COTTON RESEARCH & DEVELOPMENT CORPORATION

Spotlight on Cotton R&D

SUMMER 2012/13

RESEARCH TO FARM:

What's working & why?

Best Practice

IMAGE MELANIE JENSON

Linking growers, consultants, agribusiness and researchers to discuss research and on-farm issues in an informal manner is allowing important channels of knowledge to flow across the industry.

IN THE SPOTLIGHT

Every new season comes with the prospect of addressing a mix of known and surprising challenges. With this season now well underway this edition of *Spotlight* puts the focus on a similar range of issues.

As an industry we know the importance of continuing to improve environmental performance. The Cotton Industry's Strategic Environmental Assessment 2012 has concluded that the industry has taken seriously its previous audits and successfully continued to improve environmental outcomes. The purpose of the assessment was to evaluate how the industry had responded to the recommendations from the previous audit in 2003. It has also outlined areas where further improvement is possible and how as an industry we can manage this.

With the cessation of the Cotton CRC came a challenge to build upon the past model for delivery of research to growers and consultants. In keeping with industry spirit for collaboration, major industry bodies have come together to support a partnership in Development and Delivery. The services this D&D program offers through its people and products are already proving popular with growers and researchers and we outline some of their current initiatives this issue.

CRDC also sees the Grass Roots Grants that we offer as strengthening the link between research, growers and regions for the greater benefit of the industry. Examination of alternative energy sources for gins was the work undertaken by Tandou Farms under this grant scheme, with the outcomes being used to improve efficiency and give industry sound data to build on. We hope this gives inspiration to Cotton Grower Associations to apply for this funding.

Also in this issue industry specialists and researchers have combined to provide the latest information on Helicoverpa resistance to Bt technology and stewardship of this technology, which has become an integral part of modern-day cotton growing. Industry guidelines are developed based on rigorous science which aims to protect the Bt technology by delaying and mitigating resistance in Helicoverpa. Adherence to the Resistance Management Plan for Bollgard II, correct refuge management and continued diligence in the fight against resistance all go to good stewardship and the protection of not only our current but future technology. The detection of resistance in Helicoverpa to Bollgard III's active toxin Vip3A highlights the importance of managing the risks to the technology and industry. Stewardship also extends to the use of herbicides and insecticides.

Silverleaf whitefly management has caused some headaches in the past, however research has gone a long way in determining guidelines and thresholds. There are control methods available which have alleviated the issue of flaring other pests during whitefly management which are outlined by industry's experts in this issue.

Stewardship of herbicides and in this particular case glyphosate is also examined. With cases of reported weed species resistance to this product rising the risks to one of the most valuable weed controls is evident. While no glyphosate resistant weeds have been detected in an irrigated cotton system, the detection of resistant awnless barnyard grass in a dryland cotton system is a reminder to manage weeds according to a good integrated weed management strategy.

CRDC is continuing to fund research to assist growers improve energy use and its assessment. Partnering with the National Centre for Engineering in Agriculture, we have produced a series of articles outlining the new EnergyCalc Lite tool and other innovations in reducing on-farm energy use. Should you have any feedback on this research we would be pleased to hear from you.

Fibre quality is a growing issue for the industry and we have some timely advice about in-crop nutrient management for an optimal harvest, as well as outline the work of Mike Bange and others in developing a micronaire prediction tool. The new Harvest BMP will also go a long way to protect fibre quality and grower interests.

Continuing with the theme of fibre quality, we hope you find the back page article on cotton's future in a polyester world thought provoking.

