Spotlight

ON COTTON R&D

Spring 2017

The IPM Edition:

Managing pests with no sprays

Think early for late season

Know who's on your team

Australian Government

Cotton Research and Development Corporation

Bruce Finney

In the Spotlight

It's time to welcome in the new season of cotton growing again, with some growers in the north already well underway with planting.

As this season begins, we reflect on last season and what we learned after a cold start in most regions, prolonged heat and high insect pressure.

In this edition, we are shining the spotlight on early season insect management and the benefits to growers of using integrated pest management principles. The cotton industry has invested many millions of grower and government dollars in to pest management and what we have now is one of the most robust systems in the world – we just need to make sure we stand by the results and implement this system.

Grower Andrew Watson and consultant Rob Weinthal share their experience in controlling pests without sprayed insecticides, which shows what can be achieved when we stick to the world class research from industry scientists. We also explore the issue of resistance and the role predators and beneficials play in pest control. Since its formation, CRDC has invested heavily in pest management research – with a focus on created integrated systems that are sustainable and work with the natural environment. We continue to do this through projects researching pest suppressive landscapes, pest ecology, novel soft treatment options and our resistance monitoring programs. I'd like to encourage all growers and consultants to adopt the findings of our research programs, to ensure we continue to be the best pest managers possible.

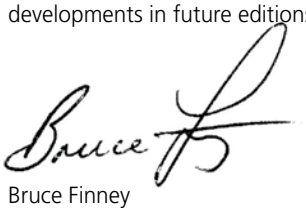
Additionally, CRDC is also pleased to present the most recent results of the Australian Cotton Comparative Analysis undertaken in co-operation with Boyce Accountants. This report reiterates that the 'top 20 percent farmers' are successful because they operate in some key ways: they pay attention to their operating costs, have consistent marketing strategies, invest in productive labour and reliable machinery, and use sustainable farming techniques. As the report shows, the lowest cost options can often have the biggest impact on the bottom line.

The report also highlights the role emerging technology is playing in improving efficiency, with irrigation being a stand out. We are pleased to see that research undertaken by CRDC and its partners is being taken up by growers keen to improve efficiency, yield and reduce inputs, in particular labour, water and fertiliser. I urge all involved in cotton growing to read the report in its entirety.

This edition we also introduce readers to some changes to the CottonInfo team as the industry continues to ramp up its capacity to meet needs in the areas of nutrition, weeds and irrigation management. Continuing to build our science capacity – be it in research, development or extension – is a critical component of CRDC's investments.

In 2017-18, these investments will equal $22.4 million invested across our research portfolio of farmers, industry, customers, people and performance; some 200 projects delivered in collaboration with our research partners and growers. And, our call for the 2018-19 funding round has just opened, with expressions of interest guidelines released for researchers to consider and respond to.

We're also thinking about the longer term success of the industry in developing our 2018-2023 Strategic R&D Plan. We have commenced consultation with stakeholders and will be incorporating the feedback, advice and input as the plan takes shape over the coming months. The plan will come into effect in July next year, and we look forward to bringing you further developments in future editions of *Spotlight*.



Bruce Finney
CRDC Executive Director

Spring 2017

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

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Want to see more of Spotlight?

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

Cotton News

Features

Fast Facts

$3159

The profit per hectare for the 'top 20 percent farmers' in the 2016 Boyce Comparative Analysis (page 10).

8.9

Bales per hectare is the yield required to cover growing expenses, according to the 2016 Boyce Comparative Analysis (page 10).

12

Years since grower Andrew Watson has sprayed for insect pests in his cotton (page 14).

52

Projects have been funded with CGAs through CRDC's Grassroots Grants program to date, representing a total investment of $466,000 (page 28).

Grow better with IPM courses

THE COTTON Pest Management short course is an interactive, thought-provoking workshop for cotton industry crop managers who want to better understand crop physiology and what it takes to implement effective cotton pest management.

The course will entail three-part training, held throughout the season consisting of:

Session 1: A two-day interactive classroom session.

Session 2: A half-day field session to apply our knowledge in the field – held mid-season.

Session 3: A half-day wrap up session to review what you have learnt.

The course will involve leading researchers and industry experts and cover:

- Cotton physiology 101 – really understanding a cotton crop.
- The insect pests and beneficials that affect our industry today.
- Insect sampling and plant monitoring.
- Pest control decisions and options.
- What influences the success of pest management in high yielding cotton?

The course will be held at Moree on August 21-22; Gunnedah on August 28-29; Burren Junction on August 30-31; Warren on September 13-14; and at Griffith on September 19-20. Numbers are strictly limited and registrations are essential, so register via your local CottonInfo REO now to avoid disappointment.

This initiative has been developed and delivered by CottonInfo and Tocal College, and made possible through funding from the NSW Government's AgSkilled program.

For more
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Or your local CottonInfo REO.

Accounting for natural capital

UNDER THE Government's Rural R&D for Profit programme, one of CRDC's fellow research and development corporations (RDCs) Forest and Wood Products Australia will receive $900,000 for a project to apply natural capital accounting on forestry, cotton and fisheries enterprises.

This investment, with additional support from the CRDC and other RDCs, will improve competitiveness, increase access to international markets and allow better risk and cost management across the industries.

Deputy Prime Minister and Minister for Agriculture and Water Resources, Barnaby Joyce, and Member for Lyne, Dr David Gillespie made the announcement in May, saying the project would apply the principles of natural capital accounting in each industry.

The Deputy Prime Minister said this project will give Australian forestry, cotton and fisheries producers the tools they need to incorporate the value of natural assets into their business systems.

"Many financial institutions are increasingly considering natural capital in their credit risk calculations, and offer lower interest rates for businesses that can prove they are managing their land and other natural resources well," he said.

Natural capital accounting is a way of calculating the value of natural assets like soil, air, water and biodiversity on cotton farms.

Dr Gillespie said natural capital accounting was an internationally recognised way of calculating the value of natural assets like soil, air, water and biodiversity, information which can then be incorporated into economic models and accounting systems.

The Rural R&D for Profit programme funds Rural RDCs to partner with researchers, universities, research agencies, funding bodies, businesses, producer groups, or not-for-profit organisations on projects that will deliver real benefits on the farm.

"Our funding for the $180.5 million Rural R&D for Profit programme is on top of around $700 million that the government already invests in rural R&D each year," Minister Joyce said.

Understanding cotton's biodiversity assets

CRDC PROJECTS have already begun as part of the Australian Government's Rural R&D for Profit programme *Increasing farm gate profits: the role of natural capital accounts.*

"This project will value natural capital on cotton farms as well as fisheries and forestry enterprises to demonstrate the sustainability of these Australian products," says CRDC R&D Manager Jane Trindall.

"Natural capital is a methodology, being used by retailers to source and compare the sustainability of raw materials globally," Jane said.

"It places a value on natural resources, such as soil, air, water, biodiversity and land - the natural resources used for food and fibre production globally.

"This project will test natural capital accounting in the Australian forestry, fisheries and cotton industries and case studies will be used in each industry to test natural capital methodologies.

"It is a universal measurement of the sustainability credentials of products, and it's important we understand the merits and limitations of the methodologies being applied and make any recommendations for their improvement."

The project is being under taken by CSIRO and Ecological Australia in partnership with Forest and Wood Products Australia and Fisheries RDC.

For this method to be applied, first bench marking and understanding the extent and condition of the natural resources the cotton industry utilises and accesses is required.

"A major outcome of this project will be an inventory of biodiversity assets associated with the cotton landscape in eastern Australia, as we compile existing information on vegetation communities within properties managed for cotton in Queensland, NSW and Victoria," Jane said.

"The project will provide a comprehensive database that documents the extent and condition of natural assets that industry utilises for the purposes of natural capital accounting. All data will be compiled as spatial data in a Geographic Information System (GIS)".

The first step for researchers is to review the methodologies and compile the information required, before looking for growers who may wish to be involved, by using their farms as natural capital case studies.

For more

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Cotton fibre on show in the capital

IT WILL be a community celebration in the Cotton Capital of Australia when Wee Waa in North West NSW hosts the Australian Cotton Fibre Expo in October, which is being supported by CRDC.

Expo president Melanie Moloney said the expo presented a fantastic opportunity to promote Wee Waa's rich cotton heritage, while bringing the whole community together. This year the committee is fundraising to provide a regular mental health service in Wee Waa.

The event will kick off with a cocktail party on Friday, October 13, including a silent auction, jazz music, trivia and a special guest speaker. On Saturday festivities begin with a big traditional bush breakfast at the Namoi Echo Museum with historical cotton displays, presentations and music. Wee Waa's main street will feature market day street stalls, and vibrant cotton fibre displays on trees and in participating store windows. The cotton fibre competition entries will be exhibited, and

Television personality Claudia Chan Shaw is a special guest at this year's Cotton Fibre Expo.

with prizes in eight categories, organisers are urging people to get their entries in.

Saturday afternoon it will be time for the Cotton Capital Country Music Muster at the showground, with music, camp oven cooking, camping and more into the evening.

The expo committee is welcoming contributions to this community based event and entries in the Cotton Fibre Exhibition. The expo website has entry details and categories.

For more
Melanie Moloney
0407 708 068
www.australiancottonfibreexpo.com.au

Building industry leadership

RICHARD MALONE from Griffith and Tim Chaffey from Quirindi have been selected to undertake one of the country's most respected leadership courses.

The Australian Rural Leadership Program is a 15-month program which takes place across Australia and overseas, immersing rural, regional and remote participants in a series of unique experiences to develop their leadership capabilities. Cotton industry participants are supported by CRDC, Cotton Australia and Auscott Limited.

"I would look around the board table,and it was full of graduates." – Mike Logan

The cotton industry and ARLP have a long history, both in support of participants and the many alumni who are so well known for their contribution to the industry, including Dave Anthony, Adam Kay, Harvey Gaynor, Bernie George, Paul McVeigh, John Hamparsum, Bruce Finney, Phil Armytage, Michael Murray, Dr Sharon Downes, Jamie Iker, Barb Grey and Arthur Spellson.

Past CRDC Chair and former Narrabri cotton grower Mike Logan was a graduate of the first intake in 1993. Mike says before being involved, he had no idea what the ARLP was or the contribution it would play in his personal and professional life.

"I discovered a whole world of agriculture, of people that were trying to do what I was doing.

"The impact the ARLP has had on leadership in agriculture has been evident, when I would look around the board table, it was full of graduates.

"From the cotton perspective, the ARLP has been a wonderful investment."

Broadening Holly's horizons

HOLLY CHANDLER says she has always been driven towards seeking a sustainable future for our planet, and believes agriculture provides a platform to which she can apply this passion for sustainable living.

Holly is studying agribusiness at Curtin University in her hometown of Perth and is supported by CRDC in a Horizon Scholarship. The Rural Industries Research & Development Corporation (RIRDC) Horizon Scholarship is awarded to first-year university students studying agriculture-related degrees. The scholarship, proudly supported by CRDC and other rural RDCs, provides $5000 per year for the duration of a student's university degree. The scholarship offers students industry work placements, access to industry leaders, professional development assistance and opportunities to network and gain knowledge at a range of industry events.

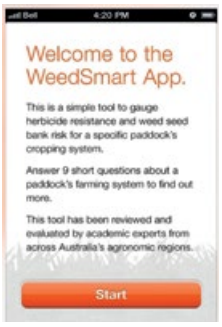
Holly's goal is to make a positive change to an industry which plays an integral role in everybody's lives. "The agricultural industry must be revolutionised by the next generation to contend with the growing demand for food. I hope to facilitate this adaption by using my degree to pursue a career in sustainable agriculture," she says.

"I want to be a part of empowering the upcoming generation to become better agricultural leaders for sustainability. I wish to further sustainable management within food and fibre industries to create a healthier future for our people and land."

Holly would also like to work on a smaller scale involved directly with the farming community.

"I'm keen to embrace the unique opportunities the Horizon Scholarship offers and in particular become more involved with industry professionals to gain industry knowledge and understand the current problems agriculture is facing," she said.

CRDC joins WeedSmart



CRDC HAS become a member of WeedSmart, an industry-led initiative to enhance on-farm practices and promote the sustainability of herbicide use.

