

# Spotlight

ON COTTON R&D

**SPRING 2018**

Pushing boundaries:  
Conference 2018 delivers

Grassroots Grants bring  
knowledge south

Cotton research  
goes nuclear





Bruce Finney

# In the Spotlight

As we all take stock of what was an amazing 2018 Australian Cotton Conference, there's not much time for rest ahead of a new cotton season commencing under incredibly dry conditions.

Some growers in the Central Highlands will have already finished planting by the time *Spotlight* goes to press. With advances in farming systems and improved flexibility in planting dates the industry has positioned itself as best possible to take advantage of opportunities when they arise. Throughout we wish you well, ultimately, as the Cotton Conference exemplifies, it's all about people.

CRDC is proud to be a founding sponsor of the Cotton Conference and congratulates the organisers on what was another outstanding event. We should never underestimate the value of coming together as an industry. The theme of pushing boundaries and the program of quality industry, research and external speakers aligned strongly with our industry vision for the future and sense of identity – successful, responsible, capable, and innovative.

Ensuring we achieve our industry vision requires leadership throughout the industry. CRDC continues to invest in the development of future leaders and along with Cotton Australia and Auscott was pleased to announce Fleur Anderson and John Durham as our 2018 participants in the Australian Rural Leadership Program. We've also announced a new crop of 16 Australian Future Cotton Leaders who are a diverse and vibrant group – we can't wait to see how their leadership evolves going forward.

Recognising our researchers is highly important, as we have much to be grateful for. It was highly fitting that NSW DPI scientist Dr Robert Mensah received a Queen's Birthday Honours Public Service Medal for outstanding public service to the NSW primary industries sector. Robert's career in research spans more than 26 years. In that time he has become a global leader in biological insecticide products and CRDC has been proud to partner in sectors of his research.

Sadly another remarkable researcher, Dr Stephen Allen, passed away recently. He was a true science leader and his contribution to cotton disease and crop management was globally recognised. Stephen's contribution to the Australian cotton industry will live on through the legacy of his research.

In this edition we have a range of articles based on research information to assist growers and consultants with ongoing improvements to crop nutrition and pest management. There is a strong cohort of CRDC-supported researchers continuously bring new information about nitrogen use which we've outlined. There is also a strong contingent of growers and consultants who, supported by CRDC Grassroots Grants, are sharing a wealth of experience in managing key pests to growers in other regions. And as we move into a new season it is a timely reminder to consider the likely consequences of early season pest management decisions and their impacts later on in the crop.

We also report on the CRDC partnership with scientists from the Australian Nuclear Science and Technology Organisation to map nitrogen cycles and the origin of water in the Lower Namoi. Using extremely high level science and ground-breaking technology, we can build very clear pictures of the impact and likely impacts of our industry. To think that we can put a date and origin on groundwater is a truly amazing achievement.

There are many more wonderful stories in this edition of *Spotlight*, we hope you enjoy reading them as much as we enjoy bringing them to you.

Bruce Finney  
CRDC Executive Director



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**ON THE COVER:**  
**Pitch from the Paddock jury:**  
 CRDC director Liz Alexander,  
 Conference chair Fleur Anderson,  
 Queensland Chief Entrepreneur  
 Steve Baxter and X-lab's Allen  
 Haroutonian.

### Want to see more of Spotlight?

This edition can be viewed online at: [www.crdc.com.au](http://www.crdc.com.au)

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# Spring 2018



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# Fast Facts



## 2460

people attended this year's Australian Cotton Conference – the biggest ever (page 7).

## 150

speakers presented at the conference (page 7).



## \$476

is the fall in operating costs (to \$3447) for the top 20 percent of cotton farmers sampled in the 2017 Boyce Comparative Analysis, putting costs \$267 below the five-year average (page 10).

## 23

bores in the Lower Namoi catchment have been sampled to measure indicators of N cycling (page 24).



JO EADY

## Future industry leaders line up

**THE** Australian cotton industry is ensuring it has a vibrant group of people to take the industry into the future, with the announcement of 16 2018 Australian Future Cotton Leaders (AFCL) participants.

From a field of worthy recipients, a panel, including graduates of the course and representatives from program supporters CRDC and Cotton Australia, chose the participants.

“We are proud to continue our partnership with Cotton Australia in the Future Cotton Leaders program, ensuring that as an industry we have a strong cohort of innovative emerging leaders,” CRDC Executive Director Bruce Finney said.

“Future Cotton Leaders has been a successful program in preparing and supporting people in the industry to fulfil their potential and enhance skills for future leadership.

“We see many of the alumni still highly involved in the industry and moving into leadership and mentor roles and we look forward to the members of this cohort doing the same.”

### 2018 Program Participants

- Greg Anthony, Baulkham Hills, NSW
- Nicholas Beer, Spring Ridge, NSW
- Dean Brookes, St Lucia, QLD
- Georgia Brown, Boomi, NSW
- Murray Connor, Moree, NSW
- Alexandra Dalton, Trangie, NSW
- Lachlan Danckert, Deniliquin, NSW
- Andrew French, Theodore, QLD
- Nathan Hamblin, Narrabri, NSW
- Tristram Hertslet, Talwood, QLD
- Sharna Holman, Emerald, QLD
- Rebecca Longworth, Mungindi, NSW
- Fiona Norrie, Moree, NSW
- Ngaire Roughly, Wee Waa, NSW
- Jack Sharp, Couradda, NSW
- Sam Simons, Gunnedah, NSW

Participants in the program have already been meeting with industry leaders and will be mentored by already established and well-recognised cotton industry figures. The future leaders will also develop and implement a leadership project that mutually benefits the individual and the wider cotton industry.

AFCL is one aspect of CRDC's broader workforce development strategy, which has recently been revised.

“We recognise that people are our most important resource, which is why we as an industry invest so heavily in programs to help upskill and develop our people, and why we at CRDC have an investment program specifically around building adaptive capacity,” Bruce said.



STEVE MCGOUGH

Dr Leanne Wiseman, Griffith University, CRDC Executive Director Bruce Finney, Minister for Agriculture and Water Resources David Littleproud, CRDC R&D Manager Jane Trindall and Tim Lester, Executive Officer Council of Rural RDCs, at the launch of the P2D Report.

## Positioning Australia for P2D

**AS** Australia's rural RDCs start planning for phase 2 of the Precision to Decision Agriculture project, the value of phase 1 has been displayed on the world stage.

The first Precision to Decision Agriculture project (P2D) under the Australian Government's Rural R&D for Profit Program wound up earlier this year. Led by CRDC, P2D involved all of Australia's 15 Research and Development Corporations (RDCs) and evaluated the state of digital agriculture in Australia, modelled potential future economic benefits and made recommendations to realise potential gains. It is the first time all RDCs have collaborated on a single project in Australia.

CRDC's Jane Trindall attended the 14th International Conference on Precision Agriculture in Canada recently and says a recurring theme was that the P2D research has put Australia in very good stead internationally.

"Australia is ahead of the pack in terms of its thinking in regard to legalities around data and agricultural data developments," Jane said.

"Such widescale research has helped Australia to visualise what good data management looks like."

Conference topics spanned the issues facing precision agriculture and more widely digital agricultural technology.

Griffith University Associate Professor Leanne Wiseman, a chief investigator on P2D, spoke about the legal issues in regard to agricultural data, which was well received by conference attendees.

"This makes me think Australia is well ahead in our thinking in regard to legal matters and agricultural data developments," Jane said.

"With this in mind, the P2D report recommendations are heading Australian agriculture in the right direction and their

implementation will make a contribution globally.

"It has the potential to be a really productive way to work with other international strategic initiatives on digital agriculture transformation and will enhance our ability to learn from and align with other efforts globally.

"For example, Canada is taking a similar approach and is developing a digital transformation strategy for the Canadian agri-food sector."

Jane said another interesting topic raised at the conference was an update on the open-source project, the US AgGateway, which has made quite a lot of progress. It has been designed to facilitate global interoperability between various agriculture software and hardware applications and it is starting to get traction with machinery manufacturers. The team behind it are enthusiastic about helping to encourage implementation in Australia.

"A presentation that really stood out for me was by computer scientist Yoshua Bengio from McGill University in Canada who spoke about artificial intelligence (AI) and the value of scaling up agricultural data over time.

"This would be to develop, for example, foundational datasets and find trends in them to help understand the big drivers of production over time.

"It was really fascinating, with his take-home message that 'Successful AI applications require data of the right kind – and as this may take years, it is important to develop a strategy and start now'."

### For more

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## New look for a new plan

CRDC has launched a new look to coincide with the release of the new Strategic Plan for 2018-23 which commenced on July 1.

After 15 months of development in close collaboration with the industry, this primary planning RD&E document provides a high-level overview of CRDC's strategic direction for the next five years.

CRDC Executive Director Bruce Finney said the plan is "unashamedly ambitious".

"Over the next five years, our aim is to contribute to creating \$2 billion in additional gross value of cotton production through our investments in RD&E," he said.

"To help achieve this, in the first year of the plan (2018-19) cotton growers and the government will co-invest \$24.3 million into cotton RD&E in about 300 projects and in collaboration with more than 100 research partners."

To align CRDC with the ambitious direction of the plan, CRDC has introduced the new logo to reflect the innovative, agile and adaptive nature of the organisation.

"We received really positive feedback about our new look which featured at the Australian Cotton Conference in August. People really liked it."

The CRDC Strategic Plan is available at [www.crdc.com.au/publications/crdc-strategic-plan](http://www.crdc.com.au/publications/crdc-strategic-plan)

## Gala awards highlight achievers

THE cotton industry has once again honoured its people at the 2018 Australian Cotton Industry Awards.

Held at the Gold Coast on the final evening of the 2018 Australian Cotton Conference, around 1000 people gathered to celebrate the talented and committed people that make up the industry.

The 2018 awards recipients are:

- **Monsanto Grower of the Year:** Brett Corish, Corish Management Pty Ltd, "Mundine", Goondiwindi, QLD.
- **AGRIRISK High Achiever of the Year:** Bernie Bierhoff, Avondale Ag, Rowena, NSW.
- **ADAMA Chris Lehmann Trust Young Cotton Achiever of the Year:** William Back, Auscott Ltd, Narrabri, NSW.
- **Cotton Seed Distributors Researcher of the Year:** Dr Joseph Foley, Dr Malcolm Gillies and Dr Alison McCarthy, University of Southern Queensland, Toowoomba, QLD.
- **IPF Service to Industry Award:** David Montgomery, Moree, NSW.

CRDC Executive Director Bruce Finney congratulated all the awardees. From a research perspective, he mentioned the team from USQ who have worked to make the Smarter Irrigation for Profit project the success it was. CRDC led this project on behalf of the Australian Government through the Rural R&D for Profit Program with partners Sugar Research Australia, Dairy Australia and AgriFutures Australia.

"This award is testament to the real impact these researchers have had not only in our industry, but across industries," Bruce said.

"They have helped producers improve water use efficiency, take up and implement cutting-edge technology."



Alison McCarthy, Malcolm Gillies and Joe Foley.



Dr Steve Yeates and Shadow Minister for Agriculture, Fisheries and Forestry Joel Fitzgibbon.

LIZ ALEXANDER

## Growing cotton interest in Northern Australia

COTTON research featured strongly at the Northern Australia Food Futures Conference held in July in Darwin, NT.