Bruce Finney

Australian Government
Cotton Research and Development Corporation

Spotlight is brought to you by Australia's cotton producers and the Australian Government through the publisher Cotton Research & Development Corporation (CRDC).
CRDC is a research and development partnership between the Australian cotton industry and the Australian Government.
Cotton Research and Development Corporation
ABN: 71 054 238 316
Our vision: A globally competitive and responsible cotton industry

Our mission: Invest and provide leadership in research, innovation, knowledge creation and transfer.
Our outcome: Adoption of innovation that leads to increased productivity, competitiveness and environmental sustainability through investment in research and development that benefits the Australian cotton industry and the wider community.
Corporate background: CRDC was established in 1990 under the Primary Industries and Energy Research and Development Act 1989 (PIERD Act.) which outlines its accountability to the Australian Government and to the cotton industry through the Cotton Australia. CRDC is responsible to the Australian Government through the Minister for Agriculture, Fisheries and Forestry, Joe Ludwig.
CRDC is committed to fulfil its legislated charter to: Invest in and manage an extensive portfolio of research, development and extension projects to enhance the ecological, social and economic values associated with cotton production systems and to benefit cotton industry participants, regional communities and the Australian community.
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THE INDUSTRY'S LATEST ENVIRONMENTAL ASSESSMENT SHOWS HIGH LEVEL UPTAKE OF MANAGEMENT PRACTICES AND TECHNOLOGY TO BETTER ITS PERFORMANCE.

REPORT CARD INFORMS FUTURE R&D

The Grower Survey was an integral part of the industry's Third Environmental Assessment 2012. Pictured are Inovact Consulting's Ken Moore and Breeza grower Rodney Grant during the survey phase of the assessment.

CRDC's General Manager Research Investment Bruce Pyke and an industry steering committee oversaw the the third industry wide environmental assessment undertaken by the cotton industry since 1991.The independent assessment was conducted by the Canberra-based consultancy firm Inovact.

They reviewed available literature, surveyed growers and a broad range of industry and external stakeholders, quantified the industry's responses to the recommendations that were made in 2003 audit (the Second Cotton Industry Environmental Audit), ran metropolitan focus groups and visited farms to reach their conclusions. Industry's response to their recommendations will inform future environmental priorities for action and strategies both on the ground and through research and development.

"The assessment is an excellent 'report card' for the industry as it showed that most of the recommendations made in 2003 have been adopted at a high level (Figure 1), particularly in critical areas such as the management of water, chemicals and natural resources," Bruce Pyke said.

"Interestingly, cotton industry and external stakeholders largely agree on environmental management issues, with most stakeholder survey respondents (78 percent) identifying water related factors as core environmental issues; 76 percent identified soil related issues; 42 percent related issues associated with chemical application; 40 percent with climate impact and energy use; and 36 percent with issues relating to protection of the surrounding environment."When asked about important environmental priorities for cotton growing over the next three to five years, industry and external stakeholders ranked water use efficiency greenhouse emissions and soil health as the top three priorities(Figure 3)."

Grower survey participants were asked to nominate their top three environmental management issues for today. Water use efficiency out-ranked pesticide use and management, soil health, and fertiliser use and management. (Figure 2)

Shaping future direction

Implementing recommendations from its two previous environmental studies in 1991 and 2003 has significantly improved the industry and the 2012 assessment will shape industry's strategic direction for the next five to 10 years.

Bruce Pyke says the report had arrived at a critical time for the industry.

"With both Cotton Australia's (CA) and the CRDC's strategic planning for 2013-18 underway, the industry is well placed to address one of the report's key recommendations which is to develop a five-year RD&E strategy for continuous improvement in environmental management and performance in cotton growing," he said.

"Improving environmental performance on cotton farms is integrated into CRDC's current Strategic Plan within the Farming Systems portfolio, and now there is an opportunity to be explicit about the commitment to continuously improving environmental management and performance in cotton growing, with a view to improve information, enable collaboration, and improve the measurement of success for growers, government and the market.

"This will enable the Australian industry to demonstrate how it has improved environmental performance over time.

"The industry has agreed that by 2029 the Australian Cotton Industry will be '*Responsible – producer and supplier of the most environmentally and socially responsible cotton on the globe*' (*Vision2029*).

