

Spotlight

ON COTTON R&D

SUMMER 2018-19

New insights into
nitrogen application

Opening windows on
pest management

The growing threat
of resistance





Bruce Finney

In the Spotlight

The vision of the cotton industry is Australian Cotton.
Carefully Grown. Naturally world's best.

This edition of *Spotlight* focuses on research results and science-based best practices that can help you successfully produce your 2018-19 crop and contribute to sustaining the responsible production of Australian cotton into the future by everyone in the industry.

There are also a number of articles featuring technology and blue-sky approaches to solving recalcitrant disease, spray drift, weed and insect pest resistance issues. Innovating through higher risk novel approaches is made possible and can be synergistic with the near 30-years of basic and applied research knowledge created by CRDC along with its world-leading research partners. CRDC recognises growers are being challenged by the cost/benefits and disease risks of their rotation choices. CRDC is focused on seeking more effective solutions (and faster) to these challenges.

The momentum within the industry for innovation in irrigation systems has been remarkable with learnings exchanged between regions, and with the sugar and dairy industries. The opportunity to improve application uniformity and scheduling, and reduce water and fertiliser losses, energy and labour using new digital technologies and automation are featured. Jon Welsh's case study on the economic returns is illustrative of the possibility. CRDC continues to bring together growers, commercial providers and talented researchers to develop new irrigation products and services that practically deliver benefits.

Articles on the CottonInfo team, ARLP, Nuffield and the Rural Women's Awards showcase the talented people that make this such a fantastic industry. Ensuring we continue to invest in and provide an inclusive environment for broad industry leadership participation is critical to the future.

We take this opportunity to share with you the highlights from the 2017-18 CRDC Annual Report. On behalf of the Board and staff at CRDC we are proud to share the achievements we have delivered for you last year, which was the culmination of the last five-year CRDC Strategic RD&E Plan. Should you have any questions or feedback for CRDC it is always welcome.

Looking forward, by 2023, CRDC aims to contribute to creating \$2 billion in additional gross value of cotton production for the benefit of Australian cotton growers and the wider community. This is a great ambition!

On another note, it's time to say farewell. Thanks to everyone for making my time in the cotton industry a rewarding experience. I wish the fabulously talented team at CRDC well and thank current and past directors for the support I received during my term as Executive Director.

Best wishes to each and all.

Bruce Finney
CRDC Executive Director



13

Spotlight is brought to you by Australia's cotton producers and the Australian Government through the publisher Cotton Research & Development Corporation (CRDC). CRDC is a research and development partnership between the Australian cotton industry and the Australian Government.



Cotton Research and Development Corporation
 ABN: 71 054 238 316

Our vision: A globally competitive and responsible cotton industry.

Our mission: To invest in RD&E for the world-leading Australian cotton industry.

Postal Address:

PO Box 282, Narrabri NSW 2390

Offices: 2 Lloyd Street,
 Narrabri NSW 2390

Tel: 02 6792 4088

Fax: 02 6792 4400

Email: spotlight@crdc.com.au

Web: www.crdc.com.au

Communications Manager/Editor:
 Ruth Redfern

Editorial co-ordinator:

Melanie Jenson

Editorial Contributors:

Melanie Jenson, Ruth Redfern.

Design: Deacon Design

© CRDC 2018

This work is copyright protected. Apart from any use permitted under the Copyright Act 1968, no part may be reproduced by any process without the written permission of the editor.

Disclaimer and Warnings

CRDC accepts no responsibility for the accuracy or completeness of any material contained in this publication. CRDC disclaims all liability to any person in respect of anything and of the consequences of anything done or omitted to be done by any such person in reliance, whether wholly or partly, on any information contained in this publication. If you intend to rely on information provided in this publication you should rely on your own appropriate professional advice. Material included in this publication is made available on the understanding CRDC is not providing professional advice. CRDC, the topic authors and their organisations accept no responsibility or liability for any loss or damage caused by reliance on the information, management approaches or recommendations in this publication.

Trademarks acknowledgement

Where trade names or products and equipment are used, no endorsement is intended nor is criticism of products not mentioned.



ON THE COVER:
 Irrigation and nitrogen timing trials are giving clear indications of the best time to fertilise and irrigate.

Want to see more of Spotlight?

This edition can be viewed online at: www.crdc.com.au

COTTON NEWS

- 5 CRDC farewells Bruce
- 6 Opt in to myBMP and better cotton
- 6 2019: the year of cotton farm fauna
- 7 Cotton leaders show their support for rural women
- 7 Generating leaders for generations
- 8 Furthering cotton through Nuffield
- 9 CottonInfo team meet to map out extension
- 10 Leading the industry to the future

 **Summer 2018-19**



FEATURES

ON THE COVER

Breakthrough in mealybug control	13
Timing and deficits a factor in yield	20
Paraquat resistance in tall fleabane a warning signal to industry	22

Converting waste to energy: does trash stack up?	12
Silverleaf whitefly: maintaining control	15
Bringing irrigation tech to the world stage – and the field	17
Doing the figures: Automation is a good investment	18
Breaking with tradition: Swapping siphons for phones	19
An emerging problem	23
Resistance: CRDC heavily invested	25
Using plant-based extracts to fight diseases	26
Industry unites in disease management	27
Building a clear picture	28
A matter of time for BRR	29
Delivering impact for growers through RD&E	31
CRDC RD&E achievements 2017-18	32
CRDC organisational highlights 2017-18	35

Fast Facts

14

Years since Bruce Finney took the reins as CRDC Executive Director (page 10).



8

Out of 16 populations of silverleaf whitefly tested in 2017-18 showed resistance to pyriproxyfen (page 15).

\$2000

Per hectare is the Net Present Value benefit equated to installing automated irrigation for the estimated 20-year life of such a project (page 18).



2

Populations of tall fleabane have been identified as resistant to the double knock control tactic of glyphosate followed by paraquat (page 22).

Michael Smith of CGS Emerald and CHCGIA President Aaron Kiely presented Susan with her award.



JAMES LAWS

CRDC manager honoured by peers

SUSAN Maas was honoured by her community for her dedication to the cotton industry at the Central Highlands Irrigation Awards Dinner in late August.

Susan is one of CRDC's R&D managers and is based in Emerald, where she was awarded the Iain Mackay Non-Grower Service to Industry Award (sponsored by CGS) by the Central Highlands Cotton Growers and Irrigators Association (CHCGIA).

On presenting the award, CHCGIA President Aaron Kiely said Susan has been a key contributor to the cotton industry in the Central Highlands and Dawson Valley regions since starting work as an extension officer with AgriScience Queensland in 2004.

"She has established excellent industry relationships with regional grower associations, cotton crop consultants, agribusiness and industry organisations," Aaron said.

"Susan has collaborated effectively with industry research scientists and research funding organisations and been actively involved in the development of *myBMP* as well as showing leadership in the area of farm hygiene procedures and management strategies, joint coordination of herbicide-resistance management workshops and strong industry support at both management and local grower levels.

"Susan played a pivotal role in the events associated with the identification and industry response to mealybug in early 2010."

Susan is also a Future Cotton Leaders Program alumni and received the Chris Lehmann Trust Young Achiever of the Year Award in 2010.

Susan received the award in front of 250 growers, irrigators, sponsors and industry representatives in the Emerald Town Hall and said she was completely surprised by the accolade, which holds special significance for her.

"Usually I'm the one organising the award!" she said.

"I was really humbled and honoured to receive this, because I love what I do and working with the growers here and the broader industry to help direct research and development.

"It is also made extra special in that the award's namesake Iain Mackay was a great friend of my father's, and someone I have a lot of respect for.

"I've been involved in the cotton industry for what seems like a long time now, and to be living and working in a cotton growing region is important to me."

CRDC Executive Director Bruce Finney said the news was "absolutely fantastic."

"This is a very deserved recognition for all that Susan does so capably and humbly for the industry and her region.

"Susan is an inspiration and we are all so pleased to see her recognised in this manner," he said.



Weeds App

A new weed identification mobile app has been released.

Weeds of Australian Cotton is a tool for cotton growers and their advisors, designed to assist in identifying 50 key weed species. It was developed as part of a CRDC project led by Dr David Thornby, with input from fellow weeds experts Graham Charles, Jeff Werth and Dr Ian Taylor.

“Weed identification in early growth stages is critical as similar-looking species often have quite different control requirements, and waiting for diagnostic features like flowers and fruits to appear means the optimal window for herbicide applications has long passed,” David said.

“For this reason, the **Weeds of Australian Cotton** key includes cotyledon shapes as an important diagnostic character.

“It is important to note that weeds not included in the key could be present in cotton fields, and misidentification is possible. Confirming identification with an expert is advised, especially if the weed is proving hard to kill.”

“Building on previous publications, we now have a way to ID weeds on the go especially in areas where cotton is relatively new, that’s really useful,” **CottonInfo Weed Management Technical Lead Eric Koetz** said.

“It has a biosecurity role to identify new weed species – if you are seeing something on your farm or elsewhere that isn’t on the app – contact us.”

The app is available for both mobile operating systems.

For more

Search 'Weeds of Australian Cotton' on the Apple App Store or Google Play.
Or visit: www.cottoninfo.com.au

CRDC farewells Bruce

After 14 years at the helm of CRDC, Executive Director Bruce Finney has announced that he will be stepping down from his position in January 2019.

AUSTRALIA leads the world in sustainable cotton production, with R&D overseen by CRDC during Bruce’s tenure a major factor in this title.

CRDC Chair Richard Haire praised Bruce’s contribution to CRDC and the Australian cotton industry.

“Bruce has made an enormous contribution to CRDC and the wider cotton industry over his time here, and his prior career in agronomy, management and corporate agriculture, and we thank him for his leadership and dedication,” Richard said.

“Bruce has worked closely with myself and previous directors to lead Australian cotton RD&E, making it the world-leader that it is today.

“He has been instrumental in driving outcomes for the industry through close collaboration with our industry partners,

through such initiatives as Vision 2029, the Cotton Innovation Network, and the Australian Cotton Industry Forum.

“On behalf of the CRDC Board and staff, I extend my thanks to Bruce, and wish him all the best in his future endeavours.”

Bruce will relocate to Orange in January 2019 to begin a new role leading business development and innovation with NSW DPI.

Dr Ian Taylor will be taking on the role of Acting Executive Director until an appointment is announced in the new year.

See our feature story on pages 10 and 11 for more on Bruce’s contribution and defining moments over the past 14 years at CRDC.

Claim the date for science

THE date has been announced for the biggest cotton research-focused conference on the calendar.

The Australian Association of Cotton Scientists' (AACCS) Cotton Research Conference will be held at the University of New England's Armidale Campus from October 28-30, 2019.

The conference will be convened by Dr Oliver Knox and is being held slightly later in the year than usual, to fit into the period just after planting but before the season gets busy for most people.

"Late October will have the added bonus of being a nice time of year in Armidale," says AACCS chair Paul Grundy.

"Oliver is now seeking expressions of interest from members who would like to be involved in putting the conference together and ensuring it is another successful event."

Stay tuned for more updates from Oliver and the conference committee as this event draws closer but for now, please enter these dates into your calendar.

For more:

Oliver Knox

oknox@une.edu.au

Opt in to *myBMP* and better cotton

ELIGIBLE cotton growers are being urged to opt-in for the Better Cotton Initiative (BCI) and Monsanto *myBMP* Bale Grant for the 2018-2019 season.

The BCI is a global sustainability program focused at farm level improvements. Australian growers now have access to premium markets for cotton grown on *myBMP* certified farms by opting in to BCI. Over the past two seasons many BCI growers have negotiated an additional \$2 to \$4 per bale for their Better Cotton Claim Units (BCI credits).

Only one form needs to be completed for both initiatives this year. Growers who are currently working towards *myBMP* accreditation have until February 26, 2019 to opt-in.

For more:

www.cottonaustralia.com.au



2019: the year of cotton farm fauna

INCLUDED with this edition of Spotlight is the 2019 cotton calendar, brought to you by the industry's extension program, CottonInfo. For 2019, the calendar focuses on the top 12 natural resource management (NRM) tips for cotton growers, and features a range of stunning fauna photographs from across the cotton industry.

According to CRDC R&D Manager and CottonInfo technical lead for natural resources and catchments, Stacey Vogel, there are over 130 species of fauna on cotton farms.

"This year's calendar showcases some of the diverse fauna species found on our cotton farms, and some of the key management principles for protecting them against such threats as habitat fragmentation, land clearing and invasive species," Stacey said.

"CRDC is investing in new, innovative technologies to assist cotton growers manage biodiversity – including fauna – and RD&E to better monitor and report industry progress against biodiversity targets. Through CottonInfo, to tie into each month's calendar message for the coming year, we will be bringing you information on these latest RD&E outcomes.

"Some of the RD&E currently underway includes a project by Griffith

University's Sam Capon into the natural and human factors that drive ecosystem services, and the management strategies to maintain and restore these; a natural capital accounting project under the Rural R&D for Profit program, which calculates the value of natural assets like soil, water, air and biodiversity; and projects led by UNE's Rhiannon Smith and QUT's Erin Peterson under the National Landcare Program Smart Farming Partnership to respectively improve the capacity for cost-effective revegetation, and develop innovative technologies to actively monitor biodiversity.

"CottonInfo will be working in partnership with CRDC to extend these findings to growers, including monthly NRM top-tips information sheets to coincide with the cotton fauna calendar," Stacey said.