CRDC Executive Director Bruce Finney along with R&D Manager Allan Williams were invited to speak at the event. This season marks a return to cotton in The Kimberley region of the NT, where early results are positive.

Bruce, Allan and Adam Kay from Cotton Australia spoke in a session focused on cotton, the use of technology and sustainability. They discussed the history, achievements and future of the industry with respect to adopting technology and improving sustainability.

Through a range of speakers the Conference attendees were informed of the unique challenges of the north, not just climate, but also that of finding sweet spots in terms of right soil type, good water availability, land tenure and access to infrastructure.

"We received positive feedback and support for current research in the Kimberley region of the NT and also for expansion based on those research outcomes," Bruce said.

"The conference went well with the cotton industry profiled positively as an important component of the future for agriculture in Northern Australia.

"There is strong farmer interest with some committed companies and individuals pioneering commercial cotton production in the north.

"Government and industry support for the success of these pioneers will be a key ingredient in facilitating the confidence and capacity for other farmers to take up the opportunity.

"With that opportunity comes significant responsibility for all involved to



Bruce Finney spoke about the opportunities for growers to lead research priorities in the north.

LIZ ALEXANDER

adopt responsible practices and ensure sustainable development.

"These new growers will have the resources of more than 30 years of world-leading cotton RD&E as well as willing and capable industry leadership to call upon to assist them."

In other positive news out of the conference, CSIRO principal research agronomist Steve Yeates was awarded the 2018 Food Futures Innovation Award. Steve has been undertaking the most recent cotton research in the Kimberley and North Queensland. Steve was also a part of research in the Ord early in his career, which spans 33 years.

### For more

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Australian UN Peacekeeper Matina Jewell shared her experiences in leading teams in some of the most volatile places on the planet, the loss of her 'brothers', leadership and recovery from the trauma of war.

MELANIE JENSON

## Pushing boundaries, breaking records

**THE** boundaries were definitely pushed at this year's Australian Cotton Conference, with 2460 people making their way to the Gold Coast to attend the premier industry event.

This year was the biggest in terms of attendance and for new faces, with a large contingent from the southern regions attending for the first time to hear the huge line-up of 150 speakers offer valuable insights and research.

Exhibitor numbers too are on the rise, with a record 110 businesses or services showcasing their products. There were record numbers for several sessions within the conference, including a dryland farming session, Pitch from the Paddock, climate and social events such as the Next Gen breakfast with National Farmers' Federation President Fiona Simson. A new-look fashion parade featured well-known local designers, who worked with the 'denim' theme to promote the use of cotton with support from Australian Cotton Shippers Association, who supplied the fabric.

Each conference a charity is chosen to support, and this year just over \$50,000 was raised for OzHarvest to provide meals

for those in need in Australia. CRDC is a founding major sponsor of the conference and in a new initiative this year supported the creation of 'Startup Alley' to showcase innovation and give young entrepreneurs the opportunity to pitch their ideas, showcase the industry's investments in startups, and the emerging technologies that are being developed specifically for cotton and agriculture.

The conference speaker line-up always kicks off with inspirational and thought-provoking speakers. The incredible line-up kicked off with mind-blowing thinking from acclaimed international futurist Thomas Frey from the US, and the inspiring and heart-wrenching story of Australian UN Peacekeeper Matina Jewell and her experiences of leadership in one of the most volatile places on the planet in Lebanon.

To end a big three days, ANZ Banking Services Business Domain Lead Nigel Dobson spoke about Emerging technologies and cotton, followed by Rachael Robertson, who led the Australian expedition to Davis Station, Antarctica – the second female to lead a team at the station and the youngest ever leader.

To send everyone off, attendees were treated to 'An irreverent overview of the Australian cotton industry' from Clancy Overell and Errol Parker of *The Betoota Advocate* who kept the crowd well amused.

Amazingly, a conference of this size and calibre is run by a volunteer group, along with Conference Secretariat Tracey Byrne-Morrison.

"Thank you to our amazing volunteer organising committee who worked tirelessly to deliver a jam-packed program," committee chair Fleur Anderson said.

"A lot of time, planning and thinking goes into delivering on this event, and we have been thrilled with the feedback from delegates.

"Thanks to our sponsors, whose support allowed us to keep registration costs to a minimum, and a huge thanks to Tracey, who burned the candle at both ends to make it all happen again this year."

**For more**

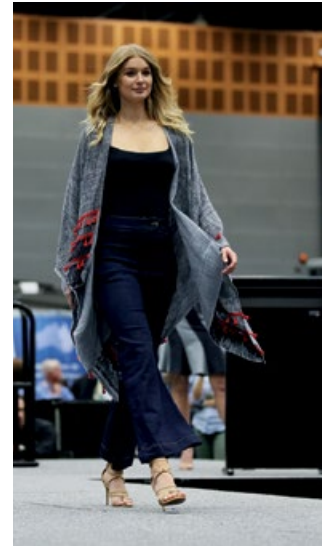
[australiancottonconference.com.au](http://australiancottonconference.com.au)



The Betoota Advocate boys bringing the house down in the final session.



Fawzia Yasmeen, Pahartali Textiles spoke about Bangladesh – 'the new hungry tiger for cotton'.



A cotton conference would not be complete without a stunning fashion parade featuring... cotton! This year 'denim' was the word.



Kate Lumbar, Fiona Norrie and Alexandra Trinder with National Farmers' Federation President Fiona Simson at the Next Gen breakfast.

BELOW: The panel of the popular dryland farming session: growers Scott McCalman, Angus Vickery, JR McDonald, CottonInfo's René van der Sluijs and Claire Welsh, CSIRO Food and Agriculture.



Lucy King of the Country Road Group spoke about the companies' 'good business journey and sustainable cotton commitment'. Lucy visited cotton fields at Narrabri earlier this year to learn more about fibre production.



Central Highlands' grower Nigel and Beth Burnett caught up with the Lone Stranger (Dr Oliver Knox, UNE) and sidekick Sharna Holman, CottonInfo, who were spreading the 'Come Clean Go Clean' message.



David Ricardo, Ricardo Farms speaking about managing climatic extremes in the Lower Namoi.



Southern contingent: Eliza Serafin, Melinda Serafin, Lillian Zanetta and Kiara Salvestro.



# Entrepreneurs take flight

Aspiring entrepreneurs had the chance of a lifetime at the 2018 Cotton Conference, with the opportunity to pitch to an audience of prospective customers within the industry and a panel including none other than Mr Shark Tank himself Steve Baxter.

**I**n all, 12 startups were chosen from a strong pool of applicants to participate. CRDC and the Cotton Conference provided the successful applicants with complimentary registration and their own booth in Startup Alley – not to mention give the pitch of their lives to Steve, startup expert from X-lab Allen Haroutonian, CRDC board member Liz Alexander and Cotton Australia board member and conference chair Fleur Anderson.

The session was titled “Pitch from the Paddock” and led by Steve, who is also the Queensland Chief Entrepreneur. It was no easy sell, with Steve and the others asking the hard questions.

Stu Adam of Agronomeye was one of the selected participants and said the opportunity had been amazing.

Agronomeye uses a fleet of UAVs and sensors to collect data from fields to create unique workflow solutions for farmers and agronomists to improve the way decisions are made.

“An Agronomeye crew is ready to be deployed Australia-wide to scan any size crop from broad acre to vineyards, identifying problems and expanding potential,” Stu said.

“Our multi spectral sensors are coupled with an onboard processing algorithm to produce immediate results at the point of collection, identifying crop stress, photosynthetic activity, population maps, canopy closure, weed maps and yield potential.

“We are able to convert data into variable rate maps for precision agriculture, which are immediately useable on-farm.”



Queensland Chief Entrepreneur Steve Baxter of Shark Tank fame with startup contender Stu Adam.

Stu has been working alongside landowners, management companies, agribusiness and agronomists to develop his system to minimise costs and maximise yields. He said being at this year’s Conference was a unique opportunity to not only pitch, but have everyone together “in the same room”.

“I think the way forward is becoming more about relationship building – the people I would have to drive around the country to see were all in one place.

“After being around for a few years it’s great to feel like we are becoming a part of the industry rather than an outsider and it’s only events like these that allow us to interact with the broader community in that environment.

“I think there’s a big danger in rushing or forcing technology in ag, at the end of the day the market will always decide who the winners are so in one sense we have ambition just to be alive for the next cotton conference because that means, slowly but surely, we are having a positive impact on those who stand to benefit most from our technology – the grower.”

So what did was the experience like with Steve Baxter during the “Pitch from the Paddock”?

“Pitching to Steve Baxter was great,

he’s clearly a bloke who doesn’t pull any punches so I was a bit nervous about getting our message across clearly, but Steve seemed to get it without drama so that certainly gives me a lot of confidence we are on the right track in a business sense.

“The key message for me was ‘If you have a product, the main consideration is what is the economic benefit of using that product and is it easy to use?’”

CRDC Executive Director Bruce Finney said they were very pleased with how this exciting new Conference initiative unfolded.

“As an investor in innovation, digital and disruptive technologies and entrepreneurs, CRDC is constantly on the lookout for innovations that will push the boundaries of Australian cotton.

“This is a great way to showcase the exciting ideas and innovations emerging from the startup community, and to connect cotton growers seeking solutions with businesses who may be able to help.”

#### For more

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# Farm profitability on the rise

**BOYCE** and CRDC have been involved in benchmarking irrigated cotton since 1986.

The draft 2018 results of the Australian Cotton Comparative Analysis were released just prior to this year's Australian Cotton Conference, showing that the average income across all farms was \$6382/ha – up from \$5575 the previous season. The top 20 percent average yield was 13.27 bales/ha, up from 11.35 in 2017.

Boyce's Paul Fisher was a speaker at this year's conference, where he outlined four areas crucial to farm profitability on the back of the latest figures.

1. Benefits of certain water, specifically in terms of making a price.
2. With limited water, should you go small with a small solid plant area or spread the water over a bigger area?
3. Being at the forefront of technology adoption and the impact of that decision on profits.
4. Understanding Terms of Trade, accepting reality and focusing on what you can change in the profit equation.

"We are not so much 'telling you what has to be', rather as 'sowing the seed of what you should consider' for your future direction and planning," Paul said.

"There is a similar thread running through each of the four points that require a decision by the farmer – whether or not to sell forward, to change row configuration, to adopt new technology or to vary the level of inputs."

## Making a price

It's not just about selling when price is high, it's about selling when the price is high and your production risk model indicates it's reasonable to do so.

There are two things to consider. Firstly, as the weather seems to get more erratic, managers need to have a production framework which allows them

to market their crop within risk boundaries. Secondly, consider the value of more certain water.

"More certain water gives you a longer time within your production risk framework to obtain a good price," Paul says.

## Innovative farming

In the modern farming world, growers need to properly assess the impact of purchasing new technology on profit prior to investing large sums of capital.

The Rogers Adoption Innovation Curve is used to show that the percentage of an average market place and how quickly they adopt new technology/ methods.

"We know that 2.5 percent of people will be at the cutting edge, whereas around 16 percent will almost be dragged across the line," Paul explained.

"Interestingly, there doesn't seem to be any correlation between profitability and where you sit on the curve and for us as accountants, this is important."