"Following and implementing the report's recommendations will better position the industry to respond to market-driven changes related to environmental performance."

Recommendations

Demonstrating good environmental performance and a commitment to continuous improvement are key industry objectives according to Bruce.

"Our industry has a strong history of taking ownership of areas where it is having environmental impacts and minimising them through the implementation of improved management based on sound R&D," Bruce said.

"Despite past achievements, the long term success of the industry continues to depend on how its practices, products and reputation are perceived by customers and the wider community and consequently this means it cannot rest on its laurels."

Six recommendations were made to industry to advance its environmental stewardship agenda and performance based on the assessment findings. Industry is now developing responses and an action plan to address these recommendations

RD&E Strategy

As a recommendation of the assessment, CRDC will continue to work with its grower base, Cotton Australia, the industry's value chain, cotton industry service providers, the Australian Government and relevant state government agencies to articulate a five-year RD&E strategy for continuous improvement in environmental management and performance in cotton growing.

*my*BMP

Cotton Australia and CRDC will undertake an appraisal of *my*BMP to ensure it more clearly adds value to cotton growing businesses and its industry level environmental stewardship objectives are clearly defined for both industry, external stakeholders and our markets.

Establishing databases

CRDC and Cotton Australia will work towards development of a more comprehensive database of cotton growers and key industry stakeholders to ensure industry organisations effectively engage levy-paying growers and influential stakeholders on industry plans and performance reporting regarding environmental management and practices.

Regular assessments

The industry will continue to commission regular, independent environmental assessments of cotton growing to establish longer-term trends in its environmental performance and data sets to provide evidence-based assessments over long periods. CRDC and Cotton Australia will also work to develop an

Figure 1. Adoption of the 46 recommendations made in the Australian cotton industry's second environmental assessment, 2012

industry wide agreed monitoring, evaluation and reporting framework support evidence based routine reporting on the outcomes of environmental management in cotton growing within a one to five timeframe.

Market-based initiatives

It is necessary for Australian cotton to access a ready market for sustainable cotton. To this end, Cotton Australia assisted by CRDC will continue to evaluate opportunities to achieve recognition for *myBMP* cotton as sustainably produced Australian cotton. This may be achieved in conjunction with existing programs such as the Better Cotton Initiative or more directly by working with key brand owners.

Cotton Australia has also agreed to actively engage Australian Cotton Shippers Association (ASCA) to identify systems to ensure a commercial pathway of sustainable produced Australian cotton through to the market that is reasonable and practical.

Continued market research

Industry needs to be armed with sophisticated market research information to influence the perceptions of consumers, the community, politicians, government officials and environmental groups. The information gathering and media world is changing rapidly and the industry needs to keep abreast of these changes so that its voice is heard and it is able to demonstrate its performance. Cotton Australia has recently commissioned a small market research survey on the perceptions of key policy makers of the cotton industry.

CRDC will engage with its industry stakeholders to communicate the role of research and development in improving the environmental performance on Australian cotton farms to the community through, for example, education and product initiatives. It will also team with Cotton Australia in using R&D-based information in a responsible way to better inform the community of the environmental performance on Australian cotton farms. CRDC and Cotton Australia will also work together to provide regular updates on new environmental key performance indicators.

Major achievements

The assessment found the industry has been substantially transformed since 2003 – through production practices, the cotton farming system and farm planning and management. Significant factors include considerable improvements in growers' water, chemical and natural resource management, particularly through the adoption of new technology.

Improved transgenic cotton varieties introduced since 2003 (Bollgard II, Roundup Ready Flex and Liberty Link) have provided growers with the opportunity to use more effective integrated pest management (IPM) practices, reduce insecticide use and decrease the use of more environmentally damaging residual herbicides.