Research partners, commercial organisations, government, advisors and growers have joined forces in WeedSmart to ensure best practice weed management is at the forefront of global farming practice. WeedSmart will support cotton industry initiatives such as the Herbicide Technical Panel and the Transgenic and Insect Management Strategic Committee (TIMS) who oversee stewardship and usage of over-the-top herbicides.

WeedSmart's on-line, 10 Point Plan provides practical tips and tricks to implement the strategies on-farm, along with further information on the research to back up these steps. The WeedSmart team works closely with the Australian Herbicide Resistance Initiative (AHRI) at the University of WA.

Users can subscribe to WeedSmart for free monthly updates, podcasts, advice and links to other useful tools and information, or download the app. The app has been reviewed and evaluated by a panel of academic experts from across Australia's agronomic regions. WeedSmart is also behind Diversity Era, an on-line training program.

A range of tools available to growers include CRDC's Cotton Industry Herbicide Resistance Management Strategy and the Glyphosate Resistance Toolkit developed by QDAF with support from CRDC. The WEEDpak Weed ID Guide and a range of publications are also available at the CottonInfo website.

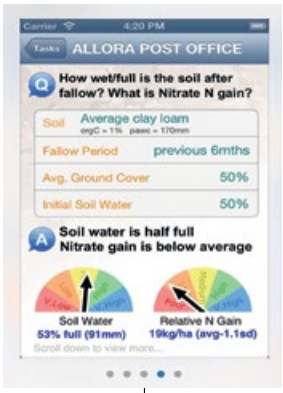
For more
www.cottoninfo.com.au
www.weedsmart.org.au
www.cottoninfo.com.au/resistance-toolkit

INDEPENDENT CONSULTANTS Australia Network consultant Mark Congreve, grower James Maunder and QDAF weeds researcher Jeff Werth at one of the recent CottonInfo Weed Management Workshops. CRDC is supporting the workshops like this one in Pallamallawa in the Gwydir Valley to give crop managers a chance to work closely with the industry's leading researchers and consultants to discuss their current management, weeds issues and how to manage them.

James farms near Pallamallawa and said the workshop was very worthwhile, as through the presentations and discussions he now has a clear understanding of managing herbicide resistance on his farm and the ongoing impact on the entire farming system if it continues.

Your new best mate

WITH THE new version of Australian CliMate app crop managers can access cotton industry decision support tools including CottAssist.



CliMate has been developed by the University of Southern Queensland for the Managing Climate Variability (MCV) program and builds on Bureau of Meteorology data from the Queensland Government's Silo database. CliMate is developed by climate specialists and supports informed decision making based on recent weather and long term climate probabilities.

The freely downloadable app allows users to quickly interrogate the last 65 years of daily rainfall, temperature and radiation data for a nearby Bureau of Meteorology station. Seasonal forecasts are provided based on current ENSO conditions. CliMate supports decision makers who require probabilities of weather events, seasonal forecasts, soil water and nitrate status drought status and climate trends.

New analyses include:

- Potential Yield: uses the French and Shultz WUE equation.
- Drought: provides a rapid assessment of drought status based on rainfall for specified "residence periods".
- Trend: allows for easy exploration of trends in weather variables.

To download the updated version: www.climateapp.net.au

Be rewarded for innovation

CRDC IS once again supporting the Department of Agriculture and Water Resources' Science and Innovation Awards, with applications for the 2018 round now open.

The Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry recognise big ideas from young rural innovators that contribute to the success of Australia's agriculture sector. Postdoctoral fellow Priscilla Johnston of CSIRO Manufacturing was the 2017 recipient, and is researching the use of polymers to improve water use efficiency and lower water requirements for cotton establishment.

CRDC supports and rewards scientists, like former awardee Dr Alison McCarthy, for their exploration of concepts and creation of new knowledge in the pursuit of scientific breakthroughs. Alison, who also received the prestigious Ministers' Award, is developing an integrated image sensing system for soil-water and nitrogen levels in cotton crops.

CRDC is encouraging interested researchers to apply. The awards aim to encourage science, innovation and technology in rural industries and help to advance the careers of young scientists and innovators through national recognition of their research ideas.

The Science Awards have already helped more than 210 young Australians make their ideas a reality and showcase their talent to the world.

CRDC Executive Director Bruce Finney, Priscilla Johnston and CRDC Chair Richard Haire.

For more
www.agriculture.gov.au/scienceawards

Past CCA president and long-term board member, Iain Macpherson of MacIntyre Independent Agronomists was presented with life membership to the association by currrent president Stuart Doyle at the Moree seminar recently.

CCA sees strength in numbers

CLOSE TO 140 agronomists, researchers and other industry members gathered in Moree on July 18 and 19 for the final Crop Consultants Australia Cropping Solutions Seminar for 2017.

Organisers say they were very happy with the calibre of the speakers and the strong support from industry and consultants, new and 'old'. The meeting included the CCA AGM, with minor changes to the board and some new faces as well.

The group farewelled Kieran O'Keeffe after two years on the board representing the southern growing areas. Kieran has played a valuable role in CCA, and is also the Southern region's CottonInfo Regional Extension Officer. Stepping into the role is a new face, Griffith consultant Matt Watson (On Point Ag). Stuart Doyle (AgVista, Moree) was re-elected as president and he is joined by Jamie Iker (Spackman Iker, Emerald), Tim Richard (MCA, Goondiwindi), Liz Lobsey (Meteora, Dalby), Ben Dawson (B&W Rural, Collarenebri) and Bill Back (Auscott, Narrabri).

CCA had the opportunity to acknowledge two industry members who have made significant contributions to both the organisation and industry as a whole. Past president and long term board member Iain Macpherson, (MacIntyre Independent Agronomists) was presented with life membership of CCA. Entomologist Hugh Brier (QDAF) was also presented with honorary membership for his ongoing contribution to industry research over the years and his support of CCA and its members.

"We had some really good feedback around our line-up of speakers and the discussions this year," president Stuart Doyle said.

"Our board works really hard to prioritise and tailor these seminars to the needs of industry."

Presentations from the seminar are available from the CCA website, and the CCA regular column features on Page 34 of this edition.

CRDC partners with Startup Catalyst

STARTUP CATALYST conducts missions to international startup hotspots for tech-savvy youth. Each year, they take Australia's most high-achieving future leaders (aged 18 to 29) on a fully-funded, 10-day mission to Silicon Valley in the US, to fundamentally reprogram the way they see the world, and the pace and scale at which they operate, inspiring the next gen of global tech business leaders.

In a new partnership, CRDC will support a scholarship position with Startup Catalyst. If you're tech savvy, aged 18-29, have an interest in entrepreneurism, leadership potential and can demonstrate a benefit back to cotton, agriculture or regional Australia, then appy now.

For more
www.startupcatalyst.com.au/missions/youth-missions/

Professor Xungai Wang, Dr Nolene Byrne, Dr Rebecca Van Amber, Dr Rangam Rajkhowa and Dr Christopher Hurren have won a global award for their ground-breaking research into denim production.

In-jean-ious research takes global award

AUSTRALIAN COTTON industry researchers have scooped an international prize and 150,000 Euros for their innovative work on reducing the environmental impact of denim production.

The researchers from Deakin University's Institute for Frontier Materials (IFM) were one of five winners out of nearly 3000 entries world-wide in the H&M Foundation Global Change Award, which provides funding for projects that promote sustainable fashion.

"We are absolutely delighted with the award as it reinforces the need for the work we've been doing and highlights the significance of the work for not only the cotton industry but also the environment," lead researcher Professor Xungai Wang said.

"We are also very grateful for the initial support from CRDC for our work in this area, as it supported a small desktop project at Deakin on *New Developments and Opportunities for Cotton Yarn and Fabric*, back in 2013.

"Through the project we did some literature study on the issues with denim products and this study has been quite helpful, providing useful background information for us."

More than 450 million pairs of denim jeans are sold globally each year and the retail jeans market is expected to reach US$56 billion by next year. Roy Morgan Research has found 1.7 million Australians are buying at least one pair of jeans in any four-week period. Jeans are the most popular clothing item on the planet, but come with a hefty price tag for the planet. On average, the life cycle of one pair of denim jeans produces over 30 kg of CO2 and uses around 3500 litres of water.

Professor Wang, Dr Rangam Rajkhowa, Dr Nolene Byrne, Dr Christopher Hurren and Dr Rebecca Van Amber developed their idea as denim is one of the most widely used textiles in the fashion industry. However the traditional process of dyeing denim requires large amounts of water and energy, and produces substantial amounts of dye waste.

By grinding used denim to create an ultrafine powder, the researchers then use the product to coat or print undyed new denim to create the typical denim appearance. A successful prototype has already been developed and using the Global Change Award will scale up the idea and work with denim producers and fashion brands to explore its potential for the fashion industry and environment. The process is unique in that it not only recycles the fibres, but also the dye. This approach will also have major implications for other textiles and applications.

Xungai, Ragnam and Nolene have current textile-related projects with CRDC. Xungai's project is looking at improving the quality of cotton yarns, which he says may have "significant implications for the cotton spinning sector".

"We are currently in the process of preparing a patent to protect the IP generated from the project," he said.

For more
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The best are getting better

The 2016 Australian Cotton Comparative Analysis (ACCA) is the twelfth report produced by Boyce Chartered Accountants in conjunction with CRDC.

As many growers look to alter irrigation techniques through automation, the Boyce report says technology adoption needs to be framed initially around ongoing cost minimisation or yield maximisation, and secondly from the point of view of the initial capital cost and other benefits. Cotton industry research shows there are various methods to improve water use efficiency and it's critical to implement the best one.

THE PRIMARY purpose of the ACCA is to show the income and expenses associated with growing fully irrigated cotton on a per hectare and per bale basis.

It presents an analytical review of the 2016 results, a comparison with prior years, and comments on emerging trends. The latest analysis sees some new, informative information. Not only are per bale figures included, but also research from industry experts and correlations between different fields of study and the numbers in this analysis. The report outlines long-term trends using Boyce's 30 years of data. To analyse the industry over three decades using the same metrics provides valuable information with which to consider where the future will take the industry.

It was another excellent season for the 'top 20 percent farmers', with profit of $3159 per hectare. This was down on last year but still well up when compared to five-year average of $2272. Interestingly, the 2016 result was a combination of a reduction in yield, price and total expenses from the previous year.

"In our view, the main focus for growers has to be the low cost options that have the biggest impact on the bottom line," Boyce's Paul Fisher said.

"While this may be self-evident, it deserves some serious structured and documented thought by the industry.

"This study has shown that being in the top 20 percent is predominately driven by yield, so 'how can I improve yield as cheaply as possible?' should be a well-considered question, and one which has been raised before.

"Specifically though, in 2016, if you look at the increase in expenses that was not specifically driven by yield, how much of that contributed to yield?"

Many growers in the industry are currently evaluating different irrigation techniques. Paul believes this evaluation is being driven by the decision making process in new areas which then impacts on the more established valleys, labour shortage and farms that require re-lasering and earthworks.

"As with any adoption of new systems and technology with large upfront costs, it will be important to analyse what others have done and what results they are achieving," he said.

Although there was an increase in total area planted and grown in 2016 compared to 2015, most of the traditional areas again had reduced hectares.

"In our view this has had two impacts on the numbers, firstly, the overheads in traditional areas remain high due to reduced hectares and secondly, the overheads of growers in newer areas are also high as they establish themselves in the industry," the report says.

"The traditional cotton growing areas continue to be impacted by lack of stored water that would allow more than one year of full production. As discussed in previous years' analyses, this is having a negative impact on profits and, following on from that, farm infrastructure."

The 2017 production was estimated at 4.2 million bales on plantings of 470,000 hectares, of which 77 percent was irrigated. The ongoing business question is then one of trying to grow similar hectares each year versus maximising yearly production when the water is there.

"The reduced average yields that we will see

when this 2017 season is finalised remind us that variable weather is a huge factor in the yearly success (or otherwise) of a crop," Paul said.

"The ability to find the 'sweet spot' between doing the same thing each year and being quick on your feet in adapting to different years is critical."