Additional copies of the calendar are available on request by emailing spotlight@crdc.com.au. CottonInfo thanks all the photographers who kindly allowed their images to be showcased in this year's calendar.

For more:

Stacey Vogel

stacey.vogel@crdc.com.au

Cotton leaders show their support for rural women

CRDC hosted a group of cotton industry leaders at the AgriFutures Australia Rural Women's Award dinner in Canberra in October.

CRDC's Communications Manager Ruth Redfern was joined by CRDC Directors Liz Alexander and Rosemary Richards, Wincott President Liz Stott, cotton grower and Darling Downs CGA President Georgie Krieg, researcher and Future Cotton Leaders graduate Katie Broughton, consultant and Chris Lehmann Trust finalist Elle Storrier, and CottonInfo technical lead and regional extension officer Sharna Holman at the dinner. Cotton Australia Director Fleur Anderson, and researcher and NFF 2030 Leaders Program participant Nicole Macdonald were also in attendance.

CRDC has long been a supporter of projects and initiatives designed to support rural women, such as the AgriFutures Australia Rural Women's Award, including the Cotton Australia-CRDC Future Cotton Leaders program, and the ABARES Science and Innovation Awards.

"Opportunities for women in our industry to network with, be inspired by, and to develop into leaders are invaluable, which is why we continue to support the AgriFutures Australia award, and other capacity building programs under our



Pictured at the Rural Women's Award dinner in Canberra, Georgie Krieg, Elle Storrier, Liz Alexander, 2018 Rural Women's Award recipient Krista Watkins, Fleur Anderson, Katie Broughton, Sharna Holman, Nicole McDonald and Ruth Redfern. Absent: Rosemary Richards and Liz Stott.

new CRDC Strategic RD&E Plan," Ruth Redfern said.

The 2018 national recipient of the AgriFutures Australia Rural Women's Award is Krista Watkins, a banana grower and food waste innovator from Walkamin in QLD. Krista is tackling the issue of food waste by turning surplus bananas into banana flour. The resulting business that Krista co-founded with her husband, Natural Evolution Foods, is the first and largest producer of banana flour in the world. With her AgriFutures bursary, Krista is turning her focus to uncovering

by-products and reducing wastage in the sweet potato industry, which currently wastes 50 tonnes per acre on average.

The runner up was Darrylin Gordon, a pastoralist from Halls Creek in WA, who will use her bursary to develop a skills training camp for unemployed locals in her region.

For more information on the AgriFutures Australia Rural Women's Award, please visit www.agrifutures.com.au. For more information on CRDC's Building Adaptive Capacity programs, please visit www.crdc.com.au.

Generating leaders for generations

TIMOTHY Chaffey of Quirindi and Richard Malone of Griffith have graduated as cotton's participants in course 24 of the Australian Rural Leadership Program (ARLP), supported by CRDC, Cotton Australia and Auscott Limited.

The graduates were presented with their certificate at an event in Canberra in October by Australia's Governor-General, Sir Peter Cosgrove who is Patron-in-Chief of the Foundation, and Lady Cosgrove.



Tim Chaffey and Richard Malone celebrate their ARLP graduation with National's Leader and Deputy Prime Minister Michael McCormack (centre) in Canberra.

Timothy and Richard are among 33 leaders from diverse industries, communities and backgrounds selected to undertake the ARLP: a 15-month leadership program which takes place across Australia and Indonesia, immersing rural, regional and remote leaders in a series of unique experiences to develop their leadership capabilities.

The next cohort of rural leaders selected to participate in the ARLP were announced in August, with Fleur Anderson and John Durham announced as the cotton industry recipients. Fleur is no stranger to leadership, having a long list of responsibilities including a Director of Cotton Australia and the chair of this year's Australian Cotton Conference, however she has found the experience so far to be an incredible one.

"I've returned from the Kimberley experience and am grateful for the support

I have in CRDC, CA and Auscott.

"Really it's a luxury to take two weeks out from your everyday to take stock and think about your 'what next'.

"Whilst the program was far from luxury I will always be thankful for the opportunity of time, personal development and reflection.

"I've met some incredible people, done some incredible things and I'm looking forward to the next instalments."

Through the sponsors, ARLP includes a \$55,000 scholarship for each participant to undertake the program. During the program the participants will develop as leaders through challenging their own behaviours, thinking and actions, and those of others and develop relationships to form a network of supportive leaders.

For more

www.rural-leaders.org.au

Furthering cotton through Nuffield

Well known Emerald cotton grower and industry advocate Renée Anderson is the 2018 Nuffield Scholarship recipient, supported by Cotton Australia and CRDC.

RENÉE'S research will focus on highlighting better management practices that not only improve the social, environmental and economic sustainability of agriculture, but also clearly communicate positive farming practices to consumers and drive broader community support for the industry.

"Renée is already very well known for her work in this area," CRDC Executive Director Bruce Finney.

"She is an untiring advocate for the industry and its people."

Renée along with husband Brad, grow



Renée Anderson – the 2018 Nuffield Scholarship recipient.

mixed irrigated crops, including cotton, chickpeas and corn, across their 455 hectare operation. She also works part

time as the Central Highlands Regional Manager for Cotton Australia.

"Having worked in agronomy and entomology for 20 years, I've observed many barriers to effective adoption of better environmental management practices and consumer communications, and I'm motivated to research strategies to overcome these barriers," Renée said.

"Urban and rural communities alike have a keen focus on environmental, welfare and sustainability issues, and these issues can directly impact farm management and consumer purchasing decisions.

"Building the capability of our industry to demonstrate the benefits of modern agriculture, and drawing connections between practices, communication and social licence for the industry is critical."

Renée will meet with experts in agricultural research and communications throughout Europe, the United States and Canada on her study tour.

New REOs for Border Rivers and Namoi Valley

THIS year the cotton industry has welcomed new talent into industry extension and technical lead roles.

CottonInfo is the industry's joint extension program and has appointed Elsie Hudson and Andrew Mackay into regional extension roles – Elsie in the Namoi Valley and Andrew in the Border Rivers region.

Elsie began in May this year, taking over from Geoff Hunter. Elsie is based in Narrabri and brings a love of agriculture, agronomy and working with growers to her role. Elsie completed her studies at The University of Queensland Gatton and is looking forward to her ninth cotton season in a new role, as a CottonInfo REO.

"My areas of focus in this position will be disease and nutrition," Elsie said.

"Working with CSD we will be conducting some trials on Verticillium management this season, as it is one of the most concerning disease issues for growers in the region.

"I've worked as an agronomist in the Namoi previously and in the Gwydir at 'Keytah' west of Moree.

"I'm looking forward to bringing my

practical and agronomic knowledge into my new role."

CottonInfo's newest REO recruit, Andrew McKay, brings an agronomy degree and broad experience across agriculture and the cotton industry to the role. He is based in St George, Queensland.

Originally from Warren in the Macquarie Valley, Andrew's family began growing cotton in the early 1980s on their mixed farming enterprise. Later in his career he worked with John Deere franchisee Vanderfield and in agribusiness finance.

"I also spent six years in horticulture roles based in Sydney and Perth – and worked for Elders and Yates Commercial/ Yates Vegetable Seeds.

"I hope to bring research outcomes to growers in a simple and easy to use format that will facilitate uptake.

"I'm really keen to work with growers and industry to promote issues and solutions, to the benefit of the industry as a whole.

"It's great to be based here in St George, where I know a lot of growers, and look forward to using those networks in the extension role.



Andrew Mackay and Elsie Hudson.

"I'm also looking forward to meeting and working with other growers and industry people throughout the Border Rivers region."

CSD's James Quinn oversees the REO team with CottonInfo Program Manager Warwick Waters, and thanked the previous REOs Geoff Hunter and Sally Dickinson for their input since the inception of CottonInfo six years ago.

For more

Elsie Hudson

0456 914 637

elsie.hudson@cottoninfo.net.au

Andrew McKay

0407 992 495

andrew.mckay@cottoninfo.net.au



CottonInfo team meet to map out extension

The CottonInfo team of regional extension officers, technical leads and *myBMP* staff met in Sydney in October to map out extension priorities for the coming cotton season.

A new Strategic Plan came into effect for the CottonInfo team in July, along with a new Annual Operational Plan, so the team meeting provided an opportunity for the team to map out key actions and activities identified under both.

The CottonInfo Strategic Plan outlines four key areas of focus for CottonInfo for the coming five years: to improve the rate and reach of R&D adoption; to enable successful cotton industry expansion; to prepare the industry to respond to biosecurity threats and assist in the event of natural disasters; and to strengthen CottonInfo as an effective team and trusted information source.

CottonInfo's Program Manager, Warwick Waters, says the team comes together twice a year to map out key priorities, and to track progress towards targets.

"The CottonInfo team are based out in the cotton growing regions, from Emerald in the north to Griffith in the south, ensuring we can provide boots on the ground support to growers and consultants, and provide information where and when it's most needed," Warwick said.

The CottonInfo team, pictured at their team meeting in October.

Back row: Amanda Thomas (Macquarie REO), Annabel Twine (Darling Downs REO), Rene van der Sluijs (Fibre Quality Tech Lead), Paul Grundy (IPM Tech Lead), Jon Welsh (Energy and Climate Tech Lead), Ben Crawley (Irrigation Tech Support), Andrew McKay (Border Rivers REO), Elsie Hudson (Namoi REO), Stacey Vogel (Natural Resources REO). Front row: James Quinn (Extension & Marketing Lead, CSD), Sharna Holman (Central QLD REO and Biosecurity/Disease Tech Lead), Oliver Knox (invited guest), Rick Kowitz (*myBMP* program manager), Eric Koetz (Weed Management Tech Lead), Kieran O'Keefe (Southern NSW REO), Janelle Montgomery (Gwydir REO), Ruth Redfern (CRDC and CottonInfo Communications Manager), Warwick Waters (CottonInfo Program Manager).

"As a result, we only come together face-to-face twice a year, and these meetings are important both in solidifying our key focuses for the coming season, and in continuously developing our skills as an extension team," Warwick said.

The team has identified key areas of focus for the 2018-19 season: helping growers improve their soil health and irrigation system efficiency; and helping to provide region-wide solutions for pest control.

Fond farewells, and a few new faces

The CottonInfo team has undergone some change over the past six months, with a number of long-standing team members departing, and new members joining.

In the Regional Extension Officer (REO) team, CottonInfo has farewelled Geoff Hunter in the Namoi and Sally Dickinson in Border Rivers, with Elsie Hunter, Narrabri, and Andrew McKay, St George, taking on these respective roles.

For the Technical Leads, CottonInfo has farewelled Sandra Williams from Integrated Pest Management, with long-standing industry researcher and 2017 CSD Researcher of the Year co-recipient Paul Grundy taking over this role. Ali

Chaffey stepped down from the position of Irrigation Technical Lead, with Ben Crawley appointed to the role of CottonInfo Technical Support for Irrigation and NSW DPI Water Productivity R&D Officer. John Smith, the former CottonInfo REO turned Nutrition and Water Technical Lead has taken up a new role with CRDC's fellow research and development corporation, AgriFutures Australia as an R&D Manager. A new Nutrition Technical Lead is soon to be appointed.

Most recently, CottonInfo has farewelled Sally Ceeney from the role of BT and Insecticide Stewardship Technical Lead. Sally commenced as the Policy Officer for Research Direction and Stewardship with Cotton Australia in October 2018, taking over from Dr Nicola Cottee who departed Cotton Australia earlier this year. Sally's new role involves convening grower input into industry research direction, which means she will stay closely connected to both CRDC and CottonInfo.

For more

www.cottoninfo.com.au

Leading the industry to the future

CRDC's Executive Director Bruce Finney will leave the organisation in January to take up a new role with NSW DPI based in Orange. After 14 years at the helm, we spoke to Bruce about the importance of R&D and some personal highlights during his leadership of the organisation.

Prior to his appointment to CRDC in August 2004, Bruce worked in the Australian cotton industry for 20 years in corporate agriculture in various management and agronomy roles in Australia and in an advisory role in Argentina. He was also a member of the Australian Cotton Growers Research Association (ACGRA) for 11 years, chairing the Association for two years as well as two Australian Cotton Conferences.

“ Having grown up in Sydney, with a liking for science at school and the experience of “working” holidays on a farm with beach frontage my interest in a career in agriculture was high if not slightly naïve. With a degree in agricultural science at University of Western Sydney behind me I sought out the opportunity to gain practical experience as a farmhand at Moree. Fortuitously my first employers, National Mutual Rural Enterprises, were very patient and offered me the chance to work as a trainee agronomist. Working with progressive people and applying the science and latest technology to growing crops was incredibly exciting and soon had me hooked on a career in cotton.

For the next 17 years I worked with the Twynam Agricultural Group. They were very generous in the range of opportunities and experiences I was provided. Throughout this time my commitment to cotton and desire to make a contribution was only strengthened by my participation in the ACGRA and support received to



Bruce says that while CRDC's core role of investing in world-leading RD&E for the cotton industry remains the same, the nature and scale of the business has certainly evolved over the 14 years of his leadership.

undertake the Australian Rural Leadership Program in 1999.