When looking at adoption of innovation, round bale pickers are a prime example.

"Everyone could have picked their crop very cheaply with old picking technology since round bale technology arrived in Australia, yet almost all growers in 2018 chose to use a round baler," he said.

"There are many reasons for this adoption, but where does profit sit within that framework?"

His advice is to firstly, treat your current position as a sunk cost, so that it doesn't get counted in the equation. Then, the analysis is the current cost of operation

versus the capital cost of adoption and (hopefully) the reduced cost of operations that flow from implementation.

"In essence it's the capital cost of adoption versus the yearly operational cost savings.

"No one outcome is right for all, but blanket adoption of new technology, at least from a short-term profit viewpoint, is always worth being put under the spotlight.

"By having a framework to analyse new technology, you can learn what drives the decision-making process in your business and from there refine the process for future decisions."

## Terms of Trade

Terms of Trade refers to the relationship of the price of outputs with respect to the price of inputs. The Boyce analysis shows little or no long-term growth in the lint price

over time, further, it's clear from the analysis that the price of inputs continues to rise.

"That means the Terms of Trade for your industry, like Australian ag as a whole, is falling rapidly," Paul said.

"From there, you need to understand the other factors that make up the profitability equation – the Terms of Trade are only one part of the profit equation.

"On the income side, this is yield: on the expense side, this is the volume of inputs per application and the number of times those inputs are applied.

"So if you accept that the price of inputs and outputs are generally out of your hands, concentrate on yield, the volume of inputs and the number of times those inputs are applied."

Paul said yield has always been in the spotlight, and should continue to be.

"It is becoming increasingly evident, especially with better technology, that we have to also look at the volume of inputs and the number of times those inputs are applied.

"Knowledge about different soil types and variable rate application technology is making this easier.

"Within this decision, I have noticed a focus on applying more of something to get more yield.

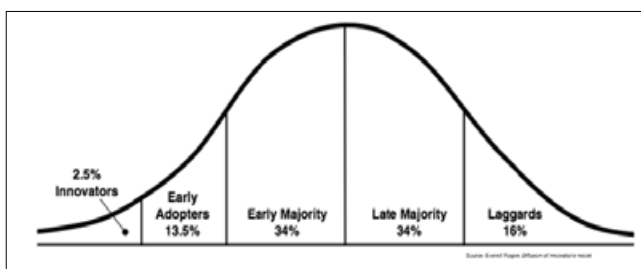
"I also think there is a place for looking into applying less of something without any impact on yield."

To download the 2017 analysis and 2018 interim report:

[www.crdc.com.au/publications](http://www.crdc.com.au/publications)



Paul Fisher



The Rogers Adoption Innovation Curve: Being at the forefront of technology adoption and the impact of that decision on profits.

# New insights on fibre quality: ‘From seeds to good shirts’

A new edition of *FIBREpak* delivers fresh insights on cotton fibre quality and how management from the field to the gin affects Australia’s reputation for producing a premium product.

CSIRO’s Mike Bange says that since its inception, *FIBREpak* has been a popular resource within the industry across all sectors of industry. It brings together, in one publication, research and knowledge on producing and delivering fibre and aspects of fibre quality that can be influenced through better management. *FIBREpak* provides an understanding of the fibre supply chain, and identifies needs and constraints within it.

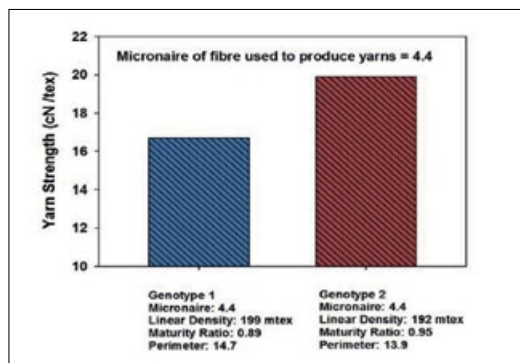
“We have termed this ‘Integrated Fibre Management’ (IFM) to emphasise the importance of a balanced and complementary approach to managing fibre quality across the whole production chain,” Mike said.

“The industry’s *myBMP* program seeks to improve quality by providing guidance and assurances in production, classing and ginning.

“Along with *myBMP*, new technologies, instruments, research and extension programs and communication will all help together to facilitate better fibre management.”

Australian cotton is viewed worldwide as an excellent fibre. It is usually purchased with the intention of producing high-quality combed, ring spun yarns for use in the woven and knitted apparel sector.

Fibre quality is affected by a large number of interacting factors; variety, seasonal conditions, crop and harvest management and ginning can all shape



Provided in the updated version of *FIBREpak*, information showing the impact of changes of the fibre properties of fibre fineness, maturity and perimeter on yarn strength from cotton measured with the HVI having similar micronaire. Yarn was 20 tex ring spun yarn following both carding and combing processes.



MELANIE JENSON

whether or not the spinner’s requirements are met.

“While some of these factors cannot be controlled, there are many that can be influenced,” Mike says.

“Better varieties, management for each region’s climate, and processing to minimise damage to fibre are opportunities to improve fibre quality.”

*FIBREpak* contains the latest information for managing fibre quality at every step, from pre-planting to processing. The *FIBREpak* team has included new insights from a range of researchers on the impacts of micronaire on post-harvest outcomes; influences of different harvest practices on quality; and honeydew impacts.

Management recommendations have also been updated to reflect changes in practices since the last edition was published in 2009. *FIBREpak* continues to form the basis of crop management recommendations provided in industry best practice guidelines such as the *Australian Cotton Production Manual*.

The second edition of *FIBREpak* can be downloaded from the CottonInfo website.

## For more

[www.cottoninfo.com.au/publications/fibrepak](http://www.cottoninfo.com.au/publications/fibrepak)

IPM involves using dynamic insect control thresholds which consider crop health, plant damage, pest number and mix and predator/parasite activity, along with diligent and regular monitoring.



MELANIE JENSON

# Constant reminders of the need for IPM



Mother Nature has a strong record for reminding us who is boss – particularly when it comes to pest management.

The Integrated Pest Management (IPM) practices for cotton have evolved over time as new technologies become available. Essentially, they revolve around growing the crop in unison with the surrounding environment rather than against it.

Our evolving IPM strategy is published in the annual *Cotton Pest Management Guide* and its main pillars are:

- avoiding the pests from the start through good farm hygiene and consideration of the cropping sequence;
- using dynamic insect control thresholds which consider crop health, plant damage, pest number and mix and predator/parasite activity;
- diligent and regular monitoring of the above; and
- doing everything possible to preserve predators and parasites, including insecticide use minimisation and predator/parasite-friendly selection, and the controlled release of predators where practical.

In recent years we have had a couple of strong reminders of the consequences of deviating from good IPM.

First, is the emergence of two pests that require a lot more than an insecticide armory to manage them – silverleaf whitefly and solenopsis mealybug. Both these insects, either through natural protection or metabolic changes can resist insecticides and tend to be the 'last bug standing' after a spray. Hence, the explosions of the populations of these two species often follow heavy broad-spectrum insecticide use.

For instance, silverleaf whitefly achieved district-wide outbreak status on several occasions including Central Queensland in 2002 and Gwydir Valley in 2016. In both instances, the problem further deteriorated when people tried to spray their way out – only to destroy beneficial insect populations.

These outbreaks proved to be hard lessons for industry and subsequent seasons have seen an improvement in whitefly management with better insect sampling and improved product selection and timing.

This was further assisted with new information from Jamie Hopkinson and his team at QDAF, ranking the impact of various mirid-controlling insecticides on whitefly parasites. Additionally, Jamie's

team is educating consultants on the importance of timely parasite identification and quantification of whitefly nymph control. This information proved very popular at the CCA Narrabri Seminar in June 2018 and has been a popular topic of discussion since that event.

The solenopsis mealybug, while not as prone to the area-wide outbreaks as silverleaf whitefly, has proven very destructive in isolated areas. QDAF entomologist Paul Grundy has been one of the first people on the scene of many outbreaks of this emerging pest. In almost all cases he has observed a significant breakdown in one or more components of good IPM – including poor farm hygiene or heavy early-season use of broad spectrum insecticides. Paul also spoke about this at CCA's Regional Workshop Series.

A second recent reminder about the consequences of cutting corners on IPM comes via miticide resistance monitoring by Dr Grant Herron and his team of entomologists at NSW DPI. Their data shows increasing levels of resistance in two-spotted spider mite to the miticide Abamectin to levels where control will be compromised. Resistance was first reported in 2007 and by 2016-17 season, more than 80 percent of populations surveyed were resistant to this product

with some comprising nearly 100 percent resistant individuals.

Much of the blame for this increase in resistance is being pinned on the prophylactic use of Abamectin – ironically the practice of systematically adding the miticide to other insecticide sprays to reduce the likelihood of flaring mites. This, however, is just one more lesson in what Mother Nature has dealt to us before.

Those new to the industry will not know that the older organophosphates dimethoate and omethoate were reliable miticides against two-spotted spider mite until resistance developed rapidly in the 1980s rendering them useless against this pest. They were replaced by newer organophosphates, monocrotophos and profenofos which too, stopped working by the early 1990s. The synthetic pyrethroid bifenthrin was then used throughout the mid-1990s but it too now has significant resistance and no longer works reliably.

It highlights that our insecticide options need to be used wisely.

These examples show that for “good” IPM to happen successfully, there needs to be a strong and trusting working relationship between the person making the recommendations, whether that be a consulting or on-farm agronomist and the person who is paying the bills.

Our role as agronomists is to accurately collect all of the relevant field information and use that to provide informed discussion with the crop owner so the best IPM-compatible decisions can be made.

Crops Consultants Australia has put a lot of resources into building an IPM knowledge bank via our series of Winter Workshops where the industry’s leading entomologists have given detailed presentations of their recent work.

Combined with the experience within our membership, whose knowledge extends way past these lessons dealt, and the network that links us all, we aim to ensure that our members and the people who they service are well equipped to cope with, or even better avoid, our next lesson from Mother Nature.

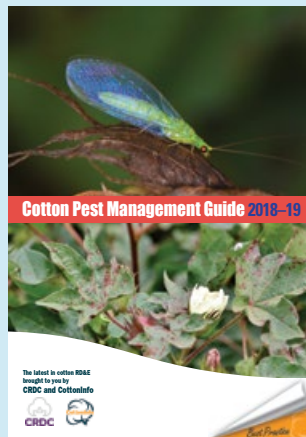
More details on events and membership are available at the CCA website.

#### For more

[www.cropconsultants.com.au](http://www.cropconsultants.com.au)

# CCA on board with new guide

This year for the first time CRDC and CottonInfo have partnered with Crop Consultants Australia (CCA) to develop the 2018-19 *Cotton Pest Management Guide*.



This year’s new partnership sees the appointment of a CCA technical review panel, who not only reviewed the publication, but provided technical expertise to ensure it remains a highly useful and useable resource for growers and consultants.

Integrated pest management (IPM) and best management practice are the cornerstone of Australia’s successful management of pests, and the Guide gives users an up-to-date clear

pathway to achieving both.

There are some major changes in this edition, including new information around mirid thresholds and management, revised tables, a section dedicated to managing volunteer and ratoon cotton, updated imagery and regional disease updates.