With profit per hectare of $1706, the 'average farmers' were slightly lower than last year's $1899, but much higher than the five-year average of $1106. Based on these figures, a yield of 8.9 bales per hectare is required to cover total expenses, a figure which (worryingly) continues to grow.

Among the top 20 percent:

- Yield (13.69 bales per hectare), decreased approximately half a bale per hectare from 2015 was (14.31 bales per hectare).
- Interestingly, operating costs for this group fell by $139 to $3923, which is $194 above the five-year average.
- This group continues to grow more cotton (.7 bales per hectare) than the Average Farmers and they also do it more cheaply ($3923 v $4500).

Technologically advanced

The report shows the cotton industry continues to be an early adopter of technology.

"At the industry level, this is a tremendous positive as it shows the innovation that has driven the industry," Paul said.

"As with any adoption of new systems and technology with large upfront costs, it will be important to analyse what others have done and what results they are achieving..." ***- Paul Fisher***

"However from a profit perspective, individual growers need to know where their profit comes from, as the early adoption of technology at the micro-level is not always conducive with maximising profit.

"We believe each technology adoption needs to be framed initially around ongoing cost minimisation or yield maximisation, and secondly from the point of view of the initial capital cost and other benefits.

"This equation needs to be kept in perspective but the answer could be different for each grower.

"I think the smart operators are spending money where they know it counts – to ensure they grow more yield or to reduce expenses (categorised between direct and overhead). They aren't spending where it's not required.

"Technology is a biggie – for example spending money and time to accurately find out which parts of the paddock are performing, why and what can be done to rectify if they aren't, is critical and in this case variable rate technology just makes sense.

"Changing irrigation methodology is a big decision - significant capital outlay is required, so this decision usually takes place in setting up a new operation or where fields need relasering.

"Cotton industry research shows there are various methods to improve water use efficiency and it's critical to implement the best one."

New developments

The analysis also highlights emerging trends or management issues in the Australian cotton industry.

An indicator of growing herbicide resistance is the cost of chipping weeds increased slightly in 2016, as resistant weeds increasingly need to be manually controlled. The use of old harvesting technology continues to decrease, although, the report says, it should be noted that if pure profit was a motive, old technology would be more prevalent. The cost of herbicides and insecticides (license fees and chemicals) both continue to rise at significant levels (16 and 22 percent from last year's figures).

"In terms of insecticide use and insect pressure, this could be a product of growers taking crops later into the season searching for more yield," Paul said,

"While growers continue to effectively 'outsource' or 'buy' products and expertise from various providers, growers must continue to monitor the profit motive.

"From a classic economical point of view, a farming operation with everything outsourced would technically make no profit!"

The 30-years of analyses gives industry some salient points to consider.

"We recommend that growers spend some time thinking about where the industry is headed in an attempt to be ahead of the game in the two main areas that impact profit – maximising yields and ensuring costs are at a minimum," Paul says.

Some interesting trends from 1997 to 2016 continue to emerge, including:

- The trend line in growth of cost per hectare continues to rise.
- Although the yield per hectare fell for the 'top 20 percent farmers', the upward trend continues. The term 'statistical yield' indicates a fixed ceiling beyond which yield cannot exceed. Without further plant development, this would be a worrying prospect, especially in light of continuing cost increases. Continuing development means that statistical yield is a moving target, but it's important to note that we are tending towards a maximum yield, whereas there do not seem to be similar cost constraints
- This year's reduction in profit per hectare for the 'average farmers' and the 'top 20 percent farmers' sees some downward pressure on the profit trendline. However, the industry must be realistic that profits will vary based on seasonal conditions.

The two statistics of relatively static price per bale and increasing costs per unit of inputs acquired confirm the decreasing terms of trade for the industry. Increased profits for the industry are coming from efficiency (less quantity of inputs) and increased yield.

In addition to its support for the ACCA, CRDC also supports industry surveys through its cotton grower survey which covers growers' views and practices annually. CRDC seeks growers' feedback on weed, pest and disease control, pesticide management, irrigation technologies, NRM, on-farm training needs and cotton to market. CRDC also supports the Crop Consultants Australia annual survey, which provides another invaluable source of information for CRDC to base investment planning and priorities around.

For more

Download the ACCA at www.crdc.com.au

The ability to find the 'sweet spot' between doing the same thing each year and being quick on your feet in adapting to different years is critical.

Depth and breadth of talent on display

THE AUSTRALIAN Cotton Industry Awards have once again highlighted the breadth, depth and passion of people the industry.

More than 380 cotton growers and industry representatives gathered to celebrate the recipients of the 2017 Awards in Griffith, southern NSW, in late July. It's the first time the awards have been held in the south. The southern region also featured when Cavaso Farming at Darlington Point were named Grower of the Year.

CRDC's Bruce Finney congratulated researchers of the year Dr Paul Grundy and Dr Stephen Yeates, who were nominated for their CRDC research project in Central Queensland which aimed to work with growers to trial planting methods and dates to avoid monsoonal weather at the back end of their season. This work has led to yields increases of up to three bales/ha with significant improvements in quality and colour. This has had a profound impact on the manageability and profitability of cotton growing in this region.

"To see this result in a three-year project is very impressive," Bruce said.

"With more than 40 years' research experience in varied cotton research between them, Paul and Stephen have so much to draw on, and it shows through their work."

By taking the approach of what they describe as "learning to think like a plant" they are fundamentally changing the philosophy of cotton production across the cotton industry, whether it be in northern Australia, established cotton production valleys, or the newer southern production systems.

Some of the Australian cotton industry's shining lights: Michael Bennett, Fiona Norrie, Mark Cathcart, Cotton Australia's Adam Kay, Steve Yeates, Paul Grundy, Matt and Daisy Toscan.

"We had a substantial number of strong nominations for the Awards program this year, and all are deserving in many ways," Cotton Australia CEO Adam Kay says.

"I know the judges found it very difficult to select recipients from the finalists, all of whom have contributed greatly to our industry.

"The Australian Cotton Industry Awards are an important way of showcasing those who are achieving great things, and also a way of discovering new ambassadors for the industry."

The awards formed a part of the two-day Cotton Collective Industry Forum (held every second year), which covered the basics of cotton growing right through to the technology and connectedness in agriculture for 'smarter' farms. A significant portion of the Collective's agenda was devoted to issues important to new growers.

"This year's program and speaker line-up was extremely diverse, giving attendees a broad variety of topics covering many issues affecting cotton growers," Adam said.

Speakers were varied, with growers, researchers, retailers, industry leaders and post-farm gate specialists enlightening the 500-strong collective crowd.

The 2017 Australian Cotton Industry Awards recipients:

Monsanto Grower of the Year:
Cavaso Farming – Tony, Joyce, Matt and Daisy Toscan, "Cavaso" Darlington Point, NSW.

AgriRisk High Achiever of the Year:
CSD Farming - Mark Cathcart "CSD Farms", Wee Waa, NSW.

ADAMA Chris Lehmann Trust Young Achiever of the Year:
Fiona Norrie, Moree, NSW.

Cotton Seed Distributors Researcher of the Year:
Dr Paul Grundy and Dr Stephen Yeates, QDAF, Toowoomba & CSIRO Ayr, QLD.

IPF Service to Industry Award:
Michael Bennett, "Killowen", Narromine, NSW.

For more
www.australiancottonawards.com

What whitefly?

Cotton grower Andrew Watson has never sprayed for silverleaf whitefly or had an infestation reported on his farm. He also hasn't sprayed an insecticide apart from trials on his cotton in the past 12 years of cotton growing on the family farm east of Boggabri in the Namoi Valley. The aim of his management style is to protect and build up populations of beneficial insects and other predators on his farm as a way to manage pests.

It's been so long since Andrew has used insecticides he says he's doesn't even know what insecticide does what these days. Not only has he not had whitefly problems, he hasn't seen a green vegetable bug for around six years and hasn't seen a mite since the days of conventional cotton. In this past season of high insect pressure across all valleys, Andrew didn't record any pests that were over threshold.

But these results aren't just a case of parking the tractor and not spraying anymore.

Simply put – "We don't spray because we don't go over thresholds, and I put a lot of this down to preserving our beneficials and other predators," Andrew says.

"If I were to go back 12 or 13 years ago when we started counting insect pests and beneficials and were going no spray, we saw mirids and green vegetable bugs regularily in our check sheets – I haven't seen a vegie bug in about six years and we don't see reports of pests above threshold, yet we did when we first started."

Andrew works closely with consultant Rob Weinthal, and over time they have seen higher levels of beneficials, but not always the same species. Some years they have higher levels of ladybeetles or red and blue beetles, and other years like last year, they saw high numbers of spiders, but, Andrew said, the general trend is more beneficial insects overall.

"I don't know if we've got enough data to draw straight conclusions about where these predators come from but I do recognise that they are having a positive effect on pest numbers, so must be preserved."

What is interesting about Andrew and Rob's management style is that they are seeing results at other farms they have recently become involved with which don't have the no-spray history "Kilmarnock" has.

"We are running these farms, one on a relatively tree-less plain where farmers are spraying around us and we're not finding anything significantly different there in terms of the need to spray. "Beneficial numbers were a week or two later to swell in numbers than the country with more native vegetation surrounding it, but that might also have related to a later planting date and later cotton development."

Andrew encourages crop managers to trust industry advice and guidelines when it comes to IPM, and cited silverleaf whitefly as an example of what can happen if they don't.

"What we're seeing in the industry at the moment with whitefly is exactly what the researchers said would happen if we spray early in the season – there would be increased pressure from silverleaf whitefly and further pressure on the chemistry that seeks to control them," he said.

"While we've never sprayed for them here, we do see whitefly, and this year despite not spraying there has been no effect on our colour grade, with 70 percent 21 or 11 for colour, and very little honeydew mould visible pre-harvest."

Working to industry pest thresholds and understanding the plant's ability to compensate from damage is integral to IPM. According to the most recent (2015-16) Crop Consultants Australia Qualitative Report, 38 percent of sprays were below industry mirid thresholds. Where the decision to control mirids was not in line with industry thresholds, the main reason was to coincide with timing of another operation.

"I think in a lot of cases growers are nervous about trusting the thresholds allowing for the crop's ability to compensate for early season damage," Andrew said.

"It's especially important when considering that first spray of the season, which is often for mirids, because once you are on the spray train it's hard to get off.

"We also know that lay-by or prophylactic sprays are a leading cause of resistance and bad for beneficials.

"If we see mirids in numbers we pretty much hold fast through the first wave, but then they seem to die away, and our yields aren't suffering as a result.

"We've never seen an infestation of SLW, which I put down to natural control of SLW."

"This season is the closest we came to spraying mirids but up until the start of December the plants were mainly growing only vegetative nodes anyway.

"There were very few fruiting branches which we believe was pretty well a result of the very cold start to the season, not insect pressure.

"As we couldn't change the weather we just waited and in a couple of weeks our retention was climbing up."

Andrew also has his own thoughts on mirids and yield.

"Years ago Ben Stephens from Auscott said to me he wasn't sure mirids were actually a yield vector, and we have taken that statement to heart and really looked to see whether damage from mirids actually reduces yield, given any cotton plant will naturally throw a significant proportion of its fruit off," he said

"This question goes to the heart of whether a cotton plant can compensate for a range of different causes for fruit loss, from climate to nutrition as well as insect damage."

Andrew's key points to a successful IPM system

- Consider very carefully your first spray - once you start on the treadmill you interrupt the beneficial building and don't get the effect at the end of the season with SLW and other pest control. We don't spray insecticides any time and have never seen an infestation of whitefly.
- Don't spray below thresholds – give beneficials a chance to build up.
- Cotton can compensate from some early damage, understand what researchers are saying about how much damage can be sustained without yield penalties.
- Appreciate the role of native vegetation. We believe it is good to have trees, shrubs and grass nearby as sources of beneficials, including birds and bats.
- Some assume when they see patches of pests like mirids in fields they will become widespread – but I don't agree with that – we always look at the average across the field – look at averages not patches.