My move to CRDC was a tremendous career step that aligned strongly with my interests and experiences. Building on the strong leadership of Ralph Schulze, the inaugural Executive Director, was certainly a large responsibility. I recall a presentation to the Cotton CRC when I challenged the research community collectively not to become complacent, to set new standards and exceed expectations. Having achieved so many gains in on-farm production through RD&E I was also keen to ensure the same level of ambition was placed on increasing the value generated through the supply chain and from premium cotton products.

Certainly managing the financial viability and performance of RD&E through the millennium drought and ongoing production volatility has been a major challenge. Having to reduce funding by 25 percent with the consequential loss of research and extension capacity after the worst of the drought in 2008 and a crop of only 0.6m bales was a lowlight. Just as that was hard it was more challenging to only two years later be faced with the circumstances

of doubling RD&E investment after production of the largest cotton crop ever, with 5.4 million bales.

The loss of talented people across the whole industry during the drought was evident and has continued to motivate myself, CRDC and industry partners to place a great emphasis on investing in people and future leaders in particular.

This period was also a time when I took the opportunity lead the development of an industry vision, Vision2029, which served to bring industry leaders together to think beyond surviving the challenges of the moment to creating the future of the industry. It remains an important reference point for industry leaders and organisations.

In 2010 a national framework for primary industry RD&E was established with research strategies developed for every sector and cross-sectoral issues, like water, climate and soils. Through CRDC I collaboratively led the development of a cotton strategy and the Cotton Innovation Network from 2012 which has successfully strengthened relationships, communication and collaboration within the cotton industry research effort.



TOP LEFT: CRDC has been a major supporter of the Australian Cotton Conference under the direction of Bruce Finney.

LEFT: Always a supporter of innovation and innovative people: with PhD student Katie Broughton and Dr Rebecca Haling back in 2012.

ABOVE: Bruce with St George grower Glenn Rogan at his farm 'Benelong' in November this year.

The members of the Network include senior representatives from CRDC, Cotton Australia, Cotton Seed Distributors (CSD), CSIRO, the Australian Government's Department of Agriculture and Water Resources, the Queensland Government's Department of Agriculture and Fisheries, the NSW Department of Primary Industries and universities, through the Australian Council of the Deans of Agriculture. Of note was an analysis in 2015 that found that the Network member's annual investment in cotton sector RD&E had reached more than \$66 million. CRDC's leadership role was evident with our involvement in more than 90 percent of the projects.

Having the Network in place was an important ingredient in supporting a smooth transition of industry R&D to new arrangements with the cessation of the Cotton CRC in 2012. These new arrangements included the formation of CottonInfo, the industry's joint-venture in extension, supported by CRDC, CSD and Cotton Australia.

Whilst the core role of investing in world-leading RD&E for the cotton

industry remains the same the nature and scale of the business has certainly evolved over the 14 years. Since 2013 we have placed a greater emphasis on blue-sky (transformational outcomes), identifying concepts that could double the value of Australian cotton production including dissolving cotton for potential use in 3D printing or making carbon fibre that's worth \$40,000 tonne. Seeking new talent, ideas and capability to complement the historical strengths of our world-leading cotton researchers has seen us deliberately double the number of research partners. Through that process I identified the start-up business sector as a huge opportunity for not only sourcing ideas, but also using their energy and agility to solve industry challenges with a customer centric focus and digital technology.

Working with Pollenizer, then X-Lab, to develop the start-up business skills of our growers, researchers, industry participants and staff has been highly motivating and rewarding when you see the scope of ideas and their potential to change the industry. From a way to reduce cotton

nitrogen fertiliser requirements by 50 percent and real-time crop nutrient measurement to producer-led innovations in farm robotics and winter grown cotton farming systems. It takes great courage to pursue out of the box ideas and my reflection is that CRDC and the industry could be better at offering support.

I know it's cliché but it has genuinely been a privilege to work with great people, serving the cotton industry and the national primary industry RD&E system through roles with the Council of Rural RDCs. I leave confident in the future of the Australian cotton industry and its RD&E. There is no complacency, there is a recognition of the importance of improving upon past standards and there is an absolute ambition for big outcomes from RD&E.

I am looking forward to working with the team at Australia's largest rural research provider to drive business and innovation outcomes from an annual R&D investment of \$300 million. I am sure cotton will be a feature in those outcomes!



Converting waste to energy: does trash stack up?

Research commissioned by CRDC has found the conversion of cotton gin trash to ethanol is scientifically achievable – but is it an economic reality?

Cotton gin trash is a waste by-product created in the cotton ginning process. It consists of leaf matter, stalks, dirt and cotton fibre. Trash is a voluminous, light substance which becomes a burden to store, sell or convert effectively into a form of organic fertiliser.

“It is generally considered a nuisance by cotton ginners,” says Janine Powell, who has analysed the economics of an ethanol production plant using gin trash in a CRDC-supported study.

Janine and Jon Welsh of AgEcon used a hypothetical case study of a gin trash to ethanol plant at Narrabri in NSW to determine the viability of conversion.

“A market for ethanol has been created by established biofuels policy in NSW and state government mandates in Queensland for inclusion of biofuels into petroleum based liquid fuel, prompting the research,” Janine said.

“As a renewable resource and waste by-product, converting gin trash to ethanol makes environmental sense.

“The economic investment analysis in this study has shown a modest yet positive return based on a hypothetical plant converting gin trash to ethanol situated in the Namoi Valley of NSW, due to accessibility and volumes of gin trash from gins in the region.

“The baseline analysis returned a positive net present value, payback in year

12 of 25 and an internal rate of return of nine percent.”

Compared to other ethanol feedstocks, gin trash is more competitive than grains and comparable to the lower-cost feedstock molasses, which is currently converted in an ethanol plant in Sarina, Queensland. The key differences between these feedstocks as suitable sources is the zero-feedstock market price of gin trash. Conversely, the variable costs to process gin trash are almost two-and-a-half times that of molasses, wheat and sorghum.

However, returns from higher capital costs such as improved processing technologies and sensitivity testing of higher feedstock costs also found considerable vulnerability in the model. Exposure to market risk on inputs and outputs can potentially be mitigated with long-term supply agreements. These would have to be carefully managed to recoup the significant capital outlay during the tardy investment payback period.

“The cost to build an ethanol plant producing three million litres per year did create a significant economic hurdle with fuel pricing at current levels coupled with the high-cost of moving the high-volume trash – even short distances on-site and between gins,” Janine said.

“Interestingly, there is some new technology underway in Asia allowing

ABOVE: Steps in ethanol production from gin trash.

combustion (for electricity generation) of the large amounts of waste liquids from the distilling process, which could potentially improve the future investment bottom line.”

CRDC R&D Manager Allan Williams says while the variable nature and low density of gin trash makes it a challenging product to add value to, the availability of new technologies will likely provide new opportunities for turning gin trash into a valuable by-product of cotton growing. He said as well as looking at the viability of turning gin trash into energy, CRDC is also investigating the potential for using it as a feedstock for creating fine chemicals given its high cellulose content.

“There are increasing expectations that a sustainable supply chain is also a ‘closed loop’, that they produce minimal levels of waste at every stage, from raw material production through to consumption,” Allan told *Spotlight*.

“Turning gin trash into a valued commodity would increase the economic returns of cotton production and enhance the reputation of the Australian cotton industry for its commitment to innovation and sustainability.”

For more

Allan Williams

allan.williams@crdc.com.au

Even with new chemical controls, researchers have stressed that the use of beneficial insects, preserved through adherence to IPM, is still key to mealybug control.



Breakthrough in mealybug control

After years of CRDC-supported research, this season will be the first that crop managers have the option of chemical controls for solenopsis mealybug.

CRDC began a ground-breaking research project with QDAF's Richard Sequeira in 2015 to investigate the possible chemical controls for mealybug, with the obvious remit that it must not disrupt integrated pest management (IPM) strategies.

Richard is the industry's foremost expert on cotton mealybug and says he found three products, which he says, "should be used as a last resort, when other IPM tactics such as beneficial insects, aren't working".

Growers will have access to

Sulfoxaflor (Transform), and spirotetramat (Movento) which are currently used in cotton to control other pests, with strict guidelines for use, as researchers say correct application is key. There is also a permit allowing limited use of Buprofezin (Applaud) for mealybug (PER85053).

Richard says this is the most difficult project he has undertaken to date, for several reasons.

"It was a tough nut to crack, as we needed to succeed where researchers in India, Pakistan and other countries

had failed to come up with chemical solutions that gave an economically acceptable level of control while also fitting in with IPM strategies," he explained to *Spotlight*.

"Firstly, we could only test products currently registered for use in use in cotton, or at least those with potential for rapid registration, so this limited our selection.

"There are many chemicals that have an effect on solenopsis mealybug but give poor (zero to 30 percent) control. We also found that chemicals recommended for controlling other mealybug species (in other crops) showed no efficacy on solenopsis.

"It might seem a solution could be to say just increase the rate, but this is the next issue we faced – working with the companies' product guidelines and parameters based on toxicity studies and trade MRLs (maximum residue limits) which we had to adhere to.

"The other main consideration was the effect of the control on beneficials and the IPM system as a whole."

Naturally tough

Glasshouse and field trials were used to test the products on mealybug, which offered more challenges due to its natural defence mechanisms and breeding habits.

Mealybugs are very well defended with a thick layer of wax covering the exoskeleton, which makes them nearly impervious to direct application with insecticides, so a systemic product targeting the plant was needed.

Furthermore, the adult female does not feed when reproducing, so even if you use a systemic product “you can’t get it into the entire adult female population every time”. Solenopsis eggs, laid in clusters called ovisacs, are also impervious to insecticides.

Beneficials have an enormous impact on mealybug numbers. Products that are too disruptive provide limited short-term control, but ultimately flare populations as the surviving mealybug population expand unchecked by beneficials.

The other major challenge was determining the correct application method, which was the ultimate key to success.

“It’s not only working out which product is effective, but we had to work out how best to apply it,” Richard said.

“Usually if we find the right chemical and apply it we expect it to work – but all chemicals need to be applied correctly for them to work on each specific pest.

“So, linked to getting the product into the plant through the best application method, we had to challenge established practices in order to find solutions.

“The complexity of the problem stemmed from the need to optimise many variables such as nozzles, pressure, volume, ground speed, and so on, simultaneously.”

Richard said all the control options now developed are based on ground rig application with droppers to target the middle and lower leaves of the canopy using specific nozzle types.

Manage ahead

Prior to this CRDC-supported project there were no viable options for mealybug control using insecticides, and their use comes with caution.

“Chemical control is the last thing you want to do, but growers may find themselves in situations where the usual

In-season considerations if you find mealybug

- Mark the plants they are on, as they can be difficult to locate when in low numbers. Mealybug colonies can disappear between checks due to predation. Re-checking marked plants will enable you to judge the efficacy of any natural enemies that are present and provide an indication of the species present when it comes to making future spray decisions and selecting options that best conserve them. Tagged colonies also provide an indication of the potential disruption that a spray decision might have had as mealybug will quickly increase in numbers when natural enemies are removed.
- Look for the presence of natural enemies. It is highly likely that there will be other colonies elsewhere in the same field, and evidence of predation and parasitism and whether or not the solenopsis colony is growing or dwindling in number will provide a picture of what is occurring in your field at a broader scale.
- Beneficials are your best weapon. Insecticide controls do not provide 100 percent control and successful management of solenopsis needs to be built around an IPM approach.
- Everyone entering the farm should practice Come Clean. Go Clean principles – brush down clothing after entering a field with mealybugs and ensure farm equipment is cleaned down after entering fields with mealybugs.

controls are not working,” Richard said.

“These chemical controls must fit in with the overall system or you will end up with a bigger issue than the one you started with and we’ve seen that with mealybugs.

“Consequences of earlier actions can end up being more expensive propositions at the end of the season and in the long-term.

“If you go chasing mealybug with chemicals at the wrong time in the wrong way, you can flare other pests such as silverleaf whitefly (SLW) which does not cause direct yield loss but has the potential to damage the industry as a whole due to risk of honeydew contamination.

“If the underlying concern is managing risk and ensuring market access, whitefly is the biggest risk, and we need to keep that in mind when managing other pests.”

Mirids have the most potential to cause yield loss, and it is their control that beneficial insect communities that are key to SLW control can be affected. Managing mirids is now key to managing pests in our cotton system, as they occur early to mid season, and this is when we also have the most potential to disrupt the system and cause issues later on, depending on how we choose to manage them. There is evidence to prove that dimethoate, fipronil

and other products can flare other insects, in particular mites whitefly and potentially mealybug.

Before you spray

As mealybugs are typically found in small congregations or ‘hot spots,’ chemical control should be based primarily on a spot spraying approach.

“If you find one hot spot on your farm it is more than likely that you have more, and they may be smaller and not always readily evident,” Richard says.

“Using drones is an excellent way to check fields for these additional hotspots and the most sensible option would be to release beneficial predators into the patches if these are limited in number.

“I would see chemical intervention being used early to mid-season when the ability of the pest to cause high mortality in young plants is most likely.

“Later in the season, harvest around the patches, let the beneficials clean them up and then harvest.

“It is also very important how you handle these hot spots after harvest.”

For more

Richard Sequeira

richard.sequeira@daf.qld.gov.au

Silverleaf whitefly: maintaining control

Resistance to pyriproxyfen in silverleaf whitefly (*Bemisia tabaci*) has emerged over the past three cotton seasons, posing a serious threat to ongoing IPM-compatible control.