Cotton Australia Policy Manger Angela Bradburn and cotton grower John Watson, "Kilmarnock" Boggabri sat on the industry steering committee guiding the assessment and subsequent delivery of the final report to industry. They were joined by committee members Bruce Pyke (CRDC), consultant Rachel Holloway, grower representative Nigel Corish, Ken Flower (*my*BMP), consultant Guy Roth and Jane Trindall, CRDC.

IPM

IPM links crop protection with conservation measures to encourage growth of beneficial insect populations, leading to substantially reduced use of chemicals and the disappearance of serious off-farm impacts in rivers and wetlands. Uptake of IPM and linking IPM to biodiversity conservation, in terms of ecosystem services on-farm and at a landscape scale has been significant.

Water

Major gains have also been made in water use efficiency (three to four percent per year) over the past 10 years, by taking up research and development, such as more water efficient varieties, evaporation mitigation, reducing leakage from channels and storages, capturing and recycling irrigation tailwater, managing stormwater and improving on-farm water quality.

Continued improvement

Cotton growers have improved soil management, riparian areas and native vegetation, hence contributing to increased biodiversity and the delivery of ecosystem services.

Growers responded in the surveys that better monitoring and reporting of the uptake of improved natural resource management practices and grower achievements was required.

The report praised the development of an integrated research, development and extension system, the Development and Delivery Program, that delivers priority research and development, extended to growers through *my*BMP and the activities of the industry's key organisations, such as CRDC, Cotton Australia, CSD and the commercial sector.

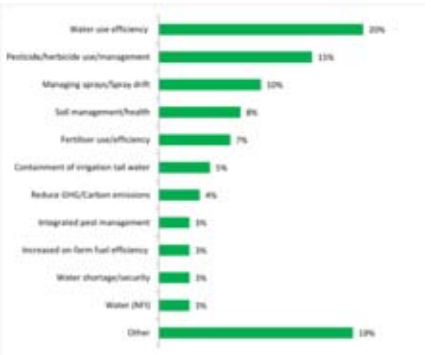

Figure 2. Grower perceptions on the top environmental issues today

NFI – no further information
Other – many issues, including tillage management, industry reputation, energy cost and efficiency, soil salinity, resistance of weeds and other pests, use of GM varieties, government policy/interference, carbon tax, mining impact on agriculture, reduce water storage evaporation and leakage, improve soil health, protect native vegetation, soil and leaf monitoring, increased electricity efficiency and implement BMP practices.
Source: Cotton Grower Environmental Performance Survey 2012

While evidence shows some improvements in energy use, greenhouse gas emissions and adaptation to climate change, the cotton industry is in an early development phase regarding improved practices and management in these areas. Improvements in the fuel efficiency of farm machinery and innovations to reduce traffic (eg round module harvesters and improved farming systems) will continue to be drivers for increased energy efficiency and reduce greenhouse gas emissions on cotton farms.

To obtain a copy of the final report, contact CRDC on 02 6792 4088. Previous audits are available on the CRDC website www.crdc.com.au

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NEW VENTURE SPEARHEADS RESEARCH TO FARM

THE NEW JOINT VENTURE ANNOUNCED AT THE 2012 COTTON CONFERENCE BETWEEN CRDC, COTTON AUSTRALIA AND COTTON SEED DISTRIBUTORS IS ALREADY PROVIDING THE INDUSTRY WITH A SUBSTANTIALLY REVITALISED DEVELOPMENT AND DELIVERY PROGRAM TO TAKE RESEARCH TO THE FARM AS QUICKLY AS POSSIBLE. D&D PROGRAM MANAGER IAN TAYLOR REPORTS.

Development & Delivery Mangement Team – CSD Managing Director Peter Graham, CSD General Manager Steve Ainsworth, Cotton Australia's Policy Manger Greg Kauter, D&D Program Manager Ian Taylor, Cotton Australia CEO Adam Kay, CRDC Farming Systems Program Manager Tracey Leven and CRDC Executive Director Bruce Finney.

Just months after the announcement, progress to implementing this comprehensive initiative is already well underway.