Stick to the research, trust the plant

Trust in the research and trust in the plant is what RAW Agriculture's Rob Weinthal says are key to managing insect pests in cotton, yet he appreciates that, from a consultant's perspective, sometimes the toughest decision is the decision to do nothing at all.

Rob is a consultant working out of Gunnedah, and has been growing his own cotton for the past three seasons. He's been a proponent of the concept of growing cotton without insecticide sprays, having worked closely with Andrew Watson at "Kilmarnock" Boggabri (see previous article) overseeing the no spray policy on his farm for the past eight years.

Rob has seen first-hand what can be achieved on both Watson's and now other farms, with careful crop monitoring of all insects and the plant itself before making any decision to spray. Sticking to what the research says around thresholds and understanding what type of damage each pest does to the plant, and the ultimate effect on yield and quality, is also crucial.

In the high insect pressure season last year, Rob put one spray over 70 percent of all his clients' cotton crops in the Gunnedah and Boggabri regions, but says in hindsight he's not certain it positively contributed to final yields.

"After the slow start last season with near record cold shock events our crops were very late fruiting, and with increasing mirid pressure we put on the lowest rate of Shield in late January across 70 percent of the crop, which is more insecticide than I've applied to my clients' crops over the last three years," Rob said.

How pests are handled at the start of the season sets the tone for the rest of it and the impact pests can have as the season progresses. Understanding plant physiology is a big factor in Rob's management style and suggests consultants and growers need to be very attentive and read the cotton plant correctly.

"It's not just about counting good bugs from bad, fruit has to be counted as well before making any pest control decisions, and in an overwhelming majority of situations, our modern varieties are out-fruiting any damage inflicted by insects.

"When it comes to insect control, I look at the cost benefit and effect on our IPM – if fruit numbers are increasing week on week in the presence of insect pests, why are you spraying?

"If you are seeing damage, are the vegetative or fruiting branches being affected? Is the damage just cosmetic or is it affecting fruit production?

"We've got some of the best researchers anywhere in the world in our industry who have done the work for us, we just

need to follow the guidelines.

"Dr Mike Bange's comments that pre-flowering retention is not the be all and end all, for my mind is 100 percent correct - the cotton plant can re-direct its assimilates to remaining fruit like no other plant, so it comes down to total fruit numbers, not where the fruit is on the plant."

Insect control can also be very costly, and protecting yield at any cost is unsustainable. Rob feels we should be taking better advantage of the IPM qualities already inherent in Bollgard varieties.

"We are already paying over $300 a hectare for insect control in Bollgard," he said, "and I see Bollgard as an IPM enabler, so why aren't we trying to maximise the return on what we are already spending by avoiding unnecessary or prophylactic sprays?

"High-yielding, quality crops can be grown without pesticides, and I'm seeing this in both my clients' and my own crops.

"Implementing a no-spray policy doesn't mean we aren't open to the concept of it, that's not the issue, we are just managing our crops by following IPM guidelines.

"Seeing the benefits doesn't just come with farms with years of no-spraying either – I'm seeing that the same results can be achieved in the first year when early sprays and hard chemistry are avoided, coupled with careful plant and insect monitoring."

Diverse system

"The strength of the system is the diversity of the insects in it and we've got to keep this system strong," Rob says.

"This has never been clearer than recent seasons with the march of mealybug, as we are relying solely on beneficial predators to control them, so we need to maintain beneficials and predators in our crops and landscape.

"The silverleaf whitefly situation is enough of an indicator as to what happens if guidelines are not adhered to, and if we run out of control options the outcome doesn't bear thinking about.

"The science and research foretold what could happen, and it nearly has.

"We've got to get over the use of prophylactic sprays, spraying below thresholds and using hard chemistry early."

Insects such as Rutherglen bugs and thrips aren't really on this consultant's radar, as he understands the effect they have on yield and their role when looking at the system from an IPM perspective.

"I don't understand spraying for adult Rutherglen bug because you need to use broad-spectrum, hard chemistry and the damage adults cause is negligible at worst," Rob said.

"Granted that nymphs can wipe out a young crop, I can't bring myself to spray for adult bugs.

"In relation to mites, we're seeing abemectin resistance increasing and prophylactic sprays still going on for control which I really don't understand.

"And in terms of controlling mites, you have to ask yourself, 'what is the key predator of mites?' and it's thrips, yet people are spraying for them when often they will not cause any yield penalty, thus taking out one of the biggest control methods.

"Thrips are like building blocks and normally the first pest you see in Bollgard crops, but they are also a key beneficial: and once you spray them you have taken out a potentially useful insect and are on the spraying merry-go-round for the rest of the season.

"Mite resistance, silverleaf whitefly, and mealybug - all three are real threats to industry.

"I saw the last few years of conventional cotton, and I don't want to go back to 15-spray seasons.

"The cotton industry has been down this path before – why are we seemingly trying to do it again? We've got to get away from the perception that things get bigger and better by doing more, spraying more.

"It's a false dawn – there won't always be a chemical option. Further to this you've got to ask yourself about the economics and cost of unnecessary sprays, as protecting yield at any cost is just not understandable as it's not economically sustainable.

"If I can personally grow a crop with just one spray and still achieve a ginned average of 12.1 bale per hectare in the season that just was, I think that is a pretty good indicator that we're doing something right, and at the same time preserving the longevity of our insecticides and resistance management strategies."

Rob's key IPM tactics

- Track fruit numbers weekly – factor this into your decision making – "What's the point in spraying insects for the sake of spraying insects if they aren't doing any damage?"
- Count beneficials, spiders and beetles.
- Have faith in the plant and control the controllables such as water and nutrition – "Irrigation, environment and nutrition will make you more dollars if you keep the plant healthy and looking after itself."
- There are too many upsides not to do practice IPM and in particular avoid early season sprays.

For more
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Think long-term early for SLW later:

When we kill natural enemies we inherit their work

Early season disturbance of beneficial insects and predators can have a huge impact on silverleaf whitefly (SLW) numbers. The most effective way of decreasing insecticide use against SLW is implementing early season integrated pest management (IPM) tactics that are mindful of minimising disruption to natural enemies.

Through recent research CSIRO's Dr Lewis Wilson and his team found that field factors were causing up to 90 percent mortality of SLW nymphs before they reached the adult stage, and 70 percent of these losses were attributable to the action of various natural enemies.

Taking into account the results that Lewis and his team found for SLW survival the above simple mathematical model shows how differences in SLW survival between each generation can have a major influence on future populations. Importantly the timing of disruption can have a major bearing on population build-up. For example, disturbance of beneficials during the first two generations of SLW with a broad spectrum insecticide (equivalent to two sprays before 14 nodes) followed by no further disturbance has as great an impact on SLW population build-up as going soft early and then disturbing beneficials during the last three SLW generations.

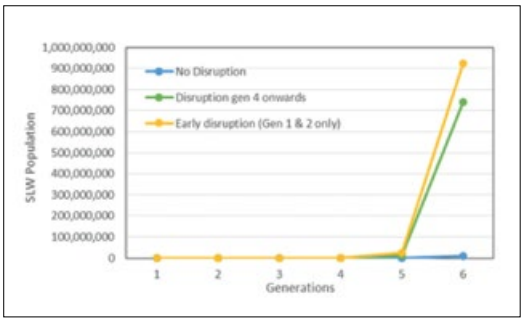
"The thing to keep in mind is that SLW numbers in the field during the first two generations would be barely detectable with regular sampling and therefore not really front of mind," co-researcher Dr Paul Grundy of QDAF, said.

"The future impact however gets locked in. When this early disturbance of beneficials is combined with further insecticide usage later in the season there is the potential for explosive changes in the SLW population dynamics which is what we saw in many fields during the 2016-17 season.

"SLW typically have an exponential rate of population increase and the numbers present in the field at generation five belie the massive change that is about to occur on the way to generation six.

"This is why many people experience what could be described as a population explosion in a matter of weeks."

Management of SLW in the absence of natural enemies will fail as insecticides alone are not sufficient to deal with a pest with such a rapid ability to breed. This is why pyriproxyfen is such an important insecticide tool as it exerts excellent control on SLW while being very selective, leaving natural enemy populations intact allowing them to continue their work mopping up survivors. This is critical with the spectre of increasing resistance as we need to give natural enemies the best chance of being able to eliminate potentially resistant individuals that might survive a pyriproxyfen application.



Modelled impact of early season disruption on SLW population numbers. Assumptions: No disruption - 10% SLW survival between generations due to natural mortality. Early disruption – Gen 1, 2 40% survival, Gen 3-6 10% survival. Disruption gen 4 on – Gen 1-3 10% survival, Gen 4-6 40% survival. (Paul Grundy QDAF)

"The best way to build up natural enemies is to take advantage of the ones that nature provides for free provided that we look after them," Paul said.

"When we kill natural enemies we inherit their work.

"The best way to conserve natural enemies is to take an IPM approach across the farm.

"This entails treating all pests only when they reach threshold and when an insecticide is required consider the true cost of some of the seemingly cheap but broad spectrum options.

"Synthetic pyrethroids and dimethoate might be inexpensive additions to a spray tank but the loss of natural enemies with these products and resultant pest flares are part of a very significant set of hidden costs."

Practical tips for managing SLW

- Consider the impact early season spraying has on disrupting beneficials. This especially includes adding insecticides with over the top glyphosate applications for pests that are below thresholds but the addition of products is driven by operational efficiency. These sprays are likely to induce the need for additional spraying down the track all of which costs money and increases the risk of pest resistance. If an early insecticide is warranted, consider spray oils or products that are soft on beneficials and will suppress SLW

- Use pyriproxyfen once and within the new 30 day window that will apply in each region (see TIMS Advisory).
- Follow the SLW Threshold Matrix and IRMS when making control decisions – refer to the updated information in the *2017-18 Cotton Pest Management Guide*.

Regional challenges in IPM

The growing conditions found in the southern cotton production regions present a different set of challenges to other valley's when it comes to implementing IPM. The southern region has a large geographic footprint and is climatically diverse, with a defining factor being the shorter growing season.

With a shorter window for flowering the southern region needs to take full advantage of this period to maximise yield potential.

Growers and consultants are trying to better understand the complex early season interactions between climatic stress factors, plant physiology and pest impacts and how these influence the rest of the growing season. A key challenge has been to understand the impact that early season square losses might have on crop yield and maturity, and whether the causal factors for low retention are pests, the environment or a combination of both.

Thrips

Thrips have been a commonly targeted seedling pest of cotton in the southern cotton growing districts. Thrips feed on growing terminals causing leaf distortion and sometimes death of the terminals. Heavy infestation may result in yield loss and maturity delay.

A CRDC project led by NSW DPI's Sandra McDougall is assessing the suitability of current industry spray thresholds for thrips, currently set at 10 thrips per plant and greater than 80 percent leaf area loss between emergence and the six leaf stage.

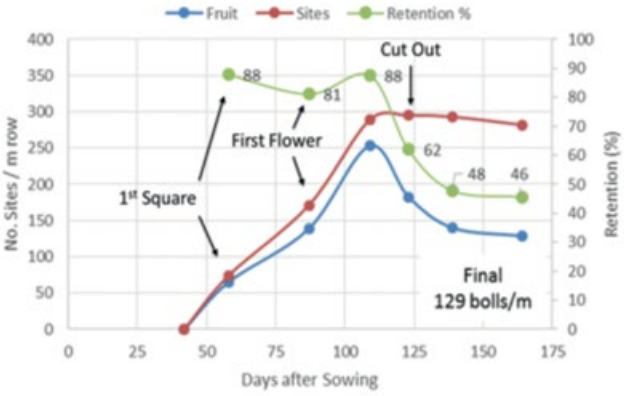


Figure 1. Retention in Sicot 74 – 9.5 plants/m, 32 sites/plant, 13.6 bolls/plant – 14.2 b/ha (Paul Grundy QDAF)

Dr Mike Bange literally taking science into the field explaining plant physiology, compensation and thresholds. Understanding the physiology of cotton plants is crucial in any pest management system.