As part of CRDC-supported research, the QDAF entomology team has been focused on testing silverleaf whitefly (SLW) for insecticide resistance over the past year. Results show that resistance to pyriproxyfen – the cornerstone product for SLW control – “has not gone away, but the situation has not gotten worse”.

Pyriproxyfen is vital to integrated pest management (IPM), with a low impact on beneficial insects. Furthermore, there are no immediately available alternative control options with an equivalent level of protection.

Last season (2017-18), in an effort to preserve the field efficacy of pyriproxyfen, the Transgenic and Insect Management Strategies (TIMS) Committee and Insecticides Technical Panel endorsed a 30-day application window for pyriproxyfen. Given pyriproxyfen resistance remains in many of the populations tested and some regions had moderate levels of resistance, the TIMS panel has again recommended implementation of the 30-day window in 2018-19. Individual Cotton Growers’ Associations have nominated a voluntary 30-day window for each region.

The aim of narrowing the pyriproxyfen window is to minimise consecutive SLW generations being exposed to resistance selection and to ensure the product is being applied once per season when most effective.

QDAF entomologists Jamie Hopkinson and Paul Grundy say feedback on the window has been mostly positive, with a general consensus that it had improved communication between agronomists in areas where SLW are a major concern.

“However, concerns were raised to us during recent Crop Consultants Australia (CCA) workshops that the window may encourage people to spray below threshold SLW populations, due to a perceived fear of missing out on using the



Consultant Iain MacPherson, Dr Richard Sequeira and Jamie Hopkinson at one of the recent Crop Consultants Australia seminars discuss consultants’ concerns around SLW resistance and mealybug.

Location	Resistance Factor (LC50)		
	Season 2015/16	Season 2016/17	Season 2017/18
Central Queensland	<1-2	<1	<1
St George	4.1-5.3	9.3-15.4	9-37.3
Goondiwindi & Border Rivers	<1-15.2	5.4-24.7	4.1-8.9
Gwydir valley	1.7-68.2	13.4-113.1	14.2-28.3
Namoi valley	5-5.3	14.8-64.4	1.7-4.6
Macquarie valley	–	–	4.6
Southern NSW	1.2	2.4	1.7

TABLE 1. Resistance factors calculated from pyriproxyfen bioassay data.

insecticide before the window closes,” Jamie said.

“While spraying earlier to control SLW may seem a logical approach, it risks applying expensive insecticides to pest populations that may never have reached threshold levels, therefore resistance selection pressure is increased unnecessarily, defeating the purpose of the 30-day window.

“In this situation it would be advisable to wait and if control is required before the end of the season, utilise an alternate product such as diafenthiuron which should provide adequate control of SLW if thresholds are reached late in the season.”

Pyriproxyfen resistance levels

In 2016-17, nine populations out of the 17 tested had resistance with low to moderate levels of resistance recorded in four production regions. In 2017-18, eight populations out of 16 tested had resistance but this resistance was recorded in only three of the four previously recorded production valleys.

To determine resistance severity, resistance factors can be calculated by dividing the LC50 (ie the dose required to kill 50 percent of insects in a given time) of a field population over the LC50 of a known susceptible population. For example a field population with an LC50 of 10 divided by a susceptible population with a LC50 of one produces a resistance factor of 10, that is, it takes 10 times the dose to kill 50 percent of the insects (Table 1).

Alternative registered options

Testing of diafenthiuron, cyantraniliprole, spirotetramat, dinotefuran, acetamiprid, and emamectin benzoate found no evidence for resistance. Testing of bifenthrin found two populations had resistant SLW.

Jamie says spirotetramat resistance has been detected in SLW populations collected out of horticulture crops from North Queensland and a collaborative research effort with Bayer has been investigating the underlying mechanism, as well as studying the inheritance and stability of resistance.

“The aim of narrowing the window is to minimise consecutive SLW generations being exposed to resistance selection.”

New insecticides

A new product has been registered for suppression of SLW adult and nymphs by BASF. The product is Versys, the active ingredient is afidopyropen (Group 9D). The QDAF entomology team has recently commenced testing of the product to develop baseline toxicity data for future resistance testing. Along with afidopyropen the team is also testing the insect growth regulator, buprofezin (Group 17A).

For more

Paul Grundy

paul.grundy@daf.qld.gov.au

www.cottoninfo.com.au/publications/

[cotton-pest-management-guide](#)

IPM still best

Management of SLW must consider more than just insecticide use. Effective SLW management involves a whole season IPM approach which includes the following key aspects.

1. The control of overwintering weed hosts including cotton volunteers and ratoons is an effective management practice for a variety of pests including SLW.
2. Base all pest control decisions on industry recommended sampling and threshold strategies.
3. Area wide management is a powerful approach to pest management, especially for highly mobile pests like SLW. On farm, consider size of your management units when applying insecticides, to minimise the risk of creating scenarios where the same population is re-treated due to between field movement. Consider working with your neighbours or at the district level to implement better coordination of planting windows, weed management and a consensus on the use of or delay of insecticides.
4. Avoid “insurance” sprays. Early to mid-season use of broad-spectrum insecticides for pests such as mirids can disrupt the establishment of important natural enemies. This can be enough to tip the balance in favour of SLW, increasing the risk of an outbreak.
5. The SLW parasitoid is available from commercial insectaries and can be manually released or there are services available to release them from drones. Releases early in the season may help parasitoids to establish locally and build up in response to SLW. Late season releases (if predator numbers are insufficient numbers) may help suppress SLW before they reach threshold although such a strategy will be more expensive than releases that aim to inoculate field areas.
6. Select the softest available product, based on the target pest, natural enemy population and Insecticide Resistance Management Strategy. This has been made easier this season with the revamping of the Cotton Pest Management Guide to include natural enemy disruption as a category in the pesticide tables.

Bringing irrigation tech to the world stage – and the field

Australian scientists have been recognised internationally for their development of IrriSAT – cutting edge technology designed to improve water use efficiency.

With support from CRDC, CSIRO's Jamie Vleeshouwer, Deakin University's Dr John Hornbuckle and Dr Janelle Montgomery (then NSW DPI, now CottonInfo) developed IrriSAT, and were named by the International Commission on Irrigation and Drainage (ICID) as winners of the technology category in the 2018 WatSave Awards. John attended the IEC Plenary to receive the award in August in Saskatoon, Canada, where he gave a presentation on IrriSAT and worked with Agriculture

and Agri-Food Canada who are looking to implement the technology for Canadian irrigators.

The developers say the big reward for them is seeing the benefits of the technology now used in the field.

IrriSAT allows irrigators to look at crop water use both in a historical and a seven-day predictive sense very easily, with just a few clicks of the mouse.

"This information can be used for irrigation management and benchmarking across fields and farms," John said

"It allows growers to look at some quite large and complex data sources (satellite remote sensing and weather information) and distil this data into useful information like current and predicted crop water use, on which decisions can be made.

"It is critical for industries to continue to maximise water use productivity and tools like IrriSAT are one part of ensuring this aim is achieved.

"To this end, IrriSAT is now



John Hornbuckle received the award on behalf of his associates in Canada.

incorporated into the GoSAT services offered by Goanna Ag and it's been great to see industry so interested in the research."

Janelle Montgomery's role in IrriSAT's development was at the grass roots level, helping trial the technology in the field near Moree in the Gwydir Valley, and "extending the great technology".

"It's very exciting to receive international recognition from peers in irrigation research," Janelle said.

"And we've been lucky to get Tom Dowling from Goanna Ag to take up the technology.

"He has many cotton clients, so it's great that the technology is being widely used.

"It has been a great collaboration between Deakin University, CSIRO and NSW DPI with support from CRDC.

"To be able to get site-specific crop factors is an enormous improvement on using the old book values when measuring crop water use."

IrriSAT's broader application

Tom Dowling says the development of IrriSAT and the algorithm he used to commercialise his GoSat platform has been fundamentally important for Goanna Ag to drive more accurate irrigation scheduling and benchmarking of water use efficiency.

"Along with our network of weather stations and moisture probes, GoSat enables us to provide accurate measurement of daily crop water use and forecast that water use over the next 10-day period.

"Our clients are then in a position to precisely plan their irrigation scheduling; optimising water use efficiency and driving farm profitability and sustainability.

"Adoption of new technology is driven by value of the information provided and the end user's trust of that data.

"Having this technology developed in Australia has provided the validation of the data we provide in GoSat and this meant a smooth adoption of the product and John is always willing to discuss and provide the answers to questions on this technology."

This season GoSat will be incorporated into a new product called GoField, which essentially bundles Goanna Ag's probe, the IrriSAT analytics and connectivity through either 3 or 4G or their LoRaWAN network.

"It is fair to say that this partnership of research, investment and commercialisation is delivering meaningful outcomes across Australian cotton fields; optimising efficiencies, profit and sustainability," Tom concluded.

For more

John Hornbuckle

j.hornbuckle@deakin.edu.au

Janelle Montgomery

janelle.montgomery@cottoninfo.net.au

Doing the figures: Automation is a good investment

Automated furrow irrigation offers economic and environmental benefits to cotton growers along with improved water use efficiency according to a recent industry study.

The analysis was undertaken by Jon Welsh of CottonInfo and AgEcon, in collaboration with Associate Professor Bob Farquharson, University of Melbourne, with support from CRDC. It suggests an automated irrigation system is a good investment due largely to significant labour savings leading to a rapid pay-back period, along with water savings of one megalitre per hectare per season.

“With a payback in four years on a turn-key pipes through the bank system, better use of inputs and ease of farm management, it makes good economic sense,” Jon says.

“A reduction in labour costs over the system’s life (in a cotton-wheat-fallow crop rotation) is the primary driver of the short payback period and 26 percent internal rate of return.

“The Net Present Value benefits (the present value of the expected future cash flows minus the cost) equated to approximately \$2000/ha for the estimated 20-year life of such a project.”

Through the study Jon also found further environmental benefits: by applying recent research findings on nitrogen fertiliser use and deficit irrigation

“Automation alleviates the likelihood of deep drainage from over-watering and allows precision irrigation.”



Automation using pipes through the bank in varying configurations is being taken up by growers, with recent analysis showing it makes good sense.

almost one tonne per hectare of carbon dioxide equivalents per year would be potentially abated.

“The study also considered the opportunity cost of utilising extra farmland from an additional irrigation channel for ease of system management” Jon said.

“The capital costs of installing the technology included a fully contracted service, however costs can be halved in some cases when a grower can take on some earthworks or capital items resulting in shorter payback and far greater returns.”

Seasonal demand for labour during the irrigation season was also found to impact on costs.

Coupled with that, time-series data from the Boyce Comparative Analysis has shown the cost of employee wages is increasing at five percent per year or double the rate of inflation since 1997, of which a large portion can be attributed to furrow irrigation tasks.

“Irrigation frequency and duration is critical to avoid both yield penalties from waterlogging and better managing crop nitrogen use efficiency,” Jon said.

“Industry data suggests typical furrow

application efficiency from syphons has room for improvement and this technology helps bridge that gap.

“Growers are getting water on and off the field more quickly for a range of reasons including nitrogen use efficiency and to avoid deep drainage.

“Automation alleviates the likelihood of deep drainage from over-watering and allows precision irrigation.”

The study used economic evaluation methods to analyse water use and carbon accounting with economic modelling to calculate economic and environmental benefits, costs and ultimately investment returns to automated furrow irrigation. Whole farm modelling and sensitivity analysis of key input parameters were used to demonstrate the robustness of this new irrigation technology.

For more:

Jon Welsh

jon@agecon.com.au



Breaking with tradition: Swapping siphons for phones

Interest in automation has been so great that Andrew Greste, 'Waverley' Wee Waa, has been a regular speaker at field days sharing his experience in moving to the system.

It takes just one person to irrigate cotton where seven were once needed with the help of automated irrigation and a move away from traditional siphons at Steve Carolan's property 'Waverley' near Wee Waa in North West NSW.

Two hundred hectares can be irrigated with full automation in any one season using 'small pipes through the bank' (sPTB), which have now been set up for use across a large portion of the property.

After seeing automation in action at a field day and demonstration site at Moree, Steve and farm manager Andrew Greste initially converted 100 hectares from traditional siphons to a fully automated system. It consists of small pipes through the bank and a series of gates in the channel delivery system which can be remotely monitored, opened and closed by mobile phone. Gates are opened remotely in a 300-metre blind channel, starting 150 pipes per set.

Working in conjunction with the Smarter Irrigation for Profit project, led by CRDC and supported by funding from the Australian Government under the Rural R&D for Profit program, the system has been expanded and refined. The advantages are significant labour savings, improved uniformity and increased water use efficiency.

"This is not cheap to set up, but we can justify some of the expense over time in terms of savings in labour and improved water use efficiency," Andrew said.

"Complete irrigation costs are estimated at between \$200 to \$250 per hectare, per year, with

a three to four-year pay back."

Fully automated sPTB furrow irrigation is commercially available and viable at around \$1200/ha. If looking to move away from traditional siphons, growers have chosen sPTB on large broad-acre fields, as it provides more precise furrow irrigation control than bankless irrigation systems, at less than half the cost.

Moveability of the system between fields is another feature of the fully-automated, remote controlled system which can currently irrigate 200 hectares. The controller heads for the channel gates can be moved to other fields now 'Waverley' has moved to sPTB across the farm.