The principal goal of the venture is to provide new resources and energy into turning research into best practice. A new Development & Delivery (D&D) services team is already building and working to improve responsiveness to grower needs through better communication and regional representation.

The management committee formed at the inception of the joint venture has built upon the already strong skills base of industry specialists put in place since the drought. A regional information delivery network with up to seven new people will play a key role of ensuring that all growers, consultants and advisors have access to the latest research information and that the information they have is strongly relevant for each region. This includes local trials where necessary to ensure that research outcomes can be better adapted to meet local needs.

Local Regional Development Officers (RDOs) will be employed by CSD (as their direct investment in the D&D Program joint-venture) and work in a dedicated new network that will drive industry R&D communications between researchers, growers, consultants, agribusiness, NRM as well as cotton and other industry organisations. The RDOs will work alongside and complement the activities of the existing CSD Extension and Development (E&D) team. This new approach to research communication will address both immediate and longer-term issues. It will also provide another important feedback loop back to CRDC and Cotton Australia through their technical panels, about grower needs and research priorities and the usefulness of existing R&D in supporting grower profitability.

The cotton RDO services team will become a key resource for industry's capacity to respond to emerging or emergency issues, whether at a regional or national level. This services team will assist industry to respond to immediate challenges cotton farmers are facing – whether they are agronomic in nature or as a result of a biosecurity or natural disaster event. It is intended that they will provide essential support to the industry's biosecurity preparedness and surveillance effort. Interviews for these positions commenced in November and it is expected that we will have some excellent people in position by the end of 2012 or early in the New Year.

"*my*BMP.COM.AU IS BECOMING THE PRIME INFORMATION DELIVERY CHANNEL FOR THE LATEST RESEARCH KNOWLEDGE."

Why invest in D&D services?

CRDC, Cotton Australia and CSD are jointly investing to address three key objectives which have become a high priority after the recent prolonged drought:

- Improve industry practices
- Improve communication of research
- Improve responsiveness to support growers and to meet industry needs

Immediately following the announcement of the joint investment initiative, a detailed operating plan was developed and will be implemented by the end of 2012.

Targets for both the long term and short term are set. Researchers and industry technical specialists have worked on developing new information campaigns that address specific industry needs. These include high priorities that underpin farm profitability such as water use efficiency, nitrogen use efficiency, energy efficiency, stewardship, pest, weed and disease management, biodiversity and natural asset management at both the farm and landscape scale.

The new team of RDOs will then work with growers and advisors to channel the information required to address specific on farm issues or matters of concern. Their role is also

HOW WE WILL IMPROVE OUR SERVICE TO INDUSTRY

- *my*BMP.com.au is becoming a primary information delivery source (taking over from the website of the former Cotton CRC)
- Cotton Regional Development Officers will be positioned in major cotton growing regions
- Regional Development Officers will provide important feedback on research gaps and needs
- The Regional Development Officers will co-ordinate/run local trials to ensure research results are adapted to meet local needs
- The new D&D services team will be highly responsive to grower needs
- Specialist information services will be developed and provided exclusively to enable consultants and advisors to provide the best research-based advice to their growers
- Technical specialists will help to develop and deliver knowledge to enable realisation of grower best management practice goals

to provide a more direct system for grower feedback via the technical specialists and researchers. It is expected that industry feedback will communicate gaps or where further research may be required to make outcomes more relevant to specific regions and localities.

New role for *my*BMP

Underpinning information delivery with the new D&D services team will be *my*BMP (*my*BMP.com.au)

The *my*BMP website will become the primary information delivery platform for research information to the industry. While *my*BMP is already an excellent information source, we intend to further enhance the capability of *my*BMP for information delivery as well as build in linkages to other sites such that growers and advisors are better supported in their information needs. To deliver against this goal the current content in the *my*BMP modules will be assessed and Best Management Practices reviewed to better define actual best practice and streamline the certification processes. *my*BMP.com.au is becoming the prime information delivery channel for the latest research knowledge, and the new full services are expected to be available through the 2012-13 growing season.