Trial treatments were an unsprayed control, a threshold of one thrips per plant and the industry threshold of 10 per plant. Thrips numbers did not reach the industry threshold in any of the three treatments. The positive control treatment reached the one thrips per plant threshold at two of the three sites and was treated with fipronil. At seven nodes there was a four percent difference in average height at one site between the unsprayed and sprayed but no difference in leaf area or dry weight. At approximately 100 days after emergence there was no difference in height, node number, leaf area or dry weight. Over the three seasons, no significant difference in yield between the different thrip threshold treatments has been measured.

As part of this research, a cotton defoliation (manual removal of leaves) trial that aimed to simulate more severe thrips damage did result in crop maturity delays for the 100 percent defoliation treatment at two, four and six-leaf stage compared to no defoliation in all three seasons of the trial.

High numbers needed for damage

In 2015-16 a yield penalty of three bales per hectare was seen in the 100 percent defoliated treatment. In the 75 percent defoliation treatment (similar to leaf area of a clubbed leaf), no maturity delay was seen and yields were not significantly different. This research suggests thrips need to be in very high

numbers and causing significant damage in order to cause a delay in maturity or yield reduction even in the south.

Thrips management

When using the industry thrips threshold, it is important to look at what other crop stresses may be occurring. If high thrip pressure in seedling cotton occurs with other plant stress such as cool (or extremely hot) temperatures, waterlogging or seedling disease, then control may be warranted. However a healthy seedling crop, in good growing conditions should be able to withstand very high thrip pressure with no delay in maturity. It is also important to remember that thrips are excellent predators of spider mites.

If control is warranted, there are unfortunately very few selective options available that will help preserve beneficial insect populations. Consider leaving some fields or areas of the farm untreated. This will provide a refuge for beneficials to survive in, and then move back into the sprayed area following treatment. Remember, early season disruption reduces beneficial numbers, meaning you are more likely to have to continue spraying during the season for other pests, particularly silverleaf whitefly. Once you are on a spraying treadmill, it is difficult to get off.

Impact of early season retention

The 2016-17 season across most growing regions had high early season pest numbers, cool temperatures and reports of low early season fruit retention were common. Low, early season fruit retention can be worrying for crop managers, yet the ability of a plant to compensate should not be underestimated.

Dr Paul Grundy demonstrated this ability through trials in Central Queensland, where data being collected to look at crop climate responses also demonstrated the ability of crops to recover from extensive early season damage.

In two trial crops during consecutive years which experienced 25 to 35 cold shocks leading up to squaring, early season retention was 88 percent and 51 percent, however by the end of each season, final boll counts were very similar. These figures are an example of a high yielding cotton crop's ability to compensate for early square loss, be it environmental or insect related.

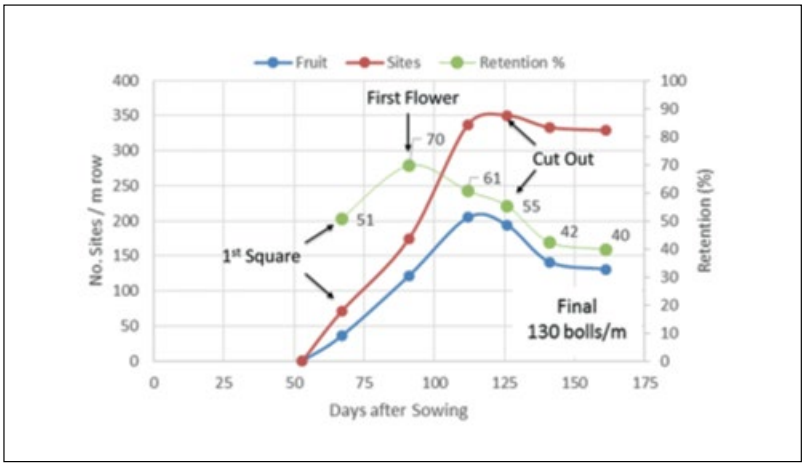


Figure 2. Sicot 746 – 10.5 plants/m, 33 sites/plant, 12.4 bolls/plant – 12.2 b/ha. Lower yield in second year is due to reduced boll size from cloudy weather post-cut-out, not boll number. (Paul Grundy QDAF)

Assessing early season square loss

- What is causing square losses? Is it pests or environmental factors? Pest damage can often be patchy or variable whereas weather related damage tends to be more uniform across the field or restricted to certain square cohorts.
- What is the plant's ability to compensate for damage? This includes looking at plant vigour, climate and what stage of the season you are in. If your crop has only 4-5 fruiting branches or less (10-13 nodes in total) it will easily compensate and fully recover from early damage without maturity delay.
- If there are pests present are they entrenched or just passing through?
- What will be the future impact of pest control now? Is intervention going to result in bigger problems later in the season, such as flaring of other pests?
- Are there low impact options (such as oils) that could control the pests and better conserve beneficial species?

Correctly estimating silverleaf whitefly populations is vital for an informed control decision, to preserve beneficial insects and avoid resistance.

Changes to SLW threshold matrix

The current recommended sampling guidelines in the new *2017-18 Cotton Pest Management Guide* are crucial for effective SLW management. Work is also underway to regionally validate better sampling and SLW threshold guidelines, that in the future are likely to include monitoring SLW nymphs.

While research is ongoing, researchers have recognised that changes to the threshold matrix are needed during this transition period and to help manage emerging resistance to pyriproxyfen (Admiral).

Revised matrix

The matrix will bring forward SLW decisions, highlighting the need to pay close attention from peak flowering to signs of an increasing SLW population (nymphs in the lower canopy, increased speckling of honey dew on lower leaves and increased adult abundance overall).

The revised 2017-18 matrix is in the *2017-18 Cotton Pest Management Guide*. The matrix aims to be clearer in windows for use of all SLW registered products, and highlight the recommendation to use insecticides that are soft and suppress SLW for control of other pests.

The *2017-18 Cotton Pest Management Guide* is a necessity for all crop managers and is included with this edition of *Spotlight*.

In order to preserve pyriproxyfen, a maximum of one application per season will remain the recommended strategy, with timing now focused on when it will be most effective (between 1300–1550 day degrees), along with the narrowing the regional pyriproxyfen window.

Pyriproxyfen is best targeted against increasing populations that have not entered the exponential population growth phase. The aim of narrowing the pyriproxyfen window is to minimise consecutive generations of SLW being exposed to resistance selection and ensure the product is being applied only once per season, when it will be most effective. The intention is to prevent usage after the commencement of boll opening.

For more
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Monitoring tells resistance story

The SLW Resistance Monitoring project undertaken by Dr Jamie Hopkinson of QDAF and supported by CRDC collects whitefly from farms across cotton growing areas for testing.

Results from testing of insects collected during the 2016-17 season show a steep increase in resistance frequency to the cornerstone product for their control – pyriproxyfen (Admiral). This has resulted in urgent calls from industry and researchers for strict adherence to integrated pest management and the Resistance Management Plan (RMP). In particular for silverleaf whitefly control, preserving beneficial insects is key, along with correctly using industry pest thresholds to mitigate unnecessary sprays, which may disrupt beneficials and promote resistance. In response to this emerging resistance threat, researchers have revised the SLW threshold matrix in the *2017-18 Cotton Pest Management Guide*.

Key points from Jamie's monitoring:

- In the past three seasons an incremental decrease in the susceptibility of SLW to pyriproxyfen has been observed (Figure 1).
- In 2015-16 resistance to pyriproxyfen was found in one strain out of 17.
- In 2016-17 the number of strains with resistance has increased, with seven out of 15 strains tested to date being positive for pyriproxyfen resistance These seven strains were collected from four regions; Namoi, Gwydir, McIntyre and St George.
- Resistance levels are classed as low to moderate.

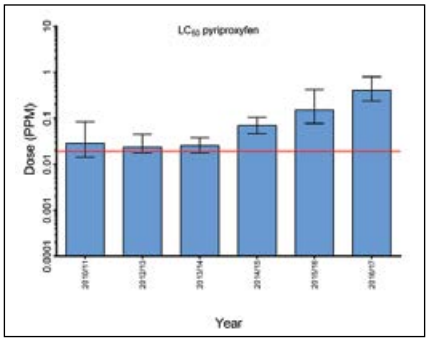

Figure 1. Seasonal mean susceptibility of SLW to pyriproxyfen as measured by the LC50. Dose required to reach 50% mortality over the past three seasons has steadily increased. The red line represents the LC 50 value of a susceptible population. Data: Jamie Hopkinson, QDAF.

Know who's on your team

In the control of Silverleaf whitefly (SLW), the message is to avoid early season broad-spectrum sprays to preserve beneficial insects which predate whitefly later in the season.

Spotlight caught up with CSIRO researcher Tanya Smith, who has worked for many years studying SLW predation and ecology as part of CRDC-supported projects which have focused on enhancing IPM in cotton systems, along with identification of beneficials attacking SLW and green vegetable bug.

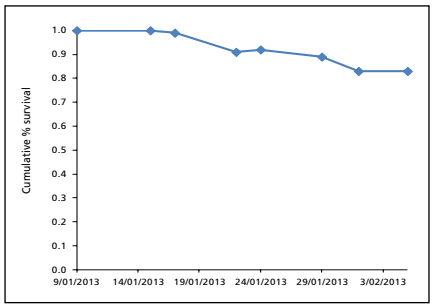

Figure 1. Closed Cages January 2013

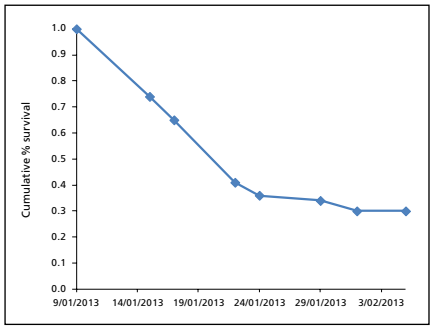

Figure 2. Open Cages January 2013

"When SLW begin to move from host plants and vegetation into cotton, often before we know they are there, predators have found and followed them, and are already impacting SLW populations," Tanya said.

"There are many insects and spiders which eat SLW, in addition to wasps which parasitise the nymphs."

Predators which consume whitefly are present at detectable levels in cotton crops by November in most years, while the wasp parasitoids appear when whitefly populations are higher, generally around early February.

"Their impact will vary depending on how many are present, and what else there is to eat, but what is certain is that their impact is important in keeping SLW population growth moderated," Tanya said.

"Many of these beneficials can be hard to spot and it is not unusual not to notice them until they begin to build up to larger numbers in a crop."

Predator effect nymphs

Tanya's research has compared survival of SLW nymphs when predators are present, compared to having no predators, under the same conditions. The experiment was carried out in January-February 2013, and her team, under Lewis Wilson, saw similar results for later experiments through to April. By caging some leaves with SLW nymphs to keep predators out, and comparing losses from exposed (Figure 2) and caged leaves (Figure 1), they found that around 50 percent or more of deaths were the result of predation.

Get to know him: male *Eretmocerus hyati.*

The power of parasitoids

The tiny parasitoid wasps *Eretmocerus spp.* and *Encarsia spp.* are important natural enemies of whitefly and contribute to the natural biological control of this pest throughout the season.

Parasitoids occur in almost all regions that grow cotton but due to their small size often go unnoticed. Like all natural enemies they are susceptible to insecticides applied to control pest species.

As the cotton growing season heats up and more SLW appear, parasitoids become

increasingly important in controlling SLW nymphs. The adult parasitoid wasp is difficult to spot. If you look carefully, it can be seen among whitefly on the underside of cotton leaves (when present). It walks about the leaf very much as the adult SLW does, is similar in size, and is yellow or yellow and brown, or occasionally yellow and black.

The first signs of parasitised SLW nymphs come in the days after the wasp has laid into the nymph, when the mycetomes (little yellow dots near the centre of the SLW nymph) start to skew, becoming asymmetrical, then push to one side of the body and the nymph takes on a milky appearance. As the parasite grows, the larva becomes more obvious (Figure 3). It is much easier to see whitefly nymphs in the later stages of parasitism around a fortnight later when they develop brown markings (Figure 3), or become intensely black.

Dr Jamie Hopkinson of QDAF looked at the impact of several insecticides used for cotton growing on *Eretmocerus hayati*.

"It's important to remember some natural enemies like *Eretmocerus* are basically invisible to the naked eye so can go unnoticed, but are still important," Jamie said.