"Water levels can be monitored from my phone, saving a lot of travelling, as a round trip is 10 kilometres, four time a day and night," Andrew says.

"Our supply and return channels are monitored so we know when to turn our pumps on and off.

"This is turn-key irrigation – we easily irrigate with one man where once we'd need seven."

Optimisation has also been achieved.

Trialling optimisation recommendations across an 18-hectare trial site in 2016-2017 during one of the hottest seasons on record, these growers were able to save their crop.

"I believe increasing the depth applied per irrigation, lowering the flowrates and providing longer cut-off times saved our crop. Because this trial was so successful, we ended up expanding this system across 1100 hectares that season."

For more

Dr Joseph Foley

joseph.foley@usq.edu.au



Timing and deficits a factor in yield

New research has shown that split application of nitrogen (N) fertiliser in irrigated cotton results in the highest yield and better fertiliser nitrogen use efficiency (NUE).

Last season, NSW DPI scientists Jon Baird, Graeme Schwenke and Guna Nachimuthu, in collaboration with CSIRO's Dr Ben Macdonald, used irrigation scheduling deficits of 50 and 70mm along with up-front and in-crop N application to compare yield, N uptake, plant growth response and tail water N losses.

Trial method

The trial was located at the Australian Cotton Research Institute near Narrabri. Up-front N was applied as urea at 30cm under the plant line. In-crop N was broadcast urea followed by irrigation within one to two days. A total of 244

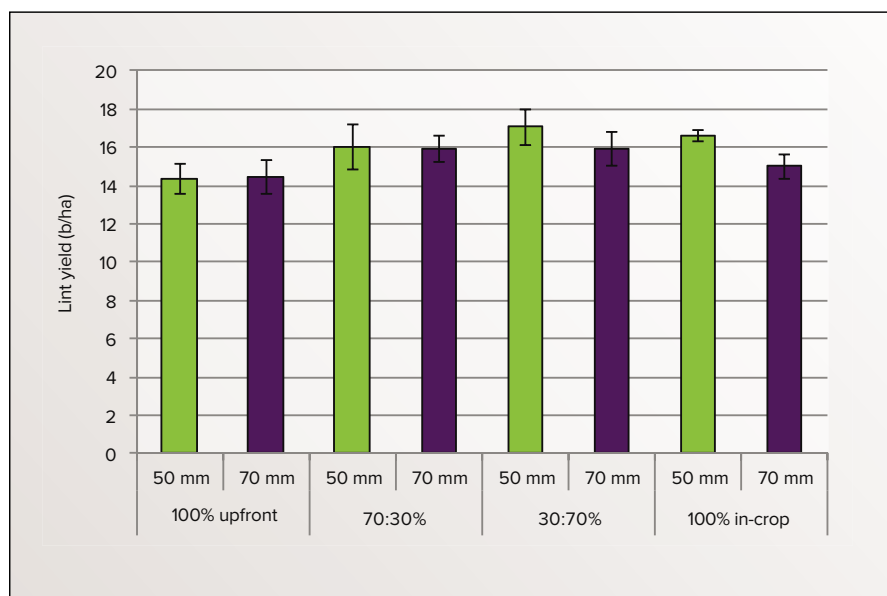


FIGURE 1. Lint yield for the N application treatments at ACRI. Error bars signify standard error about the means. The mean comparison for deficit was 0.58 b/ha, and for N timing was 1.41 b/ha.

kg/ha of urea (112 kg N/ha) was applied to each treatment. The N rate was determined after pre-season soil testing to give a total available N of 200 kg N/ha, or

80 percent of the industry-recommended 250 kg N/ha. N fertiliser application timings were: 100 percent up-front; 70:30 split; 30:70 split; and 100 percent in-crop. The in-crop N was applied prior to the first three in-crop irrigations (between 14th December and 12th January). These application timings were developed to match the peak N demand by the crop during the season.

Finding: Split application best

The trial found lint yield was affected by both irrigation deficit and timing of N application. Yield was 0.81 bales/ha higher in the 50mm deficit while the 100 percent

Deficit treatment	Irrigations applied	Applied water (ML)	Crop water use (mm)	Gross production WUE (bales/ML)	Economic WUE (\$/ML)
50 mm	11	9.8	994	1.7	725
70 mm	8	8.4	868	1.9	875
LSD (P<0.05)			93.7	0.18	ns

TABLE 1. Experimental water use efficiency for the two irrigation deficits. Crop water use (CWU) is the accumulation of soil moisture increase due to irrigation plus rainfall and the delta of starting and ending of crop soil moisture. Gross production water use efficiency is the derivative of yield and CWU.

up-front N treatment yielded less than the other three treatments, which were the same (Figure 1).

N application timing significantly affected plant height. Delaying the N supply reduced vegetative growth but led to greater lint production. Both application timing and irrigation deficit affected the retention of first-position bolls, but not fruiting nodes or total bolls. There was no interaction between irrigation deficit and N timing treatments.

An EM38 MKII was used to make regular surveys of crop water use in the two irrigation deficits treatments.

The greater lint yield produced in the 50mm deficit treatment required a higher amount of applied irrigation water, resulting in a lower gross production water use efficiency (GPWUE).

“Interestingly, although the 50 mm had lower GPWUE than the 70mm deficit, its higher yield meant that there was no difference in \$/ML,” Jon Baird says.

“This result was driven by the long growing season, high day-degree accumulation, and optimum growing conditions.

“In cooler or shorter growing seasons that potentially results in earlier plant maturity, the yield potential may be

limited in the treatments which had late in-season N applications and lower irrigation deficits.

“Previous studies have found applying an exorbitant amount of N too late in-crop in the growing season may have no benefit on lint yield, so growers who do apply N in-crop need to ensure it’s not applied too late in the growing season.”

Finding: Tail water losses

N fertiliser application timing also had a significant impact on the amount of N lost from the field in tail water over the whole season. As found in previous studies the majority of N runoff from furrow irrigated fields occurs during the first two to three irrigations of the season, especially when the majority of fertiliser N is applied up-front.

“Later in-crop N treatments reduced these cumulative N losses and also meant there was a greater amount of available N in the field at the optimum period of plant uptake, rather than having higher available N early in the season when plant uptake is low.”

However it must be noted that the form of N fertiliser and the method of application will impact the amount of N lost from an irrigated field.



NSW DPI's Jon Baird has been undertaking trials over several years to better understand the relationship between irrigation and nitrogen use.

As Guna Nachimuthu explains, “in-crop applications using water-run fertilisers, the subject of a separate trial within the nutrition project, showed much greater loss of fertiliser N in irrigation water runoff – up to 30 percent of the seasonal total applied”.

“Growers need to consider their pre-fertiliser soil mineral N levels before deciding on the fertiliser N rate to apply.

“Previous rotation crops should also be considered before making N fertiliser decision as significant in-crop N mineralisation can provide much of the crop’s N requirement.”

This project is part of the More Profit from Nitrogen project, which is supported by funding from CRDC and the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program. The More Profit from Nitrogen collaboration is led by CRDC. This project is led by NSW DPI, with collaborators including CSIRO and The University of Melbourne.

		Plant height (cm)	Nodes	Fruiting nodes	First position bolls	Total bolls
100% upfront	50 mm	103.7	23.9	16.5	8.4	10.4
	70 mm	84.6	22.2	15.5	7.6	10.4
70:30%	50 mm	94.0	22.5	15.5	7.6	10.3
	70 mm	83.7	21.6	14.7	8.1	10.5
30:70%	50 mm	90.5	23.8	17.0	8.1	11.1
	70 mm	79.1	21.3	14.4	7.2	10.2
100% in-crop	50 mm	92.9	23.1	16.1	8.4	10.9
	70 mm	79.0	22.3	15.3	7.3	10.2

TABLE 2. Cotton plant growth response to nitrogen application treatment and irrigation deficits. N application timing significantly impact plant height (P<0.05) and nitrogen timing x irrigation deficit impacted first position boll retention (P<0.05)

Irrigation deficit	100% upfront	70:30%	30:70%	100% in-crop
50 mm	38	26	18	13
70 mm	37	35	21	17

TABLE 3. Cumulative nitrogen losses in the tail water (kg N/ha). N timing significantly impacted the amount lost from the field over the season (P<0.001).

For more

Jon Baird

jon.baird@dpi.nsw.gov.au

Paraquat resistance in tall fleabane a warning signal to industry

Paraquat resistance has been detected in tall fleabane samples collected in CRDC’s 2017-18 random weeds surveys.

This discovery serves as a clear reminder of the need to manage weeds according to the cotton industry’s Herbicide Resistance Management Strategy (HRMS), particularly focusing on the need to monitor for and ensure no weed survivors.

The samples from two tall fleabane populations, collected near Nandi, Queensland and Coleambally NSW, are the first paraquat-resistant tall fleabane identified in Australia. Paraquat resistance in tall fleabane (*Conyza sumatrensis*) was first observed in Japan and then in Sri Lanka and Taiwan. Subsequently, cases of tall fleabane’s resistance to other herbicides, such as glyphosate, have been reported overseas, mainly in the US.

NSW DPI weeds researcher Dr Md Asaduzzaman (Asad) says testing of the suspect samples showed they were able to survive the ‘double-knock’ of glyphosate followed by paraquat, as well as elevated paraquat treatments alone.

“Our CRDC-supported research project found initial resistance with the recommended rate of Paraquat-250, so we then applied a range of rates on the suspected populations,” Asad said.

The rate response analysis showed that one of these biotypes is 4.9 times



Dr Md Asaduzzaman (Asad) observing paraquat biphasic response in resistant tall fleabane after application of Paraquat-240.

more resistant than the susceptible biotype, requiring more than 2.5 L/ha Paraquat-250 to kill 50 percent of the plants from the resistant population compared to just 0.5 L/ha to achieve the same result in the susceptible population.

While this level of resistance is generally considered ‘moderate’ it is clear that resistance is building and must be taken very seriously given the importance of the double-knock tactic in most cotton and grain production systems in Australia.

Tall fleabane is now the second species in Australia to have confirmed resistance to both glyphosate (Group M) and paraquat (Group L), the first being a population of annual ryegrass identified

in Western Australia in 2013. Flaxleaf fleabane (*Conyza bonariensis*) and nine other weed species have also registered resistance to paraquat. The capability of *Conyza* species for high seed production, rapid germination and high dispersal of its seeds enables it to spread of double-knock-resistant plants quickly.

“The number of resistant weed species and resistant populations are increasing,” Asad warns.

“Overall, the recent weeds survey has shown that cotton paddocks are generally relatively weed-free although the incidence of resistance to glyphosate is quite high in flaxleaf fleabane.”

Across the board, the use of the same herbicide modes of action without survivor control can accelerate resistance build up easily thereby increasing the difficulty of resistance management.

“We always need to prioritise diversified weed control tactics to avoid, or at least delay, the evolution of resistance,” Asad says.

“Tactics should include using pre and post-emergent herbicides with different modes of action, continuous monitoring of resistance dynamics, greater use of

Tall fleabane biotype	% Plant survived under		
	Paraquat-250 @ 2 L/ha	Glyphosate-540 @ 1.88 L/ha	Glyphosate +Paraquat
TFB01	>75	100	75
TFB02	75	75	75
TFb-S	0	0	0

TABLE 1: Resistance levels of tall fleabane screened against paraquat, glyphosate and glyphosate + paraquat (R-resistant >50% survival; DR-developing resistant <50 %-> 20% survival and S- susceptible <20% survival).

soil-applied residual herbicides, reducing weed seed-banks by other cultural practices and strategic tillage for control as needed.

“Above all is the need to monitor and remove any survivor weeds in line with the cotton industry’s weed control strategy of ‘2+2+0’ that recommends two non-glyphosate tactics in-crop plus two non-glyphosate tactics in the fallow plus zero survivors.”

Researchers will now focus on gaining an insight into the paraquat resistance in tall fleabane.

“There are reports that in other species, resistance can result in reduced fitness of the weed or sometimes even higher fitness of the resistant biotypes,” Asad said.

“We are also interested to know whether there is any biphasic response of these biotypes at low doses of paraquat.

“We are also doing research with different research hypotheses, where we are trying to find out any linked between double-knock resistant dynamics and biology, ecology and current management strategies for this species.”

For more:

Dr Md Asaduzzaman (Asad)

0402 353 328

md.asaduzzaman@dpi.nsw.gov.au



Paraquat resistant tall fleabane after 75 days of varying rates of Paraquat-240 application in Asad’s CRDC-supported trials.

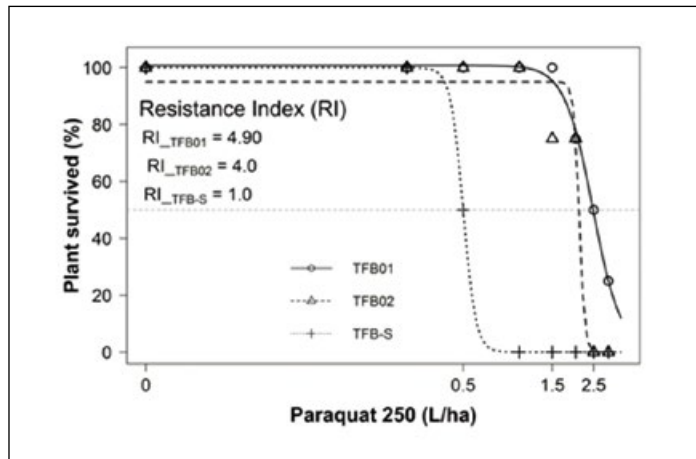


FIGURE 1. Paraquat-resistant assay in selected tall fleabane populations treated at the rosette stage with different paraquat-250 doses. Lines describe the predicted survival responses according to the statistical equation. Symbols shown are the original means from plant surviving.