Along with its sister publication the *Australian Cotton Production Manual*, the *Cotton Pest Management Guide* is one of two key ways CRDC and CottonInfo share the latest in cotton industry RD&E with industry each year. In terms of pest management, the *Australian Cotton Production Manual* contains additional information on spray application and integrated pest, weed and disease management and is available to download from the CRDC website ([www.crdc.com.au/publications](http://www.crdc.com.au/publications)).

CRDC’s Susan Maas said it was fantastic to have CCA on board this year to produce the guide.

“Our particular thanks to CCA Executive Officer Fiona Anderson and the CCA Technical Review Panel members Bill Back, Elle Storrer, Sam Simons and Peter White for their input and guidance,” she said.

“We believe the extra input from CCA has certainly enhanced the usability and information in the Guide.”

#### For more

[www.crdc.com.au/publications](http://www.crdc.com.au/publications)

# Learning from experience

CRDC's Grassroots Grants program is bringing cotton growers and consultants together to share experiences and expertise in the management of key cotton pests.



Through the Grassroots Grant program, the Gwydir and Macquarie Cotton Growers Associations, in conjunction with CottonInfo held Area Wide Management (AWM) meetings to discuss silverleaf whitefly (SLW) and solenopsis mealybug management during the 2017-18 season.

Consultants Dave Parlato from Emerald and Iain Macpherson from Goondiwindi, along with Central Highlands grower Brad Anderson were specifically invited to share their first-hand experiences managing SLW and mealybug. Auscott Cotton Marketing Manager and Australian Cotton Shippers Association Director Arthur Spellson led discussion on the impact of these pests on fibre quality via honeydew or 'stickiness'. CottonInfo regional extension officers (REOs) Amanda Thomas in the Macquarie and Janelle Montgomery in the Gwydir Valley facilitated the meetings.

"Initially, growers and consultants in the Gwydir were aware that SLW was a potential threat and approached me to restart AWM groups," Janelle said.

"The Macquarie growers were also keen to learn about managing whitefly so it was a great opportunity to collaborate between the regions.

"Bringing the consultants from other regions improved the understanding of how to best manage these pests, while growers within each region could share their experiences and management techniques."

### The Emerald experience

In 2001 Emerald saw low numbers of SLW build exponentially in a perfect storm with favourable conditions and the population 'exploded'.

"The entire region was covered in honeydew – there were clouds of SLW in town. People were wearing surgical masks; aircraft had visibility issues – that's how thick they were," he said.

"Luckily, rain at the end of the season washed off the SLW honeydew residue."

After this experience, the cotton industry responded by sending a group of growers and consultants to Arizona and Texas, where SLW had created serious issues some years ago.

They came home prepared to make changes.

"We had no choice if we wanted to grow cotton," Dave said, "so we started AWM groups because communication is the key.

"We found new approaches in soft chemistry, monitoring, retention and preserving beneficials.

"We manage the population all season, staying with soft chemistry as long as possible and no longer use SPs or OPs, and with any hard chemistry, it had to be late in the season, if at all."

The Gwydir has experienced varying but rising levels of SLW since around 2009. The Macquarie felt their presence more recently.

### Mealybug on the move

Mealybug were previously considered a Queensland issue as well, but are now on the move. They made their way to the St George area three years ago and Macintyre



Auscott's Jake Cutcliffe, Horcott's Dave Parlato based in Emerald; Emerald grower Brad Anderson and Iain Macpherson, Macpherson Agricultural Consultants, Toowoomba.

Valley around Goondiwindi in 2017. This year they were found in a dryland crop in the Gwydir Valley.

Mealybug nymphs can travel on the wind and adults can overwinter in cooler areas and on many common weeds found on cotton farms and rogue cotton itself.

Beneficials and IPM are key to their control, as only temporary permits for chemical control exist in NSW.

Dave, Iain and Brad discussed the importance of integrated pest management (IPM) using beneficials for control and the importance of protecting these natural predators throughout the season.

“If anything drives you to IPM, it’s mealybugs,” Iain Macpherson said.

“If we don’t use IPM we will pay the price with SLW and mealybug.

“It is critical to manage the population all season and to stay soft as long as possible, not just for your own IPM program.

“If one grower uses SPs it can impact others around them and we do see the impacts across the region.

“We looked at the gross margins of those who used softer chemistry and those who were locked into the ‘spray early, spray often’ regime, and it was a dollars approach that converted the growers in the end.

“Prophylactic sprays are problematic in the industry. Many sprays go in with the OTT round up even if numbers are not at threshold.

“Don’t even go there – if you do this, you are setting yourself up to spray your way out of it. It might be cheap early but expensive in the long run.” Iain was wholly backed up by Dave.

“When they first came to Emerald, people sprayed, but they just came back harder,” he said.

“Mealybug will get into every nook and cranny

on the plant, they’re just too hard to control with sprays, and if you do spray you’re still going to need your beneficials.

“Mealybug start out on one plant, then just spread out like a crop circle, then spread across whole farms.”

### Adhering to IPM

Brad Anderson said there were good discussions about the use and effectiveness of soft chemical options and the potential to implement IPM on a broad regional scale to assist in managing both SLW and mealybug.

He has used drones to drop beneficials into his crops to boost numbers to help control mealybug hot spots and any SLW present at the end of the season.

“It is great that growers and consultants down here see this as a significant emerging issue and are highly supportive of AWM groups that could possibly help implement a more targeted approach to the prevention of damage and management of SLW.”

### Early decisions affect later conditions

The impact on SLW and mealybug should be front of mind when making every spray decision, especially early season.

Dave said he’s found that all the beneficials, parasitic wasps (*Eretmocerus hayati*) and soft options help but they can’t work alone, they need to be working together to control the population.

“If you disrupt any of these it can be the leg up that SLW or mealybug need to get a hold,” he said

“Lacewings, ladybirds and parasitism are the best methods of control, but may not be able to completely control them alone.

“Monitoring the pest/beneficial ration and the population dynamics is critical to ensure any control is well timed.”

### Fibre quality

Arthur Spellson congratulated the CottonInfo and the Macquarie and Gwydir Valley Cotton Grower Associations (CGAs), whom he says want to ensure that consultants and growers fully understand the potential implications of, in particular SLW, from a fibre quality perspective.

Attendees at the AWM meetings highlighted that their greatest issues with SLW management were timing applications. Their greatest challenge to their IPM strategies was having enough confidence in natural enemies and beneficials to control pests; and a lack of soft options for some pests. There was also concern that if early retention suffered, it would affect yield, particularly in a year that has had a cooler

**Dave Parlato (centre) told the area wide meetings that if you disrupt beneficials early, it can be the leg up whitefly or mealybug need to take hold.**



MELANIE JENSON





Tangleweb spiders predate whitefly.

start, and disease and thrips have had an impact already. However, the crop does have the ability to compensate.

### Extremely helpful

Gwydir Valley grower Jake Cutcliffe from Auscott said the movement of SLW into the region was concerning, and working as a group through AWM could improve effectiveness of individual efforts.

The approach also increases grower awareness of successful strategies growers and consultants in other regions have used to manage SLW.

“The meeting was extremely helpful in particular for SLW management,” Jake said.

“Where Dave (Parlato) is at Emerald they have had a lot of SLW issues that they’ve overcome.

“From an area-wide management perspective, getting everyone in the one room to see what they are doing and when is important.

“By being aware of what others are doing we can take the same approach, or coordinate management, in terms of chemical choice and timing, as whitefly are so easy to flare.

“When you get busy in the season it is easy to shut off from what other people are doing, but these days we need to be aware what others are doing and seeing.

“We can learn from each other about different approaches and share information on pest numbers or presence.

“For example, growers might encounter a pest at Mungindi that we don’t have yet, so through these meetings we can get the heads up and be prepared or take steps to avoid infestations in our crops.

However, he says, AWMs are only as successful as the people organising and chairing meetings.

“We are lucky to have Janelle. She is doing an unbelievable job in getting us together and driving this conversation.”

## Checks and texts

While the AWM meetings continued throughout the season, Amanda Thomas said CottonInfo REOs and consultants in the Gwydir, Macquarie and Southern Regions have also been successfully using a “Bug Check” text messaging approach.

“This allows us (REOs) to send advisors queries about pests and get a quick response,” she said.

“We collate and send the responses back to consultants and growers via the CottonInfo network, so that others might get a heads-up of what’s about in their area.

“The information is also shared across the valleys, as for example, here in the Macquarie we often see the pests that the Gwydir was seeing three weeks earlier.

“This regular communication every week or fortnight throughout the season is a form of AWM that works for us well here in the Macquarie, it is instantaneous and we can respond immediately with information or researcher visits.

“Organising a meeting can take time, and it can be hard to make a time that suits everyone, and in most cases, the sooner we can get information out, more informed decisions can be made. Meetings are still a great way to communicate in season however we do need to incorporate other modes to make sure we connect with as many as we can.”

Amanda said support through CRDC’s Grassroots Grants program allowed them to respond to the need for information very quickly.

“A big thanks to CRDC for responding quickly to the industry needs and giving us the funding to bring the knowledge of Arthur, Iain, Dave and Brad to our growers.

“We were able to put our heads together and respond, which was a great example by CRDC, CottonInfo and the CGAs of how we can ‘make things can happen in-season’.”

### Key Messages

Implications of SLW damage and the potential impact on Australian Cotton’s premium position:

- US producers are closing the gap in terms of quality on Australian cotton.
- Sticky cotton is a known risk.
- Discounts could come through as a national issue – broadly speaking we are only ever one “bad season” away from this happening.
- Resistance levels to SLW are growing, chemical insecticides should be used to support control as a last resort if beneficials are absent or at very low densities and population is growing.
- Do not use broad spectrum products for management of other pests as this is likely to flare mealybug.

# Complex nature of Verticillium

Verticillium wilt is becoming a growing concern for cotton growers, as researchers work toward improving understanding of this disease that ‘doesn’t play by the rules’.

In Australia, isolates from both defoliating (D) and non-defoliating (ND) Verticillium wilt have been identified. However, researchers have found an anomaly with the ND isolates, which are showing virulence ranging from mild to complete defoliation and death of plants, which seemingly contradicts the international classification.

NSW DPI’s Karen Kirkby and her team at the Australian Cotton Research Institute and EMAI are using molecular techniques to analyse the genetic complexities of Australian *Verticillium dahliae* cotton isolates with support from CRDC.

CRDC-supported PhD student Pearl Dadd-Daigle undertook a genetic analysis of the different isolates existing in Australian cotton farming systems. Her work showed that there were three specific clusters with varying virulence:

- low virulence clustered together as ND
- high virulence clustering as D
- ND isolates with defoliating-like symptoms formed.

“Our results have shown that virulence of cotton pathotypes is not a simple qualitative distinction and a gradient of virulence exists within the defoliating and non-defoliating pathotypes,” Karen said.

“We have selected defoliating-like isolates identified in this study for genetic sequencing to look for virulence genes.”

A key to understanding this variation is international collaboration.

“We are not working to solve the Verticillium problem in isolation, our team is working in partnership with Professor Jason Woodward and Dr Terry Wheeler, Verticillium experts from Texas Tech University and Texas Tech Research and Extension Centre in the US,” Karen says.