"Therefore it is dangerous to work on the pretext that because you can't see them, they're not there."

Where do these beneficials hang out when they're not in my crop?

Whitefly predators are generalists. They eat a varied diet and will move to where ever nearby food is, so having a continuous supply of food nearby can be a good thing to encourage their presence.

"Native vegetation is potentially a great weapon for cotton farmers because if you preserve a varied ecosystem around your crops, you have a built-in supply of useful predators who don't have to move far to find whitefly," Tanya says.

"Bear in mind that SLW are a cosmopolitan species and introduced weeds are their preferred hosts, so it is important to keep these to a minimum as best we can.

"Weeds like sow thistle, marshmallow and burr medic provide overwintering sites for SLW.

"Bladder ketmia, chinese lantern, doily weed, paddy/camel melon, turnip weed, cow vine and rogue cotton are some other

Among the most important predators to conserve are:

- Brown smudge bugs

- Apple dimpling bugs

- Red and blue beetles (right)
- Lynx spiders (far right)

Many other insects play a role though may have less impact because there are fewer of them

- Lacewing

- Damsel Bugs

- Big eyed bugs

- Small ladybeetles

- Minute pirate beetle

Figure 3: Early signs of parasitism, obvious parasite larva and parasite just prior to emergence.

hosts you will find SLW happily reproducing on. Remove these and you are removing SLW sources.

"Think about planting native grasses and shrubbery onto channels and roadsides to help to choke out weedy species and provide alternative sites for beneficials.

"Also remember to think carefully when planning your cropping rotations: what was cropped/fallowed last year? What pesticides were applied and what is the likely carryover effect?"

How well do beneficials recover from early season controls?

Some growers think that if they put on an early spray then beneficials will have time to recover to control pests well enough to preserve their yield. Tanya says with luck that may be so, but it is important to keep in mind these things:

- Beneficials arrive and begin multiplying quite early in young cotton crops, particularly if they are already existing close by, and the smaller the SLW population compared to the rate of erosion of it (by predation), the much, much greater the reduction in size of later SLW populations on any given date.
- Add to this the lag between a predator finding SLW in your crop, and then the catch-up it must play to build up its own numbers to impact on SLW populations.
- Each time you spray it is important to consider the role your chemical will play. How will this affect your beneficials' activity, and what other impacts are there, particularly on other potential pests, which are often forgotten. Remember to ask when planning: if I spray now, will it cost me later in the season? If I do have to spray, what are my best options to get the result I need and best preserve beneficial insects and spiders for the rest of this, and next season?

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Pest-suppressive landscapes

Maintaining native vegetation on farms and keeping it in good condition appears to be crucial for sustaining populations of natural enemies in Australia and worldwide.

Exotic weeds and crops harbour more pests than Australian native plants on agricultural farms, which are repeatedly shown to support beneficial predatory insects and show little support for insect pests. A comprehensive study across three Australian states published in 2015 showed 75 percent of the surveyed exotic weed species hosted more pests than predators, while native plants supported the lowest pest abundances and more predators than pests.

Riparian zones and native vegetation on cotton farms harbour beneficials that play an important role in controlling pests. Enhancing these beneficials is a key requirement of an integrated pest management system. This is supported by preliminary results from CRDC-supported research by Drs Vesna Gagic and Nancy Schellhorn, with results showing a substantial benefit of neighbouring native vegetation in terms of pest suppression in cotton.

"Improving integrated pest management system is the only way the industry can move through the continually evolving science of pest control in a sustainable way," says CSIRO's Vesna Gagic.

"We are finding methods to increase the diversity and abundance of natural enemies of cotton pests on farms to capitalise on this form of biocontrol as we need to gain a clear understanding of which beneficials have the highest impact on the target pests so we can design landscapes to support them.

"In nature, natural enemies, such as predatory insects are a vital pest biocontrol method and they keep plant-eating insects in check: that is why the majority of insects never become pests.

"Pesticides come with risks of resistance and in the case of broad-spectrum products – the large risk of killing off beneficials."

Often these beneficials will not recover to populations large enough to control pests for the rest of the season, if they recover at all. In that case, it means that the most effective weapon we have against problematic, late season silverleaf whitefly is lost.

"These beneficial insects often live longer than the life of a crop so it is crucial to maintain natural habitats surrounding cotton fields, as they act as a refuge providing food such as nectar, alternative prey and shelter," Vesna said.

"These areas are particularly important between crop seasons or when there are no crops. We can think of them as landscape nurseries, which provide a source of beneficials available to colonise the next season's crops."

While it is clear that natural vegetation plays an important role for beneficial insects in Australian agricultural landscapes, less is known about how much of native vegetation and how far from the cotton field is necessary for supporting sufficient numbers of beneficial insects and a successful suppression of pests in cotton. Building on results from previous research which investigated the role of native vegetation for supporting beneficial insects, the researchers are now seeking to measure the impact of these landscape features on pest suppression. The research has included important biocontrol experiments to measure the impact of natural enemies on pests in both native vegetation and in cotton fields and the outcomes will be linked with vegetation management guidelines.

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PHOTO: SHARNA HOLMAN

Dr. Mary Whitehouse (right) with technical officer Gail Spargo and Saba Sinai setting up the Emerald Helicoverpa experiment which given a clearer picture of the need to spray for early season egg lays.

Helicoverpa egg lays: should you spray?

Research has shown that spraying Bollgard 3 for early season Helicoverpa egg lays is unnecessary and has a detrimental effect on beneficials and integrated pest management.

Many growers and consultants will remember one of the unique characteristics of the 2016-2017 season being the heavy Helicoverpa pressure and egg lays seen early in the season. This heavy pressure followed a bumper chickpea crop across Eastern Australia, as well as persistent winter rainfall events in inland Australia which resulted in the proliferation of native hosts and provided the perfect conditions for the development of a very large and widespread population of Helicoverpa.

The heavy early season egg lays (Figure 1) provided a challenge to many growers' integrated pest management (IPM) programs. In Central Queensland and other regions, consultants reported up to 200 Helicoverpa eggs per metre while in NSW smaller egg lays were seen, yet few larvae were seen in crops.

"With the release of new cotton varieties and unusually high egg lays, many growers were concerned about gene expression as well as the plant's ability to compensate for insect damage, prompting some to apply insecticide early," NSW DPI's Dr Mary Whitehouse says.

"Growers had concerns as to whether these high egg lays were causing damage to the crop and if control was needed, and many may sprayed unnecessarily, based on the results of research we've recently undertaken."

Recent trials

Experiments were undertaken last season by Mary in Narrabri and Sharna Holman of QDAF and

Southern Valleys	Macquarie	Lower Namoi (Walgett)	Upper Namoi	Gwydir	Gwydir (West of Collarenebri)	Macintyre (Goondiwindi)	Darling Downs	Central Queensland (Emerald)
5	50 – 150	100	100	20 – 40	100	<10	50 – 100	200

Figure 1. An estimate of the maximum number of eggs per metre through to peak flowering (as reported by consultants) at different sites across Eastern Australia.

CottonInfo in Emerald on flowering crops to test if heavy Helicoverpa egg lays resulted in damage to pin-squares.

The researchers put at least 20 eggs (either *H. armigera* or *H. punctigera*) suspended in a watery solution on the growing tip of the cotton to mimic the pressure of about 200 eggs per metre (Figure 2). At Narrabri, in January the presence or absence of Helicoverpa eggs had no effect on the number of pin-squares lost (average = 0.27 pin-squares per growing tip), although no more than one or two eggs hatched per tip, indicating low pressure on the tips.

In February, Mary put the eggs on the growing tips of Bollgard 3 and non-Bt cotton plants. On the non-Bt cotton, an average of 11 *H. armigera* (~55 percent survival) and 5 *H. punctigera* (~25 percent survival) larvae were found on the growing tip after eight days. No Helicoverpa survived on the Bollgard 3 tips.

The non-Bt cotton tips without Helicoverpa eggs dropped fewer pin-squares and tended to retain more pin-squares than tips with Helicoverpa eggs, showing that in non-Bt cotton, the neonates did cause pin-squares to drop off. In the Bollgard 3 cotton there was no difference in the number of pin-squares lost or retained on tips with or without Helicoverpa eggs (Figure 3).

This showed that in flowering Bollgard 3 cotton, the neonates had no effect on the number of pin-squares lost or retained.

In Emerald, the eggs were put on the growing tips of a late season flowering crop of Bollgard 3 in March. Some eggs were also put on pigeon pea to test the survivorship of the eggs.

After seven days between zero and five larvae were found on the pigeon pea tips (which were not flowering) indicating egg survivorship. One larvae was found on a Bollgard 3 tip. There was no significant difference in the number of pin-squares retained or dropped on tips with or without Helicoverpa eggs on Bollgard 3 cotton (Figure 3). These results reflected those in Narrabri where the high number of eggs did not affect pin-square numbers.

As a result of the research, the advice for crop managers is straight forward.

"Next time we have heavy early season egg lays, growers and consultants should have confidence knowing that in flowering Bollgard 3 cotton, heavy Helicoverpa egg lays do not result in significant damage to the plant or pin-squares," Mary said.

"Avoid early season sprays targeting Helicoverpa egg lays on Bollgard 3 cotton.

"These sprays will not improve yield, are an extra cost, and will disrupt beneficial insects that control other pests such as silverleaf whitefly.

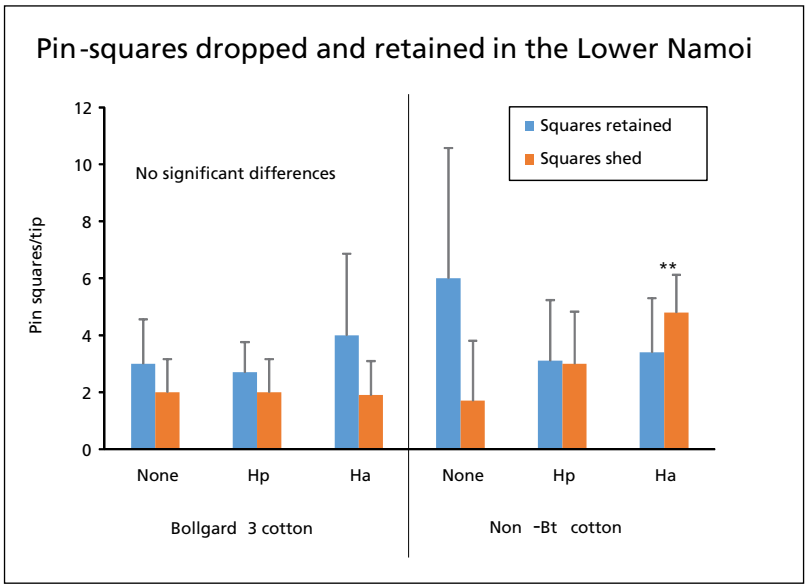

Figure 2. At Narrabri in February, applying eggs to the tip had no effect on the number of pin-squares dropped or retained in Bollgard 3, while they caused more squares to drop in the non-Bt cotton. Ha = *H. armigera*; Hp = *H. punctigera*

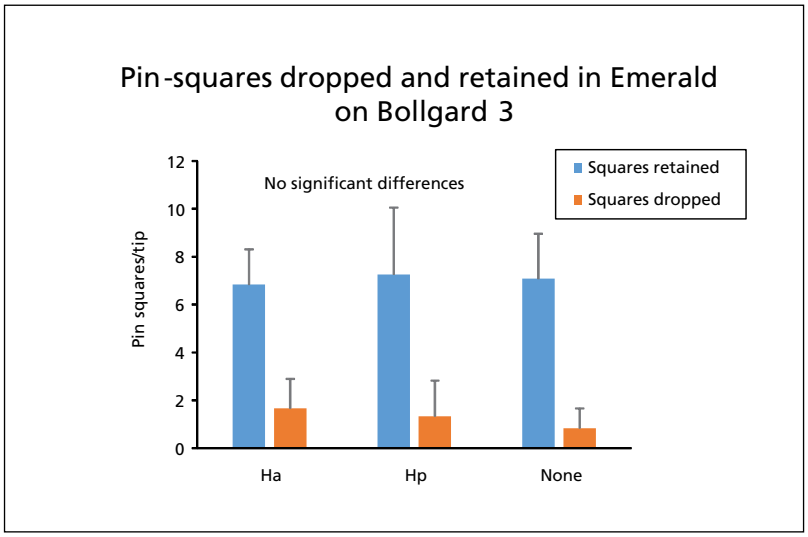

Figure 3. In March on a late crop in Emerald, applying eggs to the tip had no effect on the number of squares dropped or retained in Bollgard 3. Ha = *H. armigera*; Hp = *H. punctigera*

Mary and Sharna plan to follow up this work by testing if eggs put on pre-flowering cotton causes damage, yield loses or delays; and if high temperatures will affect egg and neonate mortality.