An emerging problem

CRDC R&D Manager Susan Maas is encouraging growers to look for and control any fleabane escapes, to prevent a very serious problem around resistance in the future.

While two samples of tall fleabane (*Conyza sumatrensis*) tested as part of CRDC’s weeds surveys were found to harbour resistance to both glyphosate and paraquat, indications from the Darling Downs (the site of one of the populations) is that the problem is actually widespread.

“Since we learned of the initial resistance, I’ve had discussions with agronomists on the Downs that suggest that resistant populations of the weed are present in varying degrees across the region.

“Where people have been vigilant with survivors, it has been kept to patches,

however there are some instances where patches from last year blew out, and now the weed is in every field of some farms.

“This is very worrying and reinforces the need for all crop managers to adhere to the Herbicide Resistance Management Strategy (HRMS).

“CRDC has invested a lot of experts’ time and money to develop this robust plan based on the best science, and we cannot stress enough that it is a major factor in managing resistance in weeds.

“If you see survivors after treatment, have a closer look; if you’re suspicious, send the plant for sampling to test for

resistance. As an industry we need to know what consultants and growers are seeing in the field to organise the appropriate response.

“I would worry that these resistant tall fleabane populations might be initially mistaken for the more common flaxleaf fleabane (*Conyza bonariensis*),” Susan said, “as both plants are characterised by the production of fluffy, cream seed heads.

“If you had a paddock with a history of flaxleaf fleabane, it could be easy to be complacent about a few escapes.

“These survivors could quickly become a whole-of-farm problem.”

So what can you do?

DOUBLE KNOCK – Double knock is a great strategy to manage difficult to control weeds. However relying on the

same approach is a resistance risk, even though two modes of action are used. Consider mix partners to improve robustness of double knock. Always follow label directions and check with chemical registrant for compatibility.

USE A RANGE OF TACTICS – There are a number of different modes of action registered for use in cotton. Strategic tillage that buries seed will substantially reduce germination. Also consider how residuals could be used in combination with tillage. Page 97 of the Cotton Pest Management Guide outlines tactics available for use in cotton. It is important to correctly identify weeds, as resistant populations can easily spread in the landscape.

CORRECTLY IDENTIFY WEEDS –



ASAD ASADUZAMAN

Tall fleabane.

- Tall fleabane (*C. sumatrensis*) grows up to two metres and has a single stem with a pyramid-shaped inflorescence. Its leaves are less indented than flaxleaf fleabane and its branches do not grow taller than the main plant axis.
- Flaxleaf fleabane (*C. bonariensis*) grows up to one metre and has erect multiple-branching stems covered with stiff hairs. Leaves are

grey-green, deeply indented, coarsely toothed and covered in fine hairs. Its branches often grow taller than the main plant axis.

Getting weeds tested for resistance will help inform planning around tactics.

NO SURVIVORS –

Of course the most important thing to do is to ensure there are NO SURVIVORS. Chipping rouge weeds that survive could help to prevent a costly and difficult blow out situation in a subsequent year.

For more

Herbicide Resistance Management Strategy (HRMS)

www.cottoninfo.com.au/publications/cotton-pest-management-guide

Harvesting the first cotton crop at IREC's Whitton site last season.



Southern weed trials

This season at the Irrigation Research and Extension Committee (IREC) site near Whitton in the Riverina, NSW, CRDC-supported herbicide resistance trials are underway.

Barnyard grass and rye grass are the main problem weeds in the region, due to glyphosate resistance. The trials will focus on these weeds, using Japanese millet as a substitute plant. Similar trials are being run near Wee Waa.

CottonInfo Regional Extension Officer Kieran O’Keeffe said it was great to add a weeds trial to the IREC site and personally have input into the research, which he’s keen to share with growers.

“The plan is to have a field day in late January, but it will depend on the season – as we have already seen a

wet start!” he said.

The Whitton site managed by IREC grew cotton for the first time last year, which provides an income for the group to run the site. IREC chair and well-known cotton grower Rob Houghton donated his time to grow the crop.

IREC has been supported by CRDC for some of the redevelopment and ongoing support needed to grow cotton there. The cotton focus is rapidly expanding as growers’ need for regionally-specific research outcomes grows. Irrigation methods (pipe through bank and bankless) and automation are being trialled side-by-side at the site in its second ever cotton crop. There are also a number of experiments planned for this season.

Drought feed alert

Drought-affected growers who are feeding stock with hay imported from other regions should be aware of the threat of introduced weeds in feed, especially weeds which may carry multiple group herbicide resistance.

While the ability to bring hay from other states and regions has been a lifeline for many livestock, it has the potential to bring other less desirable outcomes.

“The thing to be concerned about is hay and other feed sources coming from areas that have weeds with multiple resistance, which we don’t have in cotton,” CottonInfo Weed Management Technical Lead Eric Koetz said.

“We are already seeing rising resistance levels to glyphosate and other herbicide groups: we don’t want to speed the process up.”

He said there had been plenty of news in the rural media, and expected most growers would be aware of the risks, but has put out a reminder that it was vital to check areas where hay had been fed out for unknown or hard-to-kill weeds, and manage any weeds accordingly.

“Particularly after rain – go back and check. It pays to put cattle through the yards overnight when moving paddocks to stop seed transfer.”

Resistance: CRDC heavily invested

CRDC has invested \$2.7 million in a major weeds research project over the past five years.

The 'Staying ahead of weed evolution in changing cotton systems' project aims to minimise the adverse impacts of glyphosate resistant weeds, or potential impacts of multiple resistant weeds, on the cotton industry.

It aims to do this through understanding the drivers for resistance and evaluating new tactics for weed control. The project looks at herbicide resistance from a molecular perspective, conducting ecology studies of key weed species (awnless barnyard grass, feathertop Rhodes, windmill grass, fleabane and sowthistle) and testing herbicide and non-herbicide tactics that support weed management best practice.

The project has been integral in developing the industry's Herbicide Resistance Management Strategy's (HRMS) recommended strategy of 2+2+0.

Dr David Thornby has been undertaking in-depth modelling to understand the risk to industry from herbicide resistance, and has developed the 'Diversity' model.

"Because herbicide resistance evolves in very large populations over many years, modelling is an important tool for investigating the dynamics of the problem," David said.

"The Diversity model tracks the simultaneous evolution of resistance to multiple herbicides, using multiple genetic pathways, in several weed species at once, which is an important development in resistance modelling."

David used the Diversity model to test weed management strategies for the proposed new cotton varieties with tolerance to multiple herbicides ('triple-stacked' varieties), in an Australian context.

"Stacked herbicide tolerances in new cotton varieties offers potential for increased herbicide diversity, but existing glyphosate resistant weed populations



need substantial extra management beyond what a glyphosate/glufosinate/dicamba resistance stack provides," he said.

"More diverse systems can provide robust management over 30 years in the absence of very high levels of background resistance to other modes of action."

David has also developed BYGUM (featured in *Spotlight Winter 2017*) a program that gives users the ability to be able to predict resistance looking at different scenarios. The HRMS utilises David's modelling, which has required changes for 2018, as outlined in the latest Cotton Pest Management Guide. Furthermore David has been developing the new weeds ID app which has recently been released (see story page 5).

QDAF's Jeff Werth has been researching the phenology of resistant weeds in cotton farming systems to increase the ecological knowledge of key species relevant for improved control, and defining risks for evolution of herbicide resistance in awnless barnyard grass, feathertop Rhodes, windmill grass, fleabane and sowthistle. Work is starting on annual ryegrass in response to emerging populations in Northern NSW and Queensland.

Research is also underway trialling new approaches to help manage weeds, including cover cropping and pre-harvest weed seed control.

Looking at weeds at the molecular level has also yielded important findings to help better understand how resistance spreads and can be managed. Dr James Hereward of the University of Queensland oversees this aspect of the project on behalf of CRDC.

"Genome sequencing of sowthistle has revealed that there are actually four different (EPSPS) genes in this species, and one of them has a resistance-causing mutation," James says.

"Our masters student Yu Shen has focused on windmill grass and it turns out there are three different species.

"These three species look very similar, and highlights how we could be underestimating the number of species with glyphosate resistance.

"In terms of relatedness of weeds, the take home message is that for some species there is only one mutation, which could suggest that Come Clean. Go Clean has a bigger part to play in herbicide resistance than we give it credit for."



Using plant-based extracts to fight diseases

A promising extract has been identified in research to screen for novel chemistries against black root rot.

Researcher Dr Duy Le of NSW DPI has been leading a CRDC-supported project which has led to the selection of a promising plant-based extract as a candidate for further investigation of the black root rot (BRR) pathogen (*Thielaviopsis basicola*).

“At one trial site, BRR incidence and severity on cotton treated with the potential candidate extract were significantly less than those recorded on untreated cotton,” Duy said.

“However, this research is in a preliminary phase and ongoing work within the project will continue to assess its efficacy toward *T. basicola*.”

This research is part of CRDC’s ‘Innovative solutions to cotton diseases’ project which is particularly focused on investigations of new and novel control approaches against major diseases of cotton such as BRR, Verticillium wilt and emerging diseases, such as Alternaria leaf spot (ALS).

Beneficial bacteria and fungi

Duy is also undertaking laboratory-based screening for assessing efficacy of biocontrol agents, including beneficial bacteria and fungi. A bacterial strain under investigation has shown activity against BRR pathogen in laboratory assessments (Figure 1) and will be tested further in

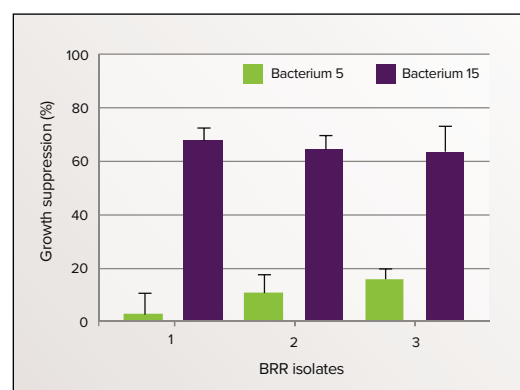


FIGURE 1: In vitro antagonistic effect of beneficial bacteria tested towards BRR pathogen *T. basicola*. Growth of *T. basicola* isolates were strongly suppressed by Bacterium 5.

glasshouse and field trials.

Meanwhile a trial at the Australian Cotton Research Institute near Narrabri in NSW is evaluating the effectiveness of biological disinfection of soil infested with Verticillium wilt pathogen using organic matter.

The emergence of Alternaria

While certainly not a new disease to cotton, particularly Pima, Alternaria is increasingly becoming prevalent in southern regions.

In a rapid response to its emergence, researchers succeeded in identifying the main pathogen of the disease and identified several fungicides which strongly suppressed the pathogen.

“BRR incidence and severity on cotton treated with the potential candidate extract were significantly less than those recorded on untreated cotton.”

To enhance the preparedness for the industry in 2018-19, these findings have been disseminated to the industry to provide supporting evidence for an emergency permit application. Additionally, glasshouse trials are ongoing to assess crop safety and verify the control efficacies of selected fungicides.

“Although there is no recent history of foliar fungicide applications to cotton, with previous uses associated with Pima cotton, some isolates of the main *Alternaria* pathogen showed reduced sensitivity to certain fungicides tested,” Duy said.

“Therefore, it is recommended that sprays in cotton should be used with caution.

“Integrated alternative approaches for managing *Alternaria* and fungicide resistance will be desirable as part of an industry-wide approach to disease management.”

As a first step toward managing *Alternaria*, research focused on characterising the pathogens associated with it and providing insights for development of control strategies. Products of interest for screening in this research include commercially available fungicides registered for use in other crops and experimental chemical and/or biological control agents. A number of these fungicides have been evaluated for efficacy toward *T. basicola* and *Alternaria* species.

Although research conducted in 2017-18 season did not identify any commercial fungicides suitable for controlling *T. basicola* in cotton, the pathologists will now expand future screening.

The project is successfully providing research for identifying key pathological issues and potential solutions for disease management. So far, the research has identified some promising candidates which will be further investigated. Where disease management solutions are identified, steps will be taken to progress these agents toward registration or commercialisation for use in cotton.

For more

Duy Le

duy.le@dpi.nsw.gov.au

Industry unites in disease management

This year’s FUSCOM, held at Griffith in NSW’s Riverina gave growers, consultants and researchers the opportunity to form a better picture of the state of diseases in cotton, the latest research and potential issues.

High on the agenda at FUSCOM was a focus on Verticillium wilt research and discussion around the prevalence and impact of black root rot in southern growing regions.

The Fusarium Wilt of Cotton Research and Extension Coordination Committee (FUSCOM) was initially established in response to the outbreak of Fusarium wilt in the 1990s, and to control its spread across the Australian cotton industry. The annual forum has evolved to cover all aspects of cotton pathology, where pathologists, virologists, microbiologists, plant breeders and industry including CSD and consultants share research on current projects and disease issues.