Certification (of best practice) still remains a key goal of *my*BMP and full certification services will continue to be fully supported for farms who want to achieve the highest level of best practice recognition, both for the farm and the bales it produces.

The services offered by the D&D services team are complementary with growers' existing information and knowledge services provided by agribusiness, agronomy consultants, state and federal departments and most importantly as partners with a number of organisations seek to leverage and extend the reach of cotton R&D to better meet grower needs.

THE D&D TEAM

(See *my*BMP.com.au for contact details)

David Larsen,
NSW DPI, Myall Vale
Information Management

Duncan Weir, QDAFF Toowoomba
Cotton Nutrition and Soil Health

Geoff McIntyre, Dalby
*my*BMP on-farm certification services

Ian Taylor, CRDC Narrabri
Development and Delivery Services Manager

Jane Trindall, CRDC Narrabri
Natural Resource Management

Janelle Montgomery, NSW DPI, Moree
Water Use Efficiency (NSW)

Jim Wark, Cotton Australia, Toowoomba
*my*BMP manager

Kirrily Blomfield, AgVance
Network development – Agvance and Upper Namoi CGA

Lance Pendergast, QDAFF
Water Use Efficiency (Qld)

Loretta Clancy, CSIRO, Myall Vale
Agronomy tools software developer

Peter Verwey, NSW DPI Myall Vale
Geospacial technologies

Rebecca Rogan, Cotton Australia, St George
*my*BMP website content and *my*BMP user support

Rohan Boehm, CRDC Narrabri
Communications and Marketing Manager

Sal Ceeney, Macquarie Regional Office, Warren
Bt and Insecticide Stewardship

Sally Dickinson, GVIA, Landcare, Moree
Regional Landcare Facilitator – Gwydir

Sandra Williams, CSIRO Myall Vale
*my*BMP Research Co-ordinator and Webtools

Stacey Vogel, Namoi CMA, Narrabri
Natural resources and catchments Namoi

Susan Maas, CRDC Emerald
Senior Technical Specialist

Tracey Leven, CRDC Narrabri
Program Manager Farming Systems

Trudy Staines, PICSE, Myall Vale
Education and curriculum liaison

Regional support team – up to 7 officers to be appointed during 2012-13 Regional Development Officers

The D&D services team will provide direct services to growers where this is not already met in the marketplace and in taking this direction, will seek to streamline information delivery, not duplicate existing services.

Contact Ian Taylor, Manager- Development & Delivery Program – 02 6792 4088
ian.taylor@crdc.com.au
Or D&D Services team members and information services via *my*BMP.com.au

email us

OUR PEOPLE, OUR HISTORY

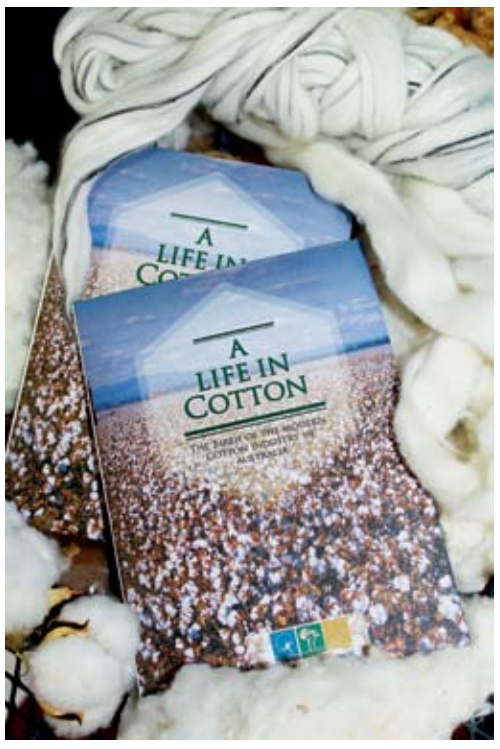
The modern Australian cotton industry took off in the early 1960s and has faced many obstacles and challenges in its growth to become the producer of the highest quality and most efficiently grown cotton on the globe. The unprecedented marrying of research, science and application has created one of the most forward-thinking and prosperous agricultural industries in Australia.