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Boost for disease team

The cotton industry's pathology capacity has been ramped up with the appointment of two new researchers.

Aphrika Gregson and Du Le have joined the cotton industry pathology team with support from CRDC.

Researchers Duy Le and Aphrika Gregson have recently joined the NSW DPI Pathology team based at the Australian Cotton Research Institute (ACRI), near Narrabri, with support from CRDC.

As part of a three-year project, Duy is working closely with NSW DPI's Dr Karen Kirkby and her team on the *Innovative Solutions to Cotton Diseases* project. The ultimate goal of the project is to commercialise potential products by assessing the efficacy of some novel and unregistered products in controlling major soil-borne pathogens in cotton. This project will further enhance cotton pathology capability in Southern NSW by appointing and training a new PhD student.

"My team will also be working with QDAF's Dr Linda Smith and her team for National Disease Survey. The project aims to monitor closely and analysis of pathology survey data, which will be useful for providing best practice advice to growers and research directions," Duy said.

Duy was previously working with the Queensland Alliance of Agriculture and Food Innovation at the University of Queensland. As part of this role he mentored a PhD student in the team to develop a super cool detection tool which allowed target pathogens to be detected and confirmed within 30 minutes, for detection of important black root rot pathogens on avocado.

"I am most looking forward to contributing in a positive way to integrated disease management (IDM) strategies," Aphrika said.

"Being involved in the CRDC-supported disease surveys, monitoring disease incidence and severity and collecting information on-farm management practices for NSW is a great place to start.

"I have really enjoyed the constant collaboration with industry, including QDAF, fellow NSW DPI staff, CottonInfo, CSD, and growers and consultants from both Queensland and NSW and am looking forward to future seasons."

For more

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Growing the industry from grass roots

Since the Grassroots Grants program commenced in 2011, CRDC has invested more than $466,000 in 52 projects throughout cotton growing regions.

The program encourages Cotton Grower Associations (CGAs) to apply for funding to support capacity building projects with grants of up to $10,000. The grants help fund projects aimed at increasing grower engagement in the industry, solving specific regional issues and improving skills, knowledge-base and networks. This has included running trials, installing weather stations, and hosting crop nutrition workshops.

CRDC General Manager R&D Ian Taylor has strongly encouraged CGAs to consider their needs and get their applications in.

"We have continued to support our Grassroots Grants program because we are seeing the benefit going back into the cotton growing community," he said.

Dryland cotton growers near Coolah are benefitting from a weather station and trial work undertaken through CRDC's Grassroots Grants program.

"In the case of the Upper Namoi CGA, for example, we are seeing initial grants leading to successive projects, which is building real capacity and having a positive impact in the region."

Through its grant, last season the Upper Namoi CGA grew 3.4 bales per hectare in a dryland trial which was set-up to investigate barriers (such as climate) to cotton growing.

"This trial showed high yielding crops can be grown in cool, elevated climates, with very little in-crop rainfall, in a very tough season climatically," says CottonInfo Climate Technical Specialist, Jon Welsh, who oversaw the project.

"With a net profit of around $900 per hectare and no fibre quality discounts this was a really eye-opening outcome in one of the toughest summer cropping seasons on record."

Jon was initially involved with the group's initial grant, the installation of a weather station near Coolah.

"The work we've done through the grants has also shown that the industry has a willingness to invest in new regions and show support for growers and advisors there."

For more

www.crdc.com.au

New CottonInfo faces in the field

The cotton industry has welcomed three technical specialists to the CottonInfo team in the areas of weeds, irrigation and nutrition.

NSW DPI weeds researcher Eric Koetz is the new Weeds Management Technical Specialist, newcomer Ali Chaffey (nee McCarthy) replaces Janelle Montgomery as the Irrigation Technical Specialist, while former CottonInfo regional extension officer (REO)John Smith will handle the newly created Nutrition and Water role.

Eric Koetz has been with NSW DPI for around 20 years, 10 of which have been spent in weeds research. He is based at the NSW DPI Wagga Wagga research institute.

"It has been really good to meet all the regional extension officers and others in the CottonInfo team recently," he said.

"I look forward to working with a tight knit group of researchers within a connected and progressive industry.

"The introduction of new genetic technology and integrated weed control tactics provides a great opportunity to help grow the cotton industry and keep farming systems profitable and sustainable in the face of herbicide resistance.

"Extending information to growers and consultants as research happens is my main focus.

"Cotton is a new crop for me and getting to understand the farming system has been both challenging and exciting.

Ali is a NSW DPI Research and Development Officer Irrigation based at the Australian Cotton Research Institute, and comes to cotton after completing a Master of Science in Agriculture at The University of New England last year. The black soil plains will be a change for Ali, who has spent the past five and a half years working in marine science roles within the aquaculture industry and state government in the Kimberley region of north-west Western Australia.

"Originally from Armidale, I have been working with a Liverpool Plains agronomy consultancy since moving back to the region last year," Ali said.

One of CottonInfo's new technical specialists Eric Koetz (second from left) has been visiting cotton growing regions, meeting with growers and consultants through the Weed Management Workshops. Eric caught up with consultant (and 2017 Young Achiever of the Year) Fiona Norrie, ICAN's John Cameron and consultant Kate Lumber at Pallamallawa.

"I am particularly excited for this opportunity to get to know and work with everyone involved in the industry, and I look forward to meeting everyone."

Former Darling Downs REO John Smith is now working with NSW DPI based at Yanco Agricultural Institute as a research officer with the water and irrigation team. John is studying his PhD through a CRDC scholarship which is focused on the interaction between irrigation management and nitrogen uptake efficiency. He re-joins the CottonInfo team as a Nutrition and Water Technical Specialist.

"I'm pleased to be back as part of the CottonInfo team," John says, "I really enjoyed working on the Downs before returning to study.

"My focus now as part of CottonInfo will be looking at water productivity in farming systems and working with crops managers to better understand the irrigation-nutrition links and how we can improve efficiencies."

John is currently leading a Rural R&D for Profit-funded project titled Maximising Irrigation Profitability – Southern Connected Systems which comes under the broader Smarter Irrigation for Profit project administered through the CRDC. The Maximising Irrigation Profitability project is investigating options for the improvement of water productivity in rice, cotton and maize production systems across the southern irrigation areas.

CottonInfo Manager Warwick Waters said CottonInfo is about connecting growers with research, and the technical specialists play an important role in following the research in their areas and extending farm ready research findings.

"CRDC is investing in many irrigation, nutrition and weed management research projects, and it is important that the findings of these projects flow through to growers and consultants," he said.

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New nitrogen focus for CottonInfo

The CottonInfo team will be tackling three new focus areas for growers this season, one of which is the relationship between nitrogen use efficiency and irrigation.

CottonInfo has recently released its annual operational plan (AOP) which outlines activities to be undertaken during the year. As the Australian cotton industry's extension program, CottonInfo is designed to connect Australian cotton growers with research and development to achieve best practice.

In 2017-18, CottonInfo has three key focus areas:

- managing irrigation to improve nitrogen use efficiency (NUE);
- 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 for profit within farming systems.

The keys to NUE

The key focus of managing irrigation to improve nitrogen use efficiency (NUE) will be overseen by NSW DPI Research Officer (Water Productivity) John Smith, who is also CottonInfo's Nutrition and Water Technical Specialist. John will oversee on-farm trials undertaken by CottonInfo regional extension officers (REOs) to highlight the efficiency interactions between irrigation and nutrition management. This will build on recent REO trials last season which measured yield responses to applied nitrogen (see following article).

"Currently there is significant investment across the industry looking at NUE and N losses," John said.

"Within our system most fertiliser N is applied as

either urea or anhydrous ammonia.

"Regardless of form, once applied this is transformed to nitrate and available for plants to take up in a relatively short period of time (days to weeks).

"However, nitrate is also easily lost from the soil either as gas or leached to deeper soil depths."

John said the latest research has gone a step further investigating the relationship between irrigation management and nitrogen and is finding that without doubt irrigation management does influence how much N gets into the plant.

"Only once N is in the plant is there a strong relationship between N and lint yield, but the plant could be taking as little as one kilogram from every three kilograms of N applied as fertiliser," he said.

"Irrigation is key to maximising what you get out of the N that is applied to a crop. Reduced efficiency can be caused by a deficit that doesn't match the soil type, poor layouts that have slow watering times, drainage that back's up in fields resulting long periods of water logging, uneven grades that hold water in particular areas and/or poor placement of the fertiliser relative to water flows during irrigation.

"All these variables influence the amount of N that gets into the plant and the ability to convert that uptake to lint.

"We need to get past the thought of just throwing more N at the crop to increase yield and consider the true cost of applied N, with research showing as little as 20 to 30 percent being used by the crop."

The principal focus of CottonInfo is to be an efficient and effective pathway for the delivery of the results of industry R&D and innovation, CottonInfo Program Manager Warwick Waters says.

"CottonInfo is designed to meet as yet commercially unmet information needs of growers, and support efforts to improve practices, productivity, competitiveness and environmental performance, in conjunction with *my*BMP," Warwick said.

In consultation with the CRDC R&D Managers, the development and extension components of new CRDC-supported research projects are considered and supported by CottonInfo. This involves the joint development of a new milestone for each project that identifies the adoption pathway for the research being undertaken.

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Trials show all N isn't equal

The lint yield response to applied nitrogen fertiliser has been consistent in on-farm irrigated trials undertaken by CottonInfo regional extension officers across the growing regions.

During the 2015-16 season, the regional extension officers (REOs) measured differences in nitrogen use efficiency (NUE) from Emerald to the Macquarie Valley. The trials showed little or no yield response to applied N between treatments, timing or application methods, suggesting factors other than N from fertiliser influence yield.

The results also highlight the value for crop managers in calculating pre and post-plant N and crop removal to determine the fate of applied N. Measured crop removal and post-harvest soil tests showed a large proportion of total available N was lost or unaccounted for.

The range of removal of N through different treatments in the trials was relatively small and

CottonInfo REO Kieran O'Keeffe and Technical Specialist Jon Welsh discuss a zero N trial at the De Bortoli farm trial site.

inelastic in response to the applied rate. Zero-N strips were found to be particularly useful in demonstrating in-crop N mineralisation to growers. The zero-N treatments in the Murrumbidgee Valley achieved an impressive 11 bales/ha yield with a starting soil N of 164kg N/ha, providing a valuable insight into the contribution of residual soil N and mineralised N at below optimum fertiliser rates.

Application effects

The different treatments of pre-plant and water-run N also found little yield response across all sites, however, there were no extended waterlogging periods resulting from irrigation and rainfall events coinciding, minimising suitable conditions for denitrification to occur.

Splitting nitrogen application throughout the season to meet peak demand is acknowledged as a key risk management strategy to ensure N is not limiting and yield is optimised. Measuring plant nitrate status through petiole testing prior to peak crop demand was also found to be an effective tool to track apparent soil nitrate-N availability and guide in-crop applications of N during peak demand. Petiole testing highlighted similar end-of-season levels regardless of N treatment suggesting significant loss of N from the higher N applications. Where a significant amount of nitrogen is drawn from the soil organic N pool, the efficiency of large amounts of applied N is generally poor.

Research into the field

The on-farm nitrogen trials are successfully used to extend industry research, which is continuously shedding more light on NUE.