This year’s forum chair was QDAF’s Sharna Holman – CottonInfo’s Regional Extension Officer for Central Queensland and Technical Lead for Biosecurity. She said to hear what the latest disease projects could hold for management was very heartening, coupled with the grower and consultant turnout to the two-day event.

“Holding FUSCOM in cotton growing regions allows growers and agronomists to engage directly with researchers and breeders, discuss diseases they are seeing in the field, how they’re impacting them and what they are trying on farm to manage them,” Sharna said.

“I really like the brainstorming of research gaps in-between sessions, particularly the CottonInfo session where researchers, growers and agronomists worked together to brainstorm where they would like regional disease research to head in terms of farming systems, in-crop management and potential solutions.”

Prevention still the best alternative

Sharna says the discussions around the impact diseases are having on growers highlighted the importance of implementing on-farm biosecurity protocols and good farm hygiene practices in line with *myBMP*.

“Preventing diseases and pests from coming on farm in the first place is definitely better than needing a cure – or a silver bullet,” Sharna said.

“My take home message from the researchers is that while everyone is working towards a solution and strategy to control and manage diseases, it will take time.

“Growers, agronomists, contractors and visitors play an important role in protecting farms, regions and agricultural industries from pests and diseases.”

The new *Be a good mate, stop it at the gate* biosecurity campaign aims to highlight the importance of everyone on and visiting farms to be implementing and adhering to on-farm biosecurity practices.

“Implementing on-farm biosecurity practices isn’t just about doing the right things to protect only your farm, it’s about having a positive impact on your neighbours and region,” Sharna says.

“Useful steps can be as simple as attaching a biosecurity sign to the front gate, and ensuring visitors and contractors know to come on farm mud and trash-free, along with educating staff to be aware of and report unusual pest or plant symptoms.”

Biosecurity Top Tips clips are available on the CottonInfo YouTube channel, or for more information and resources to help implement on-farm biosecurity practices, visit the *myBMP* biosecurity module.

For more

Sharna Holman

Sharna.holman@daf.qld.gov.au

www.youtube.com.au/CottonInfoAust



CottonInfo's Southern NSW REO Kieran O'Keeffe has highlighted the plight of growers in the region suffering significant yield loss due to black root rot.

RUTH REDFERN

Building a clear picture

The CottonInfo Southern Disease Cotton Update at FUSCOM was attended by “just about every Hillston grower”.

Most were there to talk about one thing: black root rot (BRR). Overcoming BRR in short seasons with cool starts, as experienced in southern cotton growing regions like Hillston is becoming very problematic, with some growers saying last season it cost them up to six bales per hectare. In the Riverina regional survey of growers undertaken by CottonInfo Regional Extension Officer Kieran O'Keeffe, black root rot was the second highest ranked concern.

The message from growers was there wasn't a lot they could do to manage it – and the short story was, “not much works and it seems after five seasons of cotton it is yield limiting, to the point it affects our ability to grow cotton”.

CRDC R&D Manager Susan Maas manages CRDC's disease/pathology investments and attended the disease update.

“FUSCOM has highlighted that in the southern region black root rot is seriously affecting yield and having a much greater impact than we would expect given the amount of inoculum in their soils,” Susan said.

“New approaches to disease surveys should give CRDC a better picture of disease and yield

loss as well as an understanding of how the farming system can be modified to reduce the impact of disease through more diverse soil microbiology.

“We also have many research projects researching novel disease management and are really pleased with Duy Le's work which shows there are potentially one or two products that can be used to control black root rot and Alternaria.

“Research to understand more about the complexities of Verticillium wilt, which is a serious issue for growers in the Namoi and Gwydir, is also expanding and we are seeing success in driving down inoculum through rotation crop trials.

“By bringing together CRDC-supported research with plant breeding and CSD farm trials, FUSCOM is an annual opportunity to ensure the industry's disease efforts are coordinated.

“I certainly got a lot out of sitting with all the growers and consultants and learning first-hand about their experiences.

“We had the chance to discuss key problems, significant issues and acknowledge that Alternaria and Sclerotinia are also emerging problems, also highlighted these issues to chemical companies.”

For more:

Susan Maas

susan.maas@crdc.com.au

Kieran O'Keeffe

kieran.okeeffe@cottoninfo.net.au

A matter of time for black root rot

Over the past 20 years, consultant Todd Peach has worked for many growers in central and southern NSW.

Along with fellow consultants Chris McCormack, with 28 years' experience in the Macquarie and Alan Jones with just over 20 years in the Murrumbidgee, they've had a front row seat to see the growing impact of black root rot (BRR).

"Black root rot is the biggest threat to the sustainability of cotton production in the Hillston (in the Lachlan Valley) area and consequently our number one issue," Todd told *Spotlight*.

"In the Lachlan, it's not confined to back-to-back cotton either, it's in any field that has a high frequency of cotton, even those managed with regular fallow and rotation crops.

"It has taken several years to become severe around Hillston, yet my colleagues in the Murrumbidgee say it is taking its toll there within five seasons.

"The frequency of back-to-back cotton around Hillston has declined over the past 10 years, but currently in the Murrumbidgee it is more frequent.

"There are now as many as a dozen fields in the south area which will not go back into cotton production until we resolve how we can deal with the disease."

Todd says while BRR is present in the Macquarie they don't see the impacts as much because of their slightly warmer start and finish than the more southern regions of the Lachlan and Murrumbidgee.

"In the Macquarie it was prevalent in the 90s but a reduction in crop intensity through the millennium drought reduced pathogen levels on many fields," he said.

"It has taken several years to become severe around Hillston, yet my colleagues in the Murrumbidgee say it is taking its toll there within five seasons."



Seedling samples from recent early season southern disease surveys showing black root rot symptoms.

"Profiles have been in a drier condition, which according to some researchers slows the rate of reproduction of the pathogen and this would be my field observations in both regions."

The consultants agree it is a cropping-history related issue – in the Lachlan and Macquarie they saw the impacts start 15 years ago.

"In the Lachlan now, BRR is running at about 70 percent incidence of fields and of that, 50 percent would have a severity level of eight to 10 (10 being the highest on a scale of one to 10)," Todd said.

This is translating to losses of around three bales per hectare, but some growers have reported as high as five due to the inability for the plant to compensate and/or loss of plant stands.

"BRR acts as a catalyst to and in conjunction with Pythium and rhizoctonia, and we are seeing plant stands greatly affected by seedling death," Todd said.

"Short seasons and traditionally wet winters mean growers can't take the risk of trying to grow the crop out or plant too late to mitigate BRR impacts, unlike in northern regions."

"Even if we did grow it out we wouldn't get our three bales back, as there is always four to eight nodes difference between affected and non-affected plants."

While it has taken a while to take hold in the Lachlan and Macquarie, according to Todd's fellow consultants, growers in the Murrumbidgee need to appreciate the significance of how quickly it is happening in their region.

"For developing regions in the south my advice would be to ensure farm

hygiene practices are established and most importantly maintained as I feel we had done this initially and then lost our way on the Come Clean. Go Clean message," Todd said.

"On farm it is moving in the water and machinery, and between farms there is no doubt it is being spread via soil on machinery.

"I believe planting too early is also problematic, because we get sick plants every year which contribute to the build-up of the pathogen.

"In our efforts to manage the disease we are now planting later but we are continually reassessing where the ideal time is, as we weigh up loss of earliness versus disease impacts versus yield.

"While later planting can be effective, we've seen later planted fields with high levels of pathogen in both the Lachlan and Murrumbidgee still being heavily impacted by three to five bales per hectare."

Efforts to manage BRR being adopted in the south include building large, consolidated hills for minimal slump; ensuring good field slopes and field maintenance to ensure no low spots; planting later (late October); ensuring varietal selection for high vigour; and adopting a strategy of pre-irrigate, then flush.

Despite these management techniques, the consultants say the pathogen level is already high this season, or the field has a high severity ranking.

"These band aids don't necessarily fix the wound and a replant on a number of fields has occurred and the result is yet to be observed as they are just establishing now.

"The sooner the resistant trait can be successfully bred into the current high yielding varieties that the plant breeders have done so well to produce, the better.

"If we don't resolve this issue the continued expansion of the industry will be short lived as we are starting to see it being curbed now as fields are going back into previous alternative summer crops or fields are being moved into permanent plantings.

"Growers cannot afford to lose these bales per hectare as it does not make cotton economically viable when these downsides occur in these regions."

The enigma of Verticillium

A great frustration for agronomists and growers alike are the crop disorders which we are powerless to control. Verticillium wilt is one such problem.

Crop Consultant Australia's survey data from the 2017-18 season revealed a quarter of agronomists felt Verticillium wilt has resulted in \$50 per hectare reduction in profit through either increased cost of production or reduced yield.

NSW DPI disease surveys have shown the incidence of this disease increased rapidly through the mid 1980s but then decreased and plateaued until about 2010 – an effect of more resistance varieties, particularly Sicala V2. Incidence has increased again from 2010 and while this incidence (the number of fields where the disease is present), is not as high as black root rot and Fusarium in these surveys, the level of crop loss in the areas where it does occur is arguably greater than either of these diseases.

Unfortunately, the disease seems well adapted to high yielding cotton production systems with some clear characteristics. Here's what we know:

- ◆ High nitrogen input exacerbates the disease under all irrigation systems. It's a hard call for anyone to significantly reduce nitrogen inputs and risk yield loss from deficiency.
- ◆ Low-deficit irrigation practices, used to drive high yields exacerbate the disease.
- ◆ The overhead irrigation systems that many growers have installed in recent years for improved water use efficiency also seem to increase vulnerability. The more surface-dominant crop root systems place the plant in the zone where pathogen levels are highest. Even with very conservative cotton rotations, such as cotton to wheat, several pivots throughout NSW have needed to be pulled out of cotton entirely due to the impact of the disease.
- ◆ Back-to-back cotton increases the pathogen levels in the soil. In years of good water allocation, this creates a big problem for 'land-poor' farms.

Historically, plant breeding has formed the basis of integrated disease management strategies in cotton. Bacterial blight was a major problem to the industry in its infancy but dwindled to insignificance in the late 1980s-early 1990s with the introduction of resistant varieties.

Fusarium wilt shot to prominence in the mid-1990s and rendered many fields, particularly on the Darling Downs, unsuitable for cotton. Higher F-rank varieties now mean this disease is manageable.

For breeders, Verticillium wilt is proving a bigger challenge.

CSIRO Cotton Breeding Lead, Dr Warwick Stiller says by world standards our current varieties have high levels of



Verticillium wilt is a disease with the potential for serious impact.

Verticillium wilt resistance but unfortunately, that doesn't help those growers that are significantly impacted by the disease.

Warwick contends the reasons Verticillium has proved a more difficult foe than Fusarium are because: it is far more environmentally influenced than Fusarium; unlike Fusarium there are different isolates and VCGs (vegetative compatibility groups) of Verticillium that have a different host plant response; and field sites for screening this disease are generally not as uniform or reliable.

"Importantly also, there are no commercial varieties around the world that have significantly better resistance than the current Australian varieties," Warwick said.

"All of these things go together to make breeding for resistance very challenging.

"We are working on developing germplasm that has improved resistance, but unfortunately there won't be a breeding solution for those bad fields in the near future."

Warwick expects molecular techniques will assist in the future, however, these techniques can't improve resistance by themselves.

"These techniques only track what we have so until we develop germplasm with increased resistance, molecular techniques have no value," he said.

Frustrating again, varietal resistance to Verticillium wilt is temperature sensitive – so varieties with even a high V-rank will succumb to disease when average temperatures drop to 20-22 degrees Celsius or below.

What this means for those in the field is that you could have done everything right – planted a high V-rank variety, avoided excessive N levels, used a good rotation, avoided over-watering – yet one cool period in December to February could see significant areas defoliate or die.

Clearly this will be another problem we need to research our way out of but in the meantime, for those in the field, any weather forecast for a cold change in December to February will send an extra shiver up their spine.



Cotton Australia CEO Adam Kay and CRDC Executive Director Bruce Finney at the Monsanto Cotton Grower of the Year field day at Darlington Point in southern NSW, recognising the achievements of the Toscan family of Cavaso Farming, the 2017 Monsanto Cotton Growers of the Year.

Delivering impact for growers through RD&E

In 2017-18, CRDC invested \$25.1 million into cotton RD&E on behalf of Australia's cotton growers and the Australian Government – continuing our long-standing commitment to delivering real outcomes for growers and enhancing the industry's performance.

2017-18 marked a significant year for CRDC – the culmination of five years investment under the 2013-18 Strategic RD&E Plan, and its resulting impact. In this final year, we invested in 318 RD&E projects across five key program areas (farmers, industry, customers, people and performance), working collaboratively with 118 researcher partners and growers.

In this special *Spotlight* feature, we take a look at some of the highlights of the 2017-18 year.

You can find more detail in our 2017-18 Annual Report and the Annual Report Grower Summary, both of which will soon be available via the publications section of our website: www.crdc.com.au/publications. You can also find a full list of our current research projects online at www.crdc.com.au/research-development.



Pictured at the official launch of the Accelerating Precision to Decision Agriculture project at ABARES in March 2018: Leanne Wiseman of the Australian Centre of Intellectual Property in Agriculture (ACIPA) at Griffith University; Bruce Finney, Executive Director, CRDC; the Hon. David Littleproud MP, Minister for Agriculture and Water Resources; Jane Trindall, R&D Manager, CRDC and Tim Lester, Executive Officer, Council of Rural RDCs.

