provide guidance as to whether the business is performing at an acceptable level for the business owners. If not, the business benchmarks assist in quantifying the areas which are constraining the business.

Examples of benchmark conflicts

The risk of making strategic business decisions using technical or (more likely) enterprise benchmarks is a potential undermining of the business. For example, due to the high cost of production, cotton needs to be grown on scale to provide worthy returns. The gross margins for well-run MIA cotton and rice enterprises are:

- cotton: $2,645/ha and $240/ML
- rice: $2,277/ha and $163/ML.

Cotton has the higher gross margin per area and water used, but gross margins for an enterprise do not take into account the whole farm system such as the winter crops grown with the benefits of residual soil moisture, which will be different after rice than after cotton.

The whole farm system gross margin for a 170 ha cotton and rice enterprises grown in rotation with winter crops in the Murrumbidgee Valley are:

- cotton: $979/ha and $272/ML
- rice: $697/ha and $237/ML.

Cotton has the highest system gross margins at this assumed scale. Cotton uses 25% less water to grow the same area. Hence a business growing 170 ha of rice could grow, say 210 ha of cotton with the same water assets.

Cotton requires row crop layouts and more specialised machinery than rice, so when whole farm profit is compared for 210 ha cotton and 170 ha rice enterprises in the Murrumbidgee Valley grown in rotation with winter crops, the debt-free profit is:

- cotton: $222,000
- rice $262,000.

Hence at this scale rice provides a higher profit. When taking into account the capital associated with extra irrigation development and equipment cotton requires, the return on capital for 210 ha cotton and 170 ha rice enterprises in the Murrumbidgee Valley grown in rotation with winter crops is:

- cotton: 3.0%
- rice: 4.1%.

These examples are provided to show the limitations of gross margins as benchmarks to make strategic business decisions.

Use business benchmarks to assist in measuring your own business performance and testing the merits of business and enterprise expansion or other expenditure.

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