In 2016, an examination of 2014-15 CottonInfo regional trial data by Dr Oliver Knox showed that there were few benefits of over-applying N. Soil testing and N accounting has revealed excess N isn't being stored in the soil - with the majority being lost to the environment, as supported by current research by Professor Peter Grace, who is undertaking a project on behalf of CRDC.

The links between irrigation and NUE were explored in experiments in the Upper Namoi region for CRDC by NSW DPI's Jon Baird in 2016, which found losses of 20 to 30kg/ha of pre-applied N through tail water after the first irrigation. The study also found irrigation intensity also affected water use efficiency (WUE) and NUE.

"Where a significant amount of nitrogen is drawn from the soil organic N pool, the efficiency of large amounts of applied N is generally poor."

De Bortoli farms agronomist Brendon Wells and farm manager Darrell Fiddler with CottonInfo's Kieran O'Keeffe and Jon Welsh. De Bortoli farms particpated in CottonInfo's on-farm N trials.

Industry snapshot

Good news for the industry is that feedback from attendees at 29 CottonInfo crop nutrition workshops (representing 324,000ha of irrigable land) showed that 82 percent acknowledged best practice principles on soil testing, calculating mineralised N and refining crop rotations for higher NUE offered benefits to their business. Additionally, 98 percent of growers and advisors are using a combination of up-front and in-crop application of N to meet peak crop demand and mitigate system losses from untimely rainfall events.

Consistent with this, CSIRO's Dr Ben Macdonald and his team last year found that over a five-year period, the majority of dissolved organic N and nitrous oxide occurred between irrigations one and four and did not appear to be influenced by fertiliser timing or product.

Fertiliser product and rate trials conducted by Peter Grace under furrow and centre pivot irrigation found no significant difference between treatments. The sites averaged 11.9 b/ha. The study found 198kg N/ha was mineralised from the top metre of soil and 77 percent of the mineralised N was captured by the plant. Using a high-tech method to track the fate of fertiliser, Peter also found only 20 percent of the N taken up by the plant was derived from fertiliser, that is 80 percent was soil-derived N.

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www.cottoninfo.com.au/publications/cottoninfo-nitrogen-trials-report

Where does nitrogen fertiliser go?

Synthetic nitrogen fertiliser to maintain food and fibre production has grown exponentially over the last 50 years. In Australian irrigated cotton production the application of N fertiliser has also increased to achieve high yields and to maximise gross margins, yet a common question has remained – 'where does all the nitrogen go?'

Researchers Dr Ben Macdonald, Yvonne Chang and Dr Tony Nadelko have undertaken research with support from CRDC and Australian Government Department of Agriculture and Water's Rural R&D for Profit Programme to find the answers.

In 2013, nitrogen rates for irrigated cotton in Australia ranged between 93 to 370 kg N/ha, though higher rates (370-500kg) have been reported. Early N research at the Australian Cotton Research Institute found fertiliser rates exceeding 200 to 250 kg N/ha are in excess of the crop N fertiliser requirement, and significant N losses occur. The late Ian Rochester posed a challenge in 1993 to determine the importance of the N loss pathways and the link to immobilisation and soil mineral N supply.

"Our study at the Australian Cotton Research Institute during the 2014-15 season found the average fertiliser recovery in the plant was 32 percent using labelled fertiliser at the appropriate agronomic N split management (upfront and early winter) and rate (232 kg urea-N ha^{-1})," Ben Macdonald said.

"Soil N mineralisation was the key source of N in the measured production systems, with the soil organic pool suppling 159 kg N/ha. The overall lint yield was 12 bales/ha which is the target yield for the fertiliser application."

Where did the remaining 68 percent of the fertiliser go?

At the end of the season a large amount of the fertiliser (62kg N/ha) remains in the soil organic N pool. During the season N losses occurred from the field via the atmospheric, deep drainage and surface run pathways (143kg N/ha). The losses occurred directly after fertilisation, predominantly at the start of the season when the majority of the fertiliser was applied (180kg urea N/ha). These losses indicate that the form, placement and timing of the fertiliser did not synchronise with soil and crop N dynamics and irrigation practice.

"Soil mineralisation is key for a successful season, so maintaining a large soil organic nitrogen pool is critical."

Soil mineralisation is key for a successful season, and thus maintaining a large soil organic nitrogen pool is critical for crop managers to maintain production.

"Soils that have low organic carbon and nitrogen levels will not grow cotton crops with the same nitrogen use efficiency achieved by Ian Rochester at ACRI," Ben says.

"Basically soil N mineralisation will be inadequate to supply the cotton plant and achieve the expected yields.

"This effect will be amplified if other soil constraints, such as sodicity and compaction, are present

"While the application of N will help overcome some of the impact of these constraints it is only treating the yield gap symptoms, not the root cause."

The researchers say this study represents only a single year, and combined with the longer term carbon study at ACRI, it indicates that the soil organic N is declining. This decline is due to the soil organic carbon pool coming into equilibrium with current land use and management.

"Research has shown that practices that promote increases of organic matter content in the soil, such as retaining residues, the use of legume rotations and cover crops in the fallow, could reverse this trend," they said.

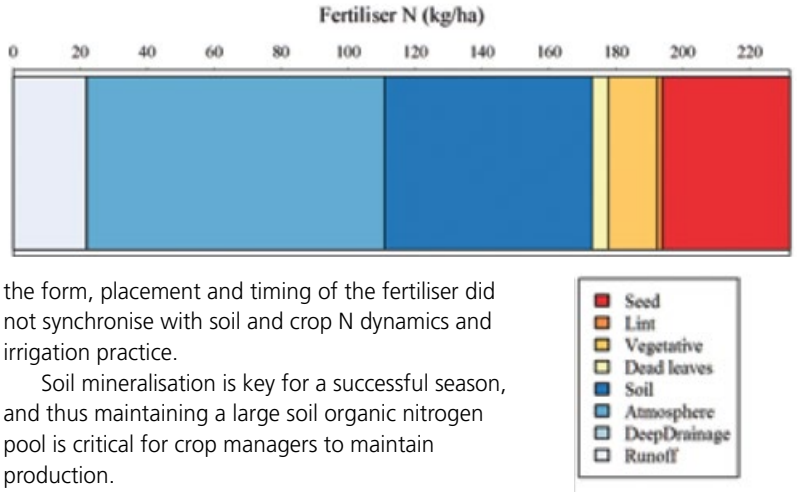

Figure 1. The fate of the applied fertiliser (232 kg ha^{-1}) at the lysimeter plot

Moving into the future

The uptake of new technology and the increasing demands on raising yield and efficiencies brings additional challenges in how we further exploit our gains in genetics and management and how to embrace new digital technologies to support this in decision making.

Tim Weaver

To meet these challenges, CSIRO has appointed two researchers, Tim Weaver and Chris Nunn, to its Integrated Cotton Management team at the Australian Cotton Research Institute (ACRI) near Narrabri.

These researchers will work with fellow CSIRO researcher Hiz Jamali, who through his CRDC-funded research focuses on infra-red canopy sensors that measure plant stress. Hiz's work is part of widespread interest across agriculture in the use of sensing technology coupled with data management and analytics.

"There are opportunities with this technology for greater water use efficiency and yield improvements by avoiding crop stress, with early indications suggesting this could be in the order of equivalent to around $55 per hectare per year with a benefit cost ratio of 34 to one," Hiz said.

Chris Nunn

Dr Mike Bange is CSIRO's Group Leader-Integrated Cotton Management and explains how these demands and some generational change is seeing a shift towards trying new concepts to solve some old and new challenges.

"One of our group's principal aims is helping develop underpinning knowledge about cotton biology and systems to help ensure the science is robust after science, and embraces new technologies and decision making processes that we already have to help the industry move forward," Mike said.

"On example is alternative ways of looking at agronomic decisions, using big data to drive decision making and harnessing new technologies. These are among the disruptors set to drive the cotton research agenda in coming years; our role will not to be to develop the technologies per se, moreover, to see that they are linked to understanding of how the system should respond."

Chris Nunn is a digital agronomist – which may be a new term for some.

Chris will be investigating the latest technologies for useful applications in the cotton industry and is especially interested in learning about how growers currently use their data and how CSIRO might be able to enhance this.

"We need to move beyond just building and supporting models and decision tools to see how sensors, drones and other new technologies can help us learn about our crops in real-time and how they can change the way we work," he said.

Tim Weaver has moved into the position of systems scientist in exploiting positive interactions of Genetics (Varieties) by Environment (Region) by Management (Agronomy) (GxExM) interactions, which is enabling CSIRO to explore a new area of research: how different genotypes of cotton can be better exploited under different environmental and management conditions.

Tim is not new to ACRI, having spent 12 years with NSW DPI at the site. His new role will see him investigating how to improve yield and efficiencies of resource use by matching the management with the variety.

Tim will initially address the response of an old conventional variety and compare it with Bollgard 3. "I'll be pulling apart the distribution of N and how the plant responds to differing N management and how efficient are our new genotypes at supplying nutrients where it is needed in the plant and when it is needed," he said.

"The overall aim is to ensure we are achieving maximum yield from our newer varieties, and if not, are there other ways that can be exploited to achieve this?

"We need to be contributing to research by adding our understanding of the cotton system to make these technologies work better for the industry."

For more

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COMMENT: WITH CROP CONSULTANTS AUSTRALIA

Thinking outside the silo

'Working in silos' is not a task for people in the grains industry: in the business world, 'silo thinking', or 'silo mentality' have a different meaning.

The Australian cotton industry has a strong reputation within agriculture for its ability to coordinate at many levels to problem solve.

It would appear however, that silo thinking continues to be a problem in Australian business and industry, according to Crop Consultants Australia. In simple terms, it refers to a reluctance to share information with others, usually within their own organisation. Many of us have ideas, concepts or research outcomes that we would prefer to keep close to our chest. It might that one idea that we believe gives us the edge on our competitors. It might also be so left of centre that we may to be ready to share for fear of ridicule. Perhaps though, we may not think that what we have to share would be of any value to others. Whatever the reason, 'silo thinking' has the undeniable outcome of stifling innovation and progress.

While often thought of as an organisational problem, the principles can easily be transposed to an industry level. If we, as the cotton industry, refuse to work together, as growers, researchers, industry members and corporate bodies, our industry will suffer in the long term.

The Australian cotton industry has a strong reputation within agriculture for its ability to coordinate at many levels to problem solve. Perhaps, as a relative newcomer on the Australian agricultural scene, we have needed to be on the front foot when it comes to dealing with issues such as chemical use, irrigation practices and indeed, a broader social licence to operate.

As a not for profit organisation working in the agricultural sector Crop Consultants Australia (CCA) has the opportunity work with a number of industry sectors. We have long recognised that it will only be through collaboration with all sectors within an industry, and sometimes by looking outside that industry for expertise, that we will achieve robust discussion on topics and learning for our members (and the industry as a whole).

At our recent Seminar in Moree, almost 140 people gathered to hear, present and network. In the room was a diverse range of people including researchers (private and governmental), growers, representatives from industry bodies and agricultural chemical companies, and of course, agronomists. Despite our diverse backgrounds, we are all are faced with the same challenges going forward – resistance, disease and pests. It is just that each of us has a different toolkit with which to tackle it. Our organisers have received feedback since the seminar from guests and attendees, who stated how welcome they felt at the seminar, and how free they felt to share ideas.

While CCA's primary charter is promote agronomy as a professional service, we feel that the role that we have within industry, as an independent forum through which ideas, research and experiences can be channelled, is an important service to the cotton industry as a whole. It helps to break down any silos and promote innovative thinking and challenging conversations within industry.

CCA would like to acknowledge the tremendous support that we have from all sectors in order to make this happen. The ever-open door that exists between CCA, CRDC, Cotton Australia, CSD and the CottonInfo team is integral to this teamwork. We feel privileged that we have so many recognised researchers from state departments of agriculture, CSIRO and the private sector giving time so readily to our organisation when requests are made.

We hope that, in turn the combined experience of our members, who together oversee over 70 percent of Australia's cotton crop (CRDC-CCA survey) adds significant value and a different perspective to research direction and market development.

It is only together that we will tackle the big issues that we face going forward.

For more

www.cropconsultants.com.au

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

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MELANIE JENSON