YEAR IN REVIEW

CRDC RD&E achievements 2017-18

CRDC RD&E: continuing to deliver real impact for cotton growers

Following the first stage of impact assessments into CRDC's RD&E investments and impacts in 2016-17 (which found our water investments delivered a benefit-cost ratio of 8.29 to 1; our nutrition investments a benefit of 5.4 to 1; and our partnership with QDAF on the Central QLD early planting research 17.1 to 1) the second stage of impact assessments were conducted in 2017-18, focusing on CRDC's sustainability RD&E investments and the industry's *myBMP* program. The assessments found that CRDC's investment of \$4.85 million on behalf of cotton growers and the Australian Government into six projects focusing on improving the sustainability of the Australian cotton industry provided a return of \$12.26 million, and a benefit-cost ratio of 2.5 to 1. In addition, CRDC's investment of \$6.39 million in six projects to support

the industry's *myBMP* program from 2012 to 2017 returned a benefit of \$58.15 million, a benefit-cost ratio of 9.1 to 1.

Completion of current, and development of new, Strategic RD&E Plan

The CRDC 2013-18 Strategic R&D Plan outlined five core goals that the organisation aimed to achieve through investment in RD&E for the benefit of the Australian cotton industry – helping cotton growers to achieve an increase in productivity of three percent per hectare per year; enabling the industry to report against recognised sustainability indicators; doubling the premium for Australian cotton; developing a skilled, educated and progressive workforce; and ensuring the measured performance of the Australian cotton industry and its RD&E drives continuous improvement. 2017-18

saw the completion of four of the five measures, with work well underway on the fifth: doubling the premium for Australian cotton.

During 2017-18, CRDC also finalised the development of the new Strategic RD&E Plan 2018-23. This Plan sets an ambitious direction for the future of the Australian cotton industry, with CRDC's goal to contribute to creating \$2 billion in additional gross value of cotton production for the benefit of growers and the wider community by 2023. The new Plan commenced on 1 July 2018.

Delivery of three major CRDC-led collaborative grant projects

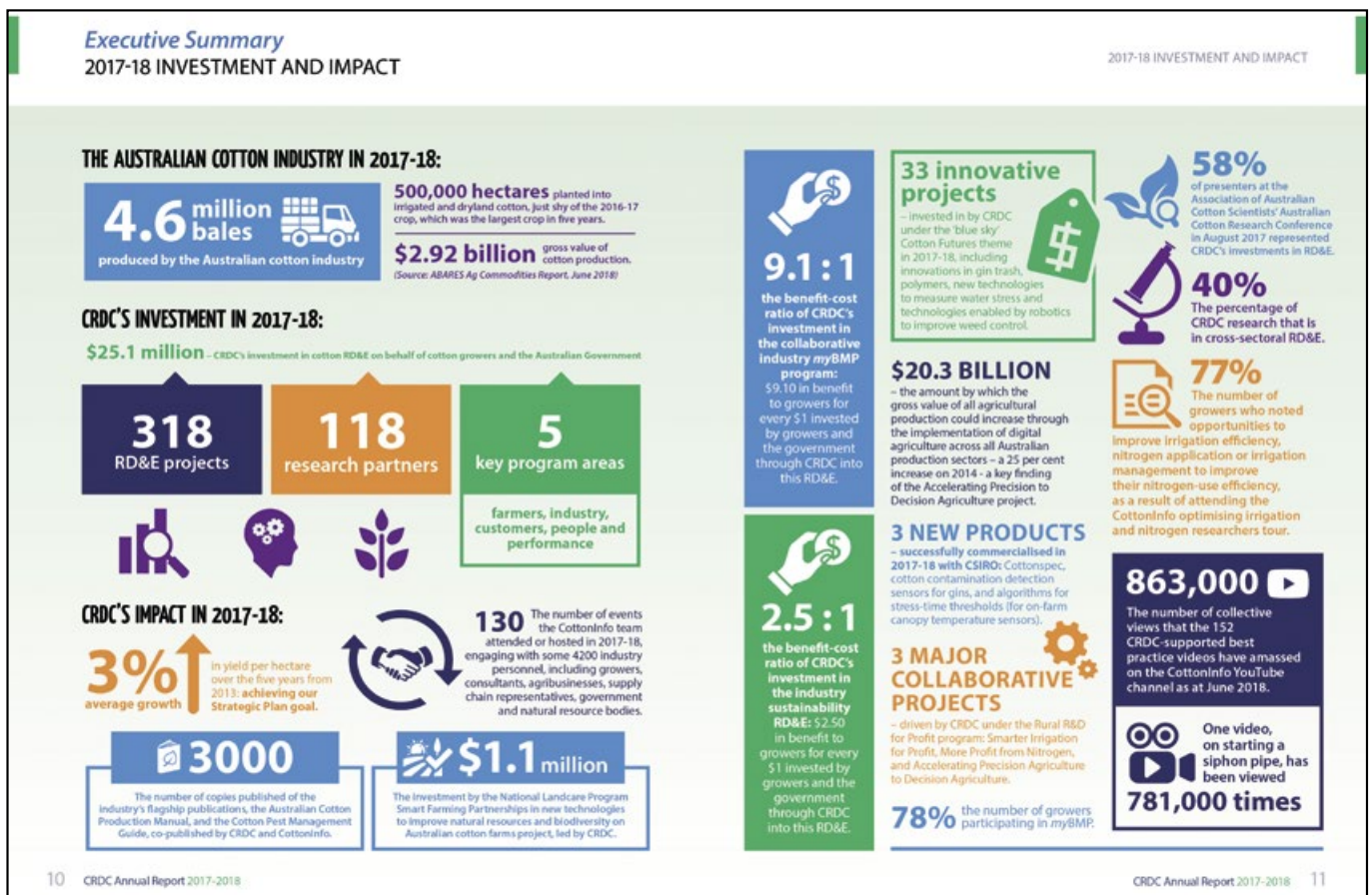
CRDC has been leading three major collaborative grants under the Rural R&D for Profit program: Smarter Irrigation for Profit, More Profit from Nitrogen, and Accelerating Precision Agriculture to Decision Agriculture. All three projects reached critical stages in 2017-18, with the finalisation of the Precision to Decision Agriculture project, and its official launch by the Minister for Agriculture and Water Resources, the Hon. David Littleproud MP at the ABARES Outlook national conference in Canberra; and the final years of Smarter Irrigation and More Profit from Nitrogen. A major outcome

of the Precision to Decision Agriculture project is the release of the final report, which has found that the implementation of digital agriculture across all Australian production sectors – represented by the 15 Research and Development Corporations who partnered in the program – could lift the gross value of agricultural production by \$20.3 billion – a 25 percent increase on 2014.

In addition to the Rural R&D for Profit program grants, an additional new CRDC-led collaborative project was announced in June 2018 under the National Landcare Program Smart Farming Partnership, focused on developing new technologies to improve natural resources (biodiversity) on Australian cotton farms.

CRDC-supported innovation commercialised in 2017-18

CRDC successfully commercialised three new products during 2017-18 with its research partner CSIRO. These included Cottonspec, cotton contamination detection sensors for gins, and algorithms for stress time thresholds. These three technologies have the potential to greatly benefit growers and the industry. Cottonspec is a yarn quality prediction program, that enables



spinners to accurately predict the yarn that will be produced from the cotton growths utilised. The cotton contamination detection sensors detect and record contamination events at the gin, helping to prevent contamination issues in ginning, spinning, weaving and knitting. And the stress time threshold algorithms are designed to support the use of canopy temperature sensors on-farm, helping growers to make decisions regarding the timing of irrigations. Using the canopy temperature sensors with the optimisation algorithms could result in a 5-10 percent benefit in water use efficiency in climatically challenging seasons. Through CRDC's commercialisation program, these project outputs are now being commercialised with industry partners to accelerate the scale and rate of adoption of these technologies.



Investing in critical core research: pests, weeds and diseases

During this year, CRDC continued to invest in critical areas of cotton industry R&D: integrated pest, weed and disease management. These three areas are core priority areas for growers and the industry: ensuring we can continue to grow high quality cotton with minimal disruption from pests, weeds and diseases. Our integrated pest management investments were in direct response to high pest pressure experienced by the industry, and included R&D focused on silverleaf whitefly, pest-suppressive landscapes, resistance monitoring, helioverpa egg lays, real time broad scale insect monitoring, and extension via the CottonInfo pest management short course.

Integrated weed management investments focused on guarding against resistance and spray drift; ensuring the industry can stay ahead of the weed evolution. This included a CRDC-supported study tour for growers to the US, membership of WeedSmart, new tools in the industry's arsenal for drift management, and continued research into temperature inversions. From an integrated disease management perspective, two new pathologists were appointed at the Australian Cotton Research Institute during this year, focusing on two CRDC-supported projects to conduct the national disease survey, and find innovative solutions to cotton diseases.

Incubating startups: new investment approach for CRDC

In 2016-17, CRDC began working in the entrepreneurial space with start-up science company Pollenizer, and its successor, X-Lab. CRDC's work to incubate potential cotton start-ups and entrepreneurs gained strength in 2017-18, with the continuation of the X-Lab partnership. In this year, CRDC invested in an incubator program, provided support to Startup Catalyst, sponsored the MIT-QUT bootcamp, solidified a partnership with X-Lab to provide a more innovation-driven approach to RD&E investments, and formed a strategic partnership with NSW DPI's The Gate. Work also began in this year on Startup Alley – a new initiative at the Australian Cotton Conference designed to showcase cotton specific entrepreneurs and innovations. One major RD&E outcome has already been delivered through this new investment approach, with CRDC investing in a new technology, Flurosat, which uses data analytics from drone and satellite imagery to assess plant health, diagnose problems and direct fertiliser application.

YEAR IN REVIEW

CRDC organisational highlights 2017-18

New CRDC Directors appointed

In November 2017, CRDC welcomed the appointment of three new Board Directors: Ms Rosemary Richards, Professor Les Copeland, and Dr Jeremy Burdon. The Directors join the existing CRDC Board: Chair Mr Richard Haire, Executive Director Mr Bruce Finney, and Non-Executive Directors Ms Kathryn Adams (Deputy Chair), Mrs Liz Alexander and Mr Greg Kauter. Two Directors completed their tenures with the Board in September 2017, and CRDC recognised their contribution to the cotton industry: Deputy Chair Mr Cleave Rogan, and Director Dr Michael Robinson.

Fourth annual Research Priority Forum identifies cotton RD&E priorities

CRDC's fourth annual research priority setting forum was held in Sydney in June 2018, bringing together cotton growers and industry supply chain members on Cotton Australia's research advisory panels to help determine the industry's future research priorities. The Forum is part of CRDC's procurement process, which was revised in 2015-16 to improve efficiency, streamline the RD&E investment process and provide greater clarity to researchers.

Collaboration: a key to cotton RD&E

CRDC partners in over 80 percent of RD&E projects conducted in the cotton sector, and in 2017-18, 40 percent of CRDC investments were in cross-sectoral RD&E. This includes international, national, cotton industry-specific and local initiatives – from international projects with our US counterpart, CottonInc; to national cross-sectoral partnerships on water and soils; to the industry-specific extension joint venture, CottonInfo with Cotton Australia and CSD; and at the local level, partnerships with CGAs on CRDC Grassroots Grants. CRDC also plays a strong leadership role in the cotton industry and the wider agricultural sector, with active involvement in the Council of Rural Research and Development Corporations (CRRDC); the Research and Innovation Sub-Committee of the Agriculture Senior Officials Committee (AgSOC); the National Primary Industries Research, Development and Extension Framework; and the Cotton Innovation Network, where CRDC collaborated with partners on the development of a vision for cotton RD&E capability.

CRDC RD&E showcased at industry events

CRDC-supported RD&E projects were showcased at the major research event, the Association of Australian Cotton Scientists' Australian Cotton Research Conference in August 2017, with 58 percent of speakers on the conference agenda supported by CRDC. RD&E also featured at the Cotton Australia Cotton Collective, held in Griffith in July 2017. CRDC also continued its support for the major industry event, the 19th Australian Cotton Conference, in August 2018.

Interactive digital dashboard for CRDC grower survey

The 2017-18 year marked 21 years of the CRDC Cotton Grower Survey, which gathers valuable information about cotton farming practices to give a greater understanding of the industry's performance. The survey provides important information to CRDC and Cotton Australia about the industry, on-farm practices, and priority areas for future research. For the first time in 2018, the results of the survey were published via a new online interactive digital dashboard: allowing growers to explore the data in more depth and to compare results across regions.

Extension of R&D outcomes to growers: CottonInfo connecting growers with research

CottonInfo's extension of cotton R&D to growers had three major focuses in 2017-18: managing irrigation to improve nitrogen use efficiency; tackling the increased threat of pests, diseases and resistant weeds in cotton growing regions; and identifying and managing soil constraints and optimising the efficient use of inputs. A major project for the team during the year was the delivery of the optimising irrigation and nitrogen researchers' tour, which saw 12 CRDC-supported researchers go on-farm with over 400 growers and consultants across the cotton-growing valleys.

For more information on all of these achievements and highlights, download your copy of our (soon-to-be-released) 2017-18 Annual Report or the Annual Report Grower Summary from www.crdc.com.au/publications.





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.

Subscribe to *Spotlight* today.

www.crdc.com.au