“We also recently hosted Jason’s Masters student Shelby Young who in turn hosted our PhD student Pearl in the US.”



MELANIE JENSON

**NSW DPI’s Karen Kirkby and her team at the Australian Cotton Research Institute and EMAI are using molecular techniques to analyse the genetic complexities of Australian *Verticillium dahliae* cotton isolates with support from CRDC.**

This collaboration has enabled the inclusion of DNA from American isolates imported to Australia for genetic comparison. The findings will increase understanding of virulence and lead to the development of a more accurate classification system for Australian cotton Verticillium isolates.

“Only after we know the extent of variation in virulence and a new classification system adopted can we look for a solution-based production risk,” Karen said.

## Predicting disease risk

Karen and her team are continuing to develop a molecular diagnostic tool for growers or agronomists to quantify *Verticillium dahliae* inoculum levels in soil prior to making planting decisions.

Fields with high levels of inoculum can then be avoided and instead use fields (for cotton) with less risk of causing disease in the following season. The research is a part of the *Digital Technologies for Dynamic Management of Disease, Stress and Yield Program*, a project under the Australian Government Department of Agriculture and Water Resources Rural R&D for Profit Program.

The aim is to differentiate strains, with a quick, accurate and reliable test.

To date, a soil sampling protocol has been established and work is continuing to establish a correlation between inoculum levels and disease risk. Karen says this has been particularly difficult given the varying symptoms from isolates from the same VCG (vegetative compatibility group).

“Understanding the virulence of individual isolates will assist in developing a meaningful risk matrix to assist growers with decisions around which fields to plant,” she said.

“We have established the natural fluctuations in inoculum throughout the cotton season, showing high inoculum levels at planting, falling over the next few months and rising again following harvest when diseased plant tissue is returned to the soil.

“This information is important as sampling timing will critically affect inoculum levels.”

## For more:

**Karen Kirkby**

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CottonInfo's Optimising Irrigation and Nitrogen tours held across all regions this year were well attended and created so much interest, a webinar was held after the tour to cover the main queries from growers and consultants.

# Nitrogen management: Your key questions answered

Cotton growers and consultants are continually striving to better understand nitrogen-use efficiency.

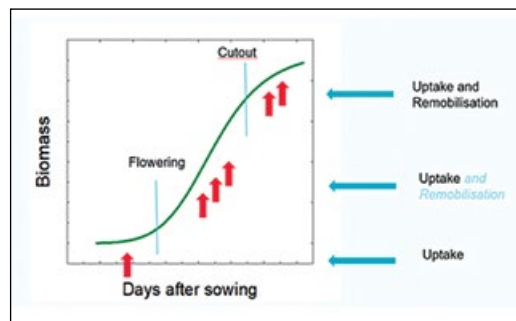
Following the well-attended CottonInfo Optimising Irrigation and Nitrogen tour earlier this year supported by CRDC, researchers and CottonInfo Regional Extension Officers (REOs) found there were a number of questions continually cropping up.

To answer these questions, Gwydir Valley and Mungindi CottonInfo REO Janelle Montgomery organised a webinar, with 42 people tuning in to get the word from a panel of experts including QUT's Professor Peter Grace, CSIRO's Dr Mike Bange and consultant David Hall.

"From our evaluation, 62 percent of 'attendees' agreed that the webinar provided them with information to better manage nitrogen in their cotton fields," Janelle said.

"Major changes were highlighted, such as moving to in-crop N application (as opposed to up front) and using variable rates.

"Research and surveys show that we are still over-applying N, so understanding where it goes and what causes losses are crucial to improving nitrogen-use efficiency (NUE)."



The three main queries were: how do I effectively soil test for N; what are the risks associated with applying N pre-season versus in-crop (and the impact of weather); and how critical is N nutrition at different stages of crop development?

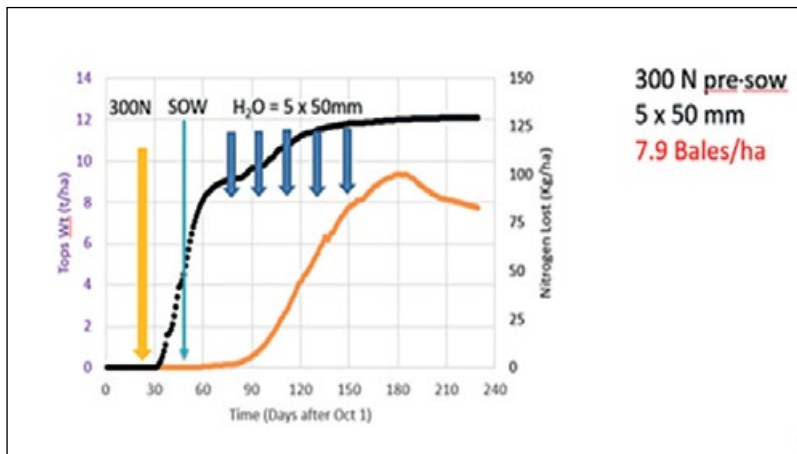
## How do I effectively soil test for N?

Trial data collected by the CottonInfo REOs across all growing regions found cotton fields showed significant variation in soil N between the head ditch and the tail drain. This raised the question: how is this accounted for during soil testing?

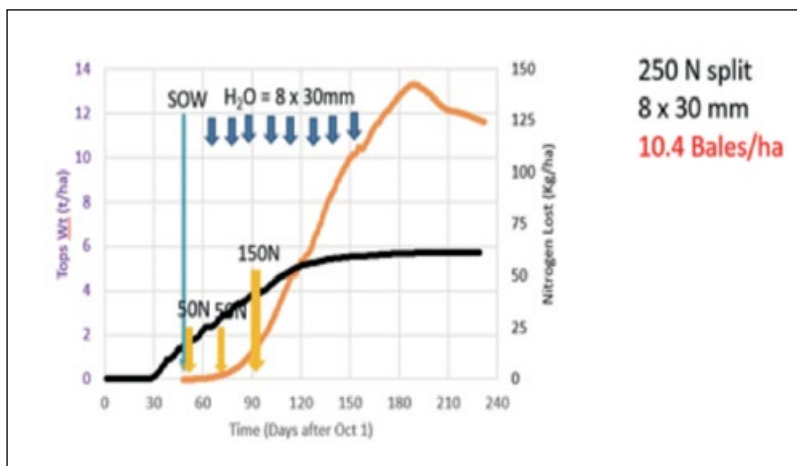
David Hall advised the use of technology such as EM mapping, NDVI maps and GPS coordinates to ensure a systematic approach to soil sampling and a better understanding of soil variability, rather than a random selection of sampling points.

"Chemical properties of soils will have a higher

## What happens when you put all your N up front?



Up front: 300 kg N/ha up front, sow 30 days later, apply 5 x 50 mm. The orange line is the N uptake pattern of the crop; the black line is N lost (kg/ha), compared to a split application (below).



level of variability than any soil physical properties," David said.

"The soil N test is only a snapshot in time of available nitrate N. It does not give you any indication of the soil's ability to provide N through mineralisation.

"It doesn't assess organic matter and how much of this would become available during the season.

"The current N test is reliable, dependable, and it's an effective monitoring tool."

A 'very normal phenomenon' is to see lower N levels at head ditch, increasing down the field, then higher at the tail drain, which should be considered when identifying soil sample sites.

### Pre-season versus in-crop application and the impact of weather

To reduce losses, N must be applied when the crop needs it. Applying it too early increases the potential of losses. Waterlogged soil leads to significant gaseous nitrogen losses, which are dependent on the duration of waterlogging and the amount of N sitting there at the time.

"You could literally lose all your N if you were waterlogged for an extended period of time," Peter Grace says.

"Every region is different, every soil is different and every year is different. You could get the same yield with different levels of N fertiliser application depending on climate, weather systems and irrigation pattern used and amount of N applied.

"With all these factors interacting, there is no simple answer.

"However, applying all N up front increases risk of lost production and profitability, especially if weather comes in wet, so split applications can spread the risk to reduce N losses.

"Irrigations must be managed efficiently to

## What we're doing (WWD) versus what the research says (WRS)...

**WWD:** 275 kg N/ha applied (irrigated) – up 13 percent since 2013.

**WRS:** Anything over 240kg N/ha is excess to plant needs.

**WWD:** 65 percent of N is applied pre-season (up front).

**WRS:** More frequent, smaller irrigation applications and 250 kg N applied in a split application after sowing lost only about 60 kg N/ha compared to up-front trials using 300 kg N/ha, when a relatively wet season saw losses of 125 kg N/ha – or over one third. The crop N uptake was much higher and N losses

significantly lower using split applications.

**WWD:** Believe 50-70 percent of fertiliser N is taken up by the crop.

**WRS:** Only 12-20 percent of crop nitrogen comes from fertiliser – ie taken up by the crop. At the end of the season, 13 to 35 percent of N fertiliser is left in the soil at harvest. A significant amount – 41 to 57 percent of fertiliser N is lost (forever) into the atmosphere. Soils mineralise approximately 200 kg N/ha before any losses. This will vary with soil organic carbon, residues you have, and the previous crop, from 150 to 300 kg N/ha.

## How to improve NUE

- Apply N later with less water more often. Obviously going to be restrictions here on what you can actually do depending on your farm layout, farming system, equipment.
- Soil testing and nitrogen budgeting are critical. You need to know how much N to put on.
- Sample to the effective root zone of the crop.
- Base fertiliser recommendation on application of 4Rs – right product, right rate, right time of application and right source.
- Remember the “Law of the limiting” as in don’t forget other essential nutrients such as phosphorus and zinc.

minimise waterlogging, deep drainage and runoff, so where possible, apply N later with less water, more often, however we understand there are obviously going to be restrictions on what crop managers can actually do depending on the farm layout and farming system.”

The researchers also reiterated that soil tests and N budgeting are critical – “You need to know how much N is there before you put more on”.

They also encouraged the use of decision support tools. With differences in crop rotations, irrigation scheduling and management, the use of decision support tools offer different scenarios in advance to make informed decisions, instead of using just a rule of thumb.

### Crop development and N

The greatest demand for N is when the plant is producing stems, leaves and fruit, from flowering to cutout. Post-cutout, the plant is just growing the fruit, not growing new fruit so N demand reduces.

“Reduced N uptake after cutout does not affect yield, its inadequate nutrition during high demand phase (flowering up until cutout) that will affect yield,” Mike says.

- Plant N demand lowest from sowing to flowering
- Plant N demand is greatest from flowering to cutout
- Plant N demand decreases post-cutout

The webinar is available on the CottonInfo website: [www.cottoninfo.com.au](http://www.cottoninfo.com.au)



Dr Ben Macdonald

MELANIE JENSON

## Have we reached ‘peak’ nitrogen?

With research showing that nitrogen (N) fertiliser is being applied at amounts surplus to crop requirements, crop managers are being urged to look elsewhere for yield constraints.

Fifty years of sustained investment in research and development has left the Australian cotton industry well placed to manage nitrogen (N) fertiliser.

The average production in the Australian cotton industry today is greater than two tonnes of lint per hectare due to improved plant genetics and crop management. However in terms of crop nutrient management, according to industry researcher, CSIRO’s Ben MacDonald, this average yield is well below the yield that would be expected from the amount of N fertiliser used.

Ben says it is clear from recent studies that across all growing regions, conversion of fertiliser N into lint is not occurring uniformly at application rates greater than 200 to 240 kg N/ha (Figure 1).

“This indicates that factors other than N availability are limiting yield, and that the observed nitrogen fertiliser-use efficiency (NFUE) values may be caused by subsoil constraints such as sodicity and compaction,” he says.

“There is a need to investigate the impact of subsoil constraints on yield and NFUE.” Gains in NFUE will be made through improved N fertiliser application timing, better targeting the amount of fertiliser applied for the expected yield, and improved soil N management.

“There is also a need to

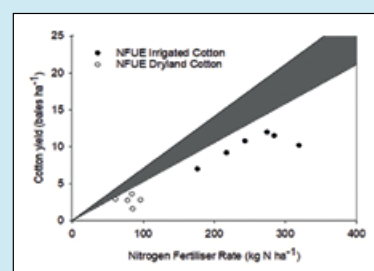


Figure 1. NFUE in the Australian irrigated and dryland cotton industries. Data corresponds to 2001-02, 2010-11 and 2012-13 – 2015-16 seasons. The shaded area represents Ian Rochester’s (2014) optimal NFUE range.

improve the ability and confidence of growers to estimate the contribution of soil N mineralisation to the crop N budget.

“Many Australian studies include data that could theoretically be collated in a meta-analysis to suggest relative NFUE values as a function of irrigation technique.

“However, with the extensive list of uncontrolled variables and few studies using non-furrow irrigation, this would be a poor substitute for a single field-based study directly measuring their efficacies.

“In irrigated cotton, a re-examination of optimal NFUE is due because of the availability of new varieties and the potential management and long-term soil resilience implications of the continued removal of mineralised soil N suggested by high NFUE values.

“NFUE critical limits also still need to be derived for dryland systems.”

### For more

Ben MacDonald

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# Improving soil health and the bottom line

Rotation crops are an integral part of cotton farming systems that provide multiple benefits.

These benefits include improving soil health, water infiltration and soil moisture holding capacity; guarding against disease and stimulating microbial activity. Research has shown healthier soils require less synthetic fertiliser and tillage and form the basis for providing optimal crop nutrition.

Many crops are able to be grown in rotation with cotton and there are many reasons to plant a rotation crop: it may be purely for income, or a combination of factors including improving soil health or managing disease. Either way all these factors must be considered when making a decision.

Crop rotation research supported by CRDC, with NSW DPI and CSIRO has been investigating another potential advantage of selected rotations systems and if they help make farms better able to cope with extreme weather events and a more variable climate.

## Recent research

In the long-term trial running at the Australian Cotton Research Institute near Narrabri since 1985, the three base cropping systems (conventional tillage cotton monoculture, minimum tillage cotton monoculture and minimum tillage cotton-wheat rotations) have had maize incorporated into the rotation sequence since 2011 as part of developing cropping systems and soils that are more resilient to extreme weather events.

NSW DPI's Guna Nachimuthu says the inclusion of maize into the trial has demonstrated a positive relationship with cotton yield and overall profitability in the years when cotton is grown.

"There was also a positive yield result when minimum tillage was adopted in the treatments, resulting in all minimum tillage subplots returning

the highest yield compared to a similar regular tillage treatment," Guna said.

"In seasons of full water allocation the intensive cropping systems of cotton-wheat-maize can generate gross margins higher than traditional cotton-wheat rotations on a two-year cycle and growers can return to cotton after a summer maize crop".

Also part of the project is NSW DPI Economist Fiona Scott, who says the inclusion of maize and/or wheat in the rotation has shown that cotton yields can be increased compared to continuous cotton treatments at the cost of overall profitability; however whether or not these crops are incorporated depends on whether the rotation fits into the grower's farm management plan.

For example, as Guna notes, "The results indicate that in situations where soil health, disease and water limitations are of major concern and requiring a rotation to be adopted, that returns can be maximised by adopting minimum tillage".

## Soil health benefits

Soil organic carbon status in soil is affected by the balance between on-farm biomass inputs from crop shoots and roots (along with external inputs such as compost or manures) and mineralisation or breakdown losses as carbon dioxide.

Often, if there is a long fallow period along with soil disturbance associated with operations such as pupae busting or tillage, the rate of breakdown of organic matter is accelerated as it is made available to soil microbes.

In an irrigated cotton system, cotton and wheat crops add about four t/ha of shoot dry matter whereas maize adds 8.7 to 10 t/ha.

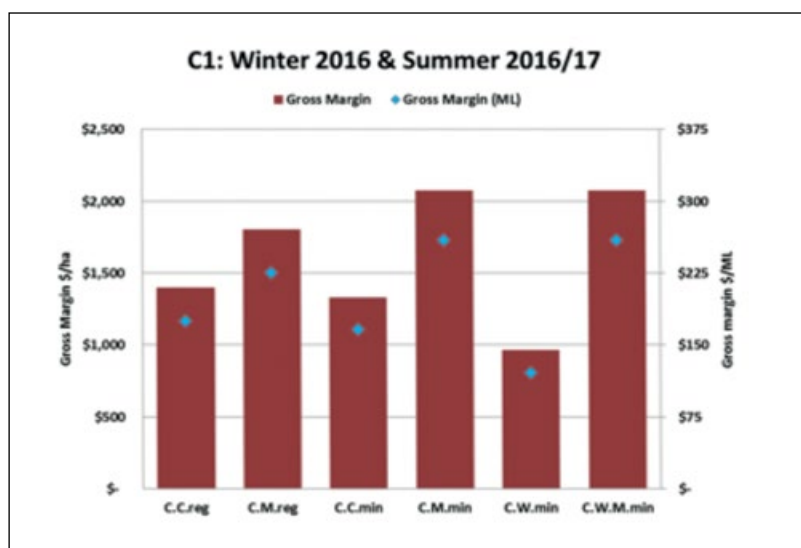
"Approximately 40 percent of the dry matter is carbon," Guna said.

"The maize shoot residues add more than twice the carbon as cotton or wheat shoot residues, excluding root dry matter, and this has resulted in a short-term increase of soil organic carbon after the inclusion of a maize rotation.

"Introducing a maize rotation into the cotton monoculture resulted in not only higher yield, but also lower black root rot incidence and complete control of volunteers in subsequent cotton.

"Furthermore, the cotton-wheat-maize rotation also minimises runoff by enhancing infiltration leading to improved water use-efficiency."

Gross margin of cotton cropping systems.



## For more

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# Crop nutrition: Key resource updated

*NUTRIpak* reflects the significant nutrition research and development that CRDC continues to support, particularly in the areas of nitrogen and phosphorous management.

Good and efficient management of soil fertility and fertilisers remains a vitally important area of research, development and extension (RD&E) for cotton growers and for CRDC. Crop nutrition is the biggest portfolio of research, and a new version of *NUTRIpak* has been released to reflect this.

The publication is designed to provide growers and consultants with the latest science in the field of cotton nutrition. It has been developed to help identify crop nutritional problems and develop management plans to meet crop demand and long-term sustainability.

Much has changed since the previous edition was published in 2001 when 10 bales per hectare was generally considered the upper yield limit.

Today, Australian farm averages of 15 bales and field averages of more than 16 bales per hectare are being achieved. This new version of *NUTRIpak* takes this into account and considers changes in plant nutritional requirements and nutrient exports, particularly nitrogen and phosphorus, the key nutrients needed for cotton production.

“Much has been learned around nitrogen management, and while the nitrogen cycle is complex, and nitrogen-use efficiency is affected by a diverse range of factors, through research there is a better understanding of nitrogen uptake and the importance of soil mineralisation,” says CRDC Impact and Investment Manager Allan Williams.

“The interactions between nitrogen management and irrigation management are also much clearer.”

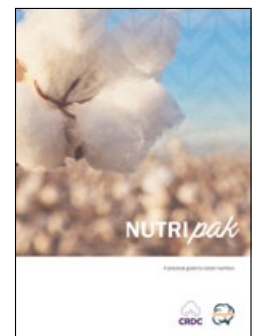
A new section has been added focused on soil organic matter, and there is specific information on managing the risk of denitrification in irrigated cotton based on this new research.

Much has also been learned about phosphorous management, which has resulted in a significant change to best practice.

“Previous advice that phosphorus should be banded has been revised as new research suggests that cotton roots are not very good at exploiting banded applications of phosphorus,” Allan said.

“Rather, the updated advice is to treat the largest volume of soil as possible to maximise the fertiliser that can be intercepted by plant roots.”

The new edition also includes new research into carbon, precision agriculture and soil testing.



#### For more

*NUTRIpak* is available for download from the CottonInfo website:

[www.cottoninfo.com.au/publications/nutripak](http://www.cottoninfo.com.au/publications/nutripak)

# Looking deeply in nitrogen cycling

The Australian cotton industry strives for responsible management of nutrients, minimising any potential transfer to the environment.

Nutrients added to soil can be dispersed from their intended primary use via losses to the atmosphere, rivers and aquifers. The industry is acutely aware of the need for aspirational claims about the off-farm movement of nutrients to be supported by detailed longitudinal studies.

In a new CRDC study that will run for three years, a multidisciplinary team of scientists from Australian Nuclear Science and Technology Organisation (ANSTO) and UNSW Sydney will look at the irrigation sector's impact on the nitrogen cycle from its application in the field and subsequent contributions to the atmosphere, surface waterways and aquifers.

Project leader Dr Dioni Cendón from ANSTO said three areas in the Murrumbidgee, Namoi and Nogoia River valleys have been selected for study. The three regions were selected because they cover a diverse range of climatic, hydrogeological and farming practices in eastern Australia.

Measurements will be made in each of the catchments for two years. Detailed isotopic monitoring of selected nitrogen species in surface and ground water will quantify nitrogen transfer to waterways and groundwater systems, and enable apportionment between natural and anthropogenic sources. The concentration of nitrogen measured throughout the landscape will also be compared to the Australian water quality guidelines.

"This research will provide evidence that can be used to map the cotton industry's nitrogen cycle footprint in the selected river catchments," Dioni said.

"Increased N inputs to waterways can alter their N:P (phosphorus) ratio, resulting in risk of eutrophication and algal blooms, mostly in inland rivers.

***"If we want to understand the entire cycle, we can't keep considering groundwater, rivers and the atmosphere separately."***

## Going nuclear

The inclusion of ANSTO's new tandem accelerator provides a wonderful opportunity for the cotton industry to understand in more detail the extent and nature of N losses from the farming system. ANSTO is a centre of excellence in understanding how environmental systems function and interact and the impact that humans are having on the environment. Its scientists collaborate with national and international partners in using nuclear and isotopic techniques to understand the role of natural variability and human impacts on water, air and Earth systems.

"ANSTO has some of the best instruments in the world for environmental research," Dioni said.

"These instruments are capable of showing us what the Earth was like millions of years ago, helping us to model and predict future climate change, manage our limited water resources and monitor air pollution and its effect on human health."

"Increased catchment runoff can also contribute to lowering water quality in marine environments and possibly contribute to coral decline.

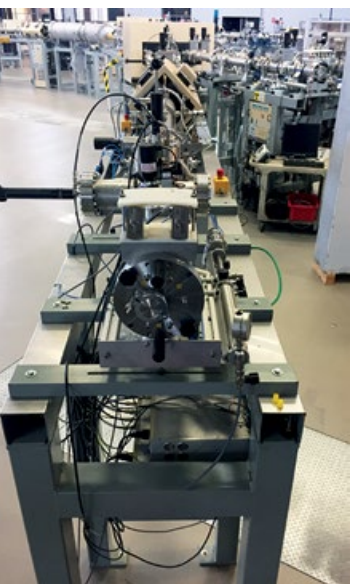
"As government legislation increasingly recognises the connection between surface and ground water systems it will incorporate combined water management plans with properly revised thresholds from catchment nutrient exports."

Dioni says nutrient surveys in Australia are quite ad hoc and mostly represent base flow conditions (easier to collect) while event-based studies used to estimate soil, nutrients and other constituent load exports are sparse. Most surveys incorporate total nitrogen and/or other constituents but that approach cannot decouple N sources (eg effluent from agriculture).

"Nitrogen-stable isotopes (see figure 1) can distinguish nitrogen derived from agricultural activities from those like septic waste, rainfall and soil, improving classic methods based on total N measurements.

"Despite the powerful insights obtained from

A small line in ANSTO's new 6MV tandem accelerator, named SIRIUS. Samples from the project are being measured in this facility for chloride isotopes.



DIONI CENDÓN



nitrate isotopes we cannot differentiate mixed-crop inputs, as most synthetic fertilisers have similar isotopic signatures.

“To better characterise inputs from specific crops we can select regions where cotton has been a dominant crop and compare to results upstream of selected regions.

“Furthermore, incorporating on-farm atmospheric losses closes the N cycle and provides novel data to growers that can be linked to different stages in the crop cycle.”

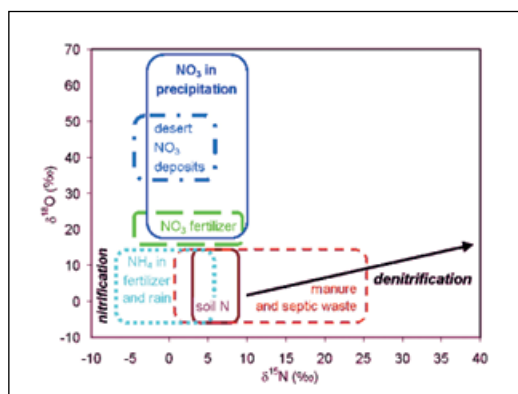


Figure 1.



Nogoia River near Emerald with Lake Maraboon in the background. Surface water has been sampled in selected sites between the Fairbairn Dam and the confluence of the Comet River. Groundwater in the Emerald region will be sampled in late October 2018.

## PhD students at the forefront

UNSW PhD student Stephen Harris, co-supervised by Associate Professor Bryce Kelly and Dr Dioni Cendón, is presently working on linking the atmospheric, groundwater and river N losses in the Lower Namoi catchment. Recently, Stephen and the ANSTO team sampled shallow groundwater from 23 bores (from 8 to 33 m deep) in the Lower Namoi catchment, measuring important indicators of N cycling, such as nitrate ( $\text{NO}_3^-$ ) and nitrous oxide ( $\text{N}_2\text{O}$ ) accumulation.

“If we want to understand the entire cycle, we can’t keep considering groundwater, rivers and the atmosphere separately,” Stephen asserts.

“Nitrogen that is lost to groundwater or rivers can be transformed into the powerful greenhouse gas  $\text{N}_2\text{O}$ , which can then be lost to the atmosphere.

“We need a better understanding of these transformation processes and quantifying how much nitrogen is being lost.”

Stephen presented the first results of the N cycle project at the European

Geosciences Union 2018 in Vienna, Austria, which is the largest and most prominent European geosciences event, attracting more than 14,000 scientists from all over the world. He showed that the highest concentrations of dissolved  $\text{NO}_3^-$  and  $\text{N}_2\text{O}$  were measured in groundwater beneath intensely cropped farms. Encouragingly, the results are on the lower end of similar measurements made in other agricultural districts worldwide.

Stephen also showed that riparian groundwater (the zone adjacent to the river bank) was an important buffer between the farm-sourced  $\text{NO}_3^-$  and the Namoi River.

Another important insight gained from the work has been the effect that of discharging Great Artesian Basin groundwater could be having on the N cycle.

Last year, PhD student Charlotte Iverach, who also worked with Bryce and Dioni on the Lower Namoi groundwater baseline project (see page 26 in this issue), showed that in the Lower Namoi

there was a continuum of mixing between the Great Artesian Basin and Lower Namoi groundwater.

“In The Basin-affected groundwater, we see some evidence to suggest that the upwelling groundwater is actually removing  $\text{NO}_3^-$ ,” Stephen said.

“However, because the oxygen content of the groundwater is so low, the  $\text{NO}_3^-$  is converted to gaseous nitrogen ( $\text{N}_2$ ), rather than  $\text{N}_2\text{O}$ .”

While there was an overall positive relationship between N content and  $\text{N}_2\text{O}$  accumulation in the Lower Namoi groundwater, the relationship was not clear-cut, suggesting that more complex processes are at play.

“The next steps will be to combine and process these data with our more powerful isotopic measurements, which can help narrow down nitrogen cycling pathways,” Stephen said.

Stephen, Dioni and the team hope to conduct more groundwater sampling in early 2019 to improve the spatial and temporal resolution of their dataset.



Associate Professor Bryce Kelly and Charlotte Iverach measuring groundwater levels.

BRYCE KELLY

# Where does the water come from?

Scientists in a cotton industry study are using 'isotopic tracers' to determine the age of groundwater up to a million years old.

Groundwater has been an important resource for cotton growers in the Lower Namoi region of North-West NSW since the 1960s. Little information existed about the mechanisms affecting the aquifer recharge until a recent CRDC-funded study using modern hydrogeochemical methods provided insights into the age and origin of the groundwater. This information will be used by the cotton industry to enable best management of this groundwater resource for future generations.

The project is being led by Associate Professor Bryce Kelly of The University of NSW. He says that in their work they are interested in better defining how much aquifer recharge comes from continuous river leakage, floodwater recharge, deep drainage across the landscape from rainfall and irrigation, and outflow from the Great Artesian Basin into the base of the Namoi alluvium. Bryce has been working with Dr Dioni Cendón at ANSTO, who has also determined the 'age' of some of the groundwater in the Lower Namoi.

They found the zone where water used by irrigators that is less than 70 years old is restricted to within a few kilometres of the Namoi River. Many irrigators five or more kilometres from the Namoi River are using groundwater that is many thousands to hundreds of thousands of years old.

"While it has been known for many decades that the Great Artesian Basin discharges into the Lower Namoi alluvium, one of our goals was to better map where this happens and to do that we examined multiple aspects of the Basin's water chemistry," Bryce said.

"The surprise finding from this research was that at a few locations on the western side of the aquifer between Narrabri and Wee Waa up to 70 percent of the groundwater was sourced from the Great Artesian Basin.

## Origin of water

The new insights on the origin of the water in the Namoi alluvial aquifer are coming from the hydrogeochemistry component of the project, which is being led by Dr Dioni Cendón at ANSTO.

The key to tracing the origin and movement of groundwater is the application of isotopes (atoms of the same chemical element that have the same number of protons, but different numbers of neutrons).

“Examining the isotopic composition of the hydrogen and oxygen in water tells us about the origin of the rainfall, for example frontal systems from the south-west, or low-pressure storm cells that originated in the subtropics,” Dioni said.

“The isotope chemistry of water also enables us to determine how much evaporation has occurred before the rainwater recharges the aquifer.

“We use three isotopic tracers that originate in the upper atmosphere to quantify the age (or residence time) of the groundwater.”

These are:

- Tritium – used to map the distribution of modern water, less than 70 years old.
- Carbon-14 – used to date water that is hundreds to about 30,000 years old.
- Chlorine-36 – used to identify water that is 100,000 to about one million years old.

“For those irrigators using water sourced from the Great Artesian Basin, it is important to monitor the sodium absorption ratio (SAR) of their water to maintain soil health.”

Bryce said insights from both the review of the historical groundwater-level data and trends, plus the isotope hydrogeochemistry also highlight that sustainable access to groundwater for irrigators far from the river corridor will depend on future flood frequency.

“The use of old water is sustainable provided the aquifer being pumped reaches a new equilibrium, where groundwater withdrawals are in balance with the capture of both local recharge and outflow at the western end of the Namoi alluvial aquifer,” he said.

“In regions far from the river, when the pumps are first turned on, the groundwater level must fall.

“Then over decades, if the groundwater withdrawals are in balance with recharge and groundwater outflow capture, the decline in the groundwater level will stabilise.



BRYCE KELLY

“Where groundwater levels have fallen in the Lower Namoi, a space has been created where we could store water in an evaporation-free environment.

“This research demonstrates the opportunity to explore managed aquifer recharge to optimise water use at the catchment scale and to improve sustainable access to groundwater in regions far from the Namoi River.”

The results of this study have been presented to both federal and state water management departments and have been cited by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Developments.

“It is clear that this CRDC-funded project is having impact, and we hope this will result in the sustainable management of this important groundwater resource,” Bryce said.

Dioni added that it was not an object of this study to map where and when the Great Artesian Basin was recharged. However, based on the new groundwater chemistry data they collected and reviewing historical data in the literature, he said it had become clear to them that further research is required to comprehensively understand where and when the south-east portion of the Great Artesian Basin recharged.”

Further comprehensive details on the research finds are reported in Iverach et al. (2017): <https://www.hydrol-earth-syst-sci.net/21/5953/2017/>

And details on monitoring the Sodium Adsorption Ratio of water can be obtained from the CottonInfo web site:

[https://www.cottoninfo.com.au/sites/default/files/documents/Water%20and%20Soil%20Quality\\_3.pdf](https://www.cottoninfo.com.au/sites/default/files/documents/Water%20and%20Soil%20Quality_3.pdf)

**Researchers have examined multiple aspects of the Great Artesian Basin’s water chemistry in the Lower Namoi. Pictured are Dr Dioni Cendon, Stuart Hankin and Charlotte Iverach undertaking testing.**

### For more:

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CSIRO's Katie Broughton in elevated CO<sub>2</sub> trials at ACRI which are supported by CRDC.

# Can new varieties handle our changing climate?

MELANIE JENSON

Understanding the impact of elevated CO<sub>2</sub> levels is important for developing cotton systems that are resilient to stresses induced by variable and changing climates into the future.

Atmospheric CO<sub>2</sub> levels have been steadily increasing over the past 200 years from pre-industrial values of about 280 ppm to more than 400 ppm in 2016, with projections for further increases. This, in combination with rising air temperatures that drive leaf temperatures above the optimum (28-30°C), and changes in rainfall may have significant impacts on the physiology, growth, and yield of cotton.

A project supported by CRDC with CSIRO has compared the early-season physiology and growth

of older and more recent varieties under current and future climate regimes.

"Given the significant changes in Australian cotton varieties, management and yields, it is important to assess potential beneficial traits in older and more recent varieties in projected CO<sub>2</sub> and temperature conditions to maximise cotton production in future environments," CSIRO's Katie Broughton says.

"Our controlled environment glasshouse experiment compared the early-season growth and physiology responses of (Deltapine's) DP16 and Sicot 71BRF grown in high CO<sub>2</sub> and warmer temperatures."

The researchers measured vegetative plant growth (leaves and stems), leaf photosynthesis, stomatal conductance (a measure of the degree of stomatal opening), and night respiration of young, well-watered cotton grown in differing

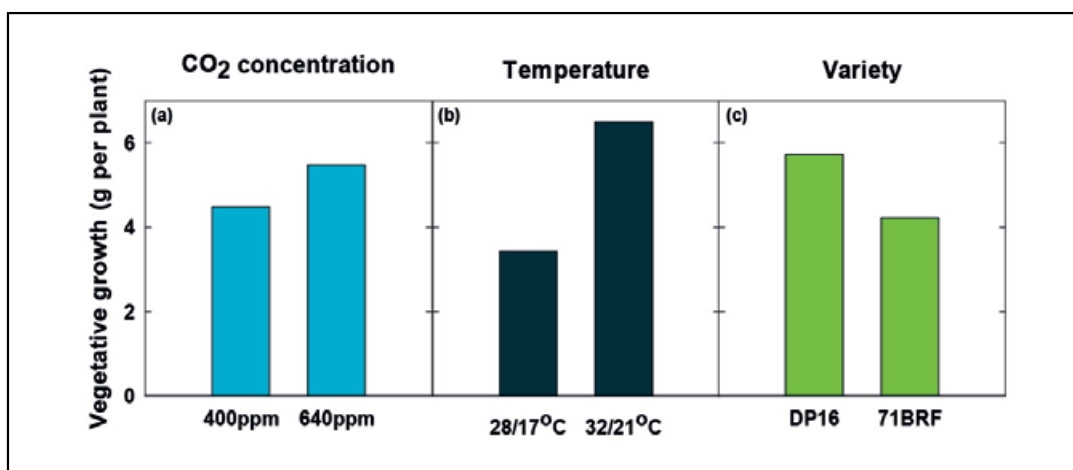


Figure 1: the main effects of (a) elevated CO<sub>2</sub>, (b) warmer air temperature and (c) variety on the early vegetative (leaf and stem) growth of cotton.

environmental conditions (temperature= 28/17°C or 32/21°C; and CO<sub>2</sub> concentration= 400 ppm or 640ppm). (Table 1 and Figure 1.) Changes in photosynthesis and night respiration could potentially alter growth, and changes in stomatal conductance may influence water use. These measurements are important for determining how the plants are growing, functioning and using water under different environmental scenarios.

**Photosynthesis change**

Across both varieties, high CO<sub>2</sub> levels increased photosynthetic rates compared with plants grown at current CO<sub>2</sub> levels (Table 1). Leaf photosynthesis of both varieties responded positively to high CO<sub>2</sub>, with a significant CO<sub>2</sub> by variety interaction because 71BRF responded more strongly.

In a high CO<sub>2</sub> environment, photosynthesis of 71BRF was 43 percent greater than plants grown at current CO<sub>2</sub> levels, whereas photosynthesis of DP16 was increased by 28 percent (Table 1). DP16 plants grown at high CO<sub>2</sub> had 27 percent higher respiration rates than plants grown at current CO<sub>2</sub> levels, but this trend was not observed for the 71BRF variety.

Stomatal conductance of DP16 and 71BRF responded differently to warmer air temperatures.

Warmer air temperatures increased stomatal conductance of 71BRF by 23 percent, whereas DP16 did not respond to warmer air temperatures. Greater stomatal conductance of 71BRF may have contributed to greater leaf-level water use than DP16, although it is also possible that total plant water use is greater for DP16 given it is a larger plant overall.

High CO<sub>2</sub> increased early vegetative growth (stems and leaves) of cotton by 22 percent compared with plants grown at current CO<sub>2</sub> levels. Plants grown at warmer air temperature (32/21°C) also had nearly 90 percent greater early vegetative growth than plants grown at 28/17°C. DP16 had consistently greater vegetative growth than 71BRF (Figure 1). This can be attributed to greater leaf number and size, and thus greater light interception by DP16 plants, despite higher leaf-level photosynthesis per unit leaf area of 71BRF plants (Table 1).

“The compact growth habit and higher leaf-level



photosynthetic rates and lower respiration rates of 71BRF are potentially advantageous in current Australian production systems due to reduced leaf surface area for water loss by transpiration,” Katie said.

“In other words, 71BRF compensates for less early biomass and a more compact growth habit by having a higher photosynthesis per unit leaf area.”

**Physiology responses of DP16 and 71BRF cotton grown in high CO<sub>2</sub> and warmer temperatures were measured at the Western Sydney University’s Hawkesbury Campus.**

**The future**

Future environments are anticipated to produce larger cotton plants with potentially greater requirements for water. Thus, plants with smaller, more compact vegetative growth habits and higher photosynthetic rates (eg Sicot 71BRF) may have an advantage over varieties with substantial plant growth and leaf area (eg DP16).

“Our research continues to focus on understanding the implications of warmer temperatures and higher levels of atmospheric CO<sub>2</sub> on cotton physiology, growth and water use, using a combination of controlled environment glasshouse and field-based experiments.

“This will be important for optimising management of cotton in Australian production systems into the future.”

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| Physiology measurements | Variety | ↑ CO <sub>2</sub> | ↑ temperature |
|-------------------------|---------|-------------------|---------------|
| Photosynthesis          | DP16    | +28%              | 0             |
|                         | 71BRF   | +43%              | 0             |
| Stomatal conductance    | DP16    | 0                 | 0             |
|                         | 71BRF   | 0                 | +23%          |
| Night respiration       | DP16    | +27%              | 0             |
|                         | 71BRF   | 0                 | 0             |

**Table 1: Percentage change in physiology of each cotton variety in response to high CO<sub>2</sub> and warmer air temperatures. This shows where there are significant interactions between CO<sub>2</sub> and variety, and CO<sub>2</sub> and temperature.**

# Taking technology to biodiversity

Under the National Landcare Program's Smart Farming Partnerships initiative, CRDC has been successful in securing a \$1.3 million grant to bring new technology to on-farm biodiversity and sustainability management.

CRDC's R&D Natural Resource Management Investment and Impact Manager Stacey Vogel said the grant would support the Australian cotton industry to monitor, report and improve its environmental footprint.

"By implementing and developing cutting-edge technologies such as drone mapping and aerial seeding, acoustic monitoring and big data we can facilitate a step-change in the way we manage on-farm biodiversity, as well as how we are able to report on it," Stacey said.

"We can offer new approaches to land managers to establish native vegetation and improve survival rates of revegetation projects, using, for example, an innovative tree-planting approach with drones that's tailored to our soils and climate.

"Farmers manage over 60 percent of the Australian landscape (Australia's biodiversity conservation strategy 2010–2030), so efforts to increase the extent of on-farm vegetation and reduce fragmentation will significantly contribute to the maintenance and re-establishment of ecosystem function at local and regional scales.

"This also delivers benefits to the broader

community through increased biodiversity protection."

Current CRDC researcher Rhiannon Smith of The University of New England will work with growers and the revegetation industry to improve capacity for cost-effective revegetation of the biodiverse plant communities on cotton farms. Pre-and post-planting management and planting methods will be investigated using new technologies, including drones that fire seed into the ground, to improve seed broadcast and direct drill methods of revegetation.

Innovative technologies developed by the University of Queensland will be used to actively monitor biodiversity. Acoustic sensors and automatic species recognisers will be used on farms to form an industry-wide acoustic-monitoring network for birds and microbats. The data can be used to indicate whether on-farm management is providing the desired biodiversity outcomes as revegetation projects take place.

"By encouraging uptake of new and innovative natural resource management practices, together, these activities will increase the number and area of Australia's farming entities and land managers who have developed, trialled and/or implemented innovative practices for maintaining or improving the natural resource base and sustainable use of Australia's biodiversity," Stacey said.

"However, this project is not limited to farms, as we will work across the value chain through the 'One Tree One Bale' initiative."

This project will develop a business plan that creates a 'One Tree per Bale' revegetation campaign, aimed to be a legacy project that engages the Australian cotton value chain in their commitment to sustainably produced cotton.

The project will also contribute towards Australia's efforts in meeting international obligations to protect and improve biodiversity. To assist with the adoption of technologies developed and explored during the project, training workshops and extension events are planned, including drone flying, native seed collection and propagation as well as field days demonstrating new and improved methodologies for undertaking direct seeding restoration projects and recording biodiversity activity on-farm.

**CRDC is bringing future tech to vegetation management.**



MELANIE JENSON

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The cotton industry has the opportunity to lead the way in groundwater management and health with new CRDC-supported research.

# Leading groundwater quality research

The research has resulted in an improved groundwater management program, shifting to an approach that considers groundwater biodiversity and the maintenance of ecosystem function and services. Researcher Kathryn Korbelt of Macquarie University says this signals a shift from the current approach of managing only water quality and quantity.

“It will allow for future assessment of potential groundwater health decline due to competing industries,” Kath says.

“My research findings will be implemented through the cotton industry *myBMP* program, promoting ecological sustainability and natural resource stewardship, while concurrently improving the capacity for the future management of this resource.”

In 2006, the cotton industry, through the Cotton Catchment Communities CRC, became the first industry in Australia to recognise the importance of groundwater ecosystem health for the supply of sustainable groundwater resources by funding the development of a groundwater ecosystem monitoring program. The CRC began a world-first program to develop a toolbox of biological and chemical indicators to measure and monitor groundwater ecosystem health.

Recent funding from CRDC enabled the initial toolbox to be refined through additional sampling and research. From this work, the weighted Groundwater Health Index was developed.

“The new, refined method allows groundwater health to be assessed and monitored using a combination of biological and water chemistry variables,” Kathryn said.

“Since publication of this method, we were invited to present the framework to the European Union Groundwater Working Group in 2017 as a potential framework for adoption in the Groundwater Framework Directive. NSW DPI have been in discussions about including the approach in their monitoring for groundwater-dependent ecosystems within NSW.”

During her research, Kathryn discovered some invertebrates that are new to science, in the form of stygofauna, which resemble tiny prawns.

“The ongoing provision of clean groundwater depends on healthy groundwater ecosystems containing microbes and invertebrates (stygofauna),” she said.

“These organisms improve water quality and aid water flow.



MELANIE JENSON

“Without sustainable management, it is likely that the health of these ecosystems will decline, with the consequence that growers may be faced with increased costs for groundwater extraction, water treatment and/or declining yields.

“We are really pleased to have been able to improve groundwater ecosystem sampling methodologies which will be incorporated into best management practice, along with the Groundwater Health Index which can be used on farm.”

CRDC will use information from this study to directly report against sustainability requirements for the industry and demonstrate the responsible environmental management and stewardship of this resource.

“The project will not only help farmers manage and monitor groundwater, it will help establish the cotton industry as a proactive, world leader in managing groundwater resources through implementing the first worldwide groundwater health monitoring and reporting program,” CRDC R&D Investment and Impact Manager Stacey Vogel said.

**Researcher Kathryn Korbelt sampling groundwater as part of a CRDC project to develop a Groundwater Health Index.**

**For more:**

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*Spotlight* is brought to you by CRDC: the Australian cotton industry's research, development and extension investment body, jointly funded by Australian cotton growers and the Australian Government.

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