A Life In Cotton – The birth of the modern cotton industry in Australia charts the industry's course from the early days, with interviews from some of industry's most well-known faces and pioneers. In one of the last Cotton CRC projects, the documentary captures the knowledge and history of the pioneering growers, researchers and consultants at an important time for the industry as it undergoes a significant generational shift.

"The cotton industry, as opposed to other primary industries in Australia is quite young, so our pioneers are still around to tell their stories," says former Cotton CRC program manager Paula Jones.

"A lot of these pioneers are retiring or have retired, so it was important to capture their knowledge and put it all together in this production as a visual history for the industry – our story – told through the eyes of those people who were instrumental in making the industry what it is today."

A Life In Cotton – The birth of the modern cotton industry in Australia is free and available by contacting CRDC on 02 6752 4088.



Central Highlands Cotton Growers and Irrigators Association Chair Ross Burnett is supportive of increased awareness about *Come clean. Go clean.*

SIGN UP TO COME CLEAN. GO CLEAN

CRDC SENIOR TECHNICAL SPECIALIST **SUSAN MAAS** IS SPEARHEADING THE INDUSTRY CAMPAIGN TO INCREASE AWARENESS AND ADHERENCE TO FARM BIOSECURITY.

"Seeds from difficult to control weeds or herbicide resistant weeds, as well as diseases and pests can all be delivered right to your doorstep – on to your farm and into your fields if you don't *Come clean. Go clean,*" warns the biosecurity specialist.

"It takes time and effort, and the reward won't necessarily be noticeable in the short term, but the benefits in preventing these added problems from coming onto your farm are very real.

"Industry has partnered with AgriRisk to help growers communicate their commitment to *Come clean. Go clean.*

"For a limited time, growers can order AgriRisk *Come clean. Go clean.* farm signs and/or equipment stickers to raise awareness on their farms, improve their farm hygiene and lessen the risks associated with weeds, diseases and pests.

"Communicating *Come clean. Go clean.* requirements is important in ensuring that all visitors and workers are aware of the requirements."

Ross Burnett, Chair of the Central Highlands Cotton Growers and Irrigators Association is supportive of increased awareness about *Come clean. Go clean.*

"The Central Highlands are very familiar with the impact that is seen through pest and disease incursion.

"We actively promote the issue of *Come clean. Go clean*. throughout our local area and are glad to see this issue promoted through an increased national profile, and increased cross industry collaboration.

"*Come clean. Go clean.* takes commitment. It takes time to stop equipment and wash it down properly, but if you prevent a new pest or disease coming on to your farm, just once, it will be time well spent."

ACRI Manager David Halliday signs onto the Come clean. Go clean. campaign.

To place your sign and sticker order please e-mail ComeCleanGoClean@*my*bmp.com
For more information contact Susan Maas – susan.maas@crdc.com.au

email us

NSW DPI weeds researcher Graham Charles is considered a leader in the field of weed control, resistance and herbicide damage. He is pictured sharing his thoughts with grower Darren Eather, one of the hosts for the day.

VALUE IN TWO-WAY INFORMATION FLOW

COTTON GROWERS AND CONSULTANTS IN THE UPPER NAMOI HAD PLENTY TO TALK ABOUT WHEN THEY HAD 16 LEADING COTTON INDUSTRY RESEARCHERS ALL TO THEMSELVES FOR A DAY.

The Cotton Researcher Tour in November was organised by Upper Namoi Network Development Officer Kirrily Blomfield and CSIRO Plant Industry Research projects officer Sandra Williams.

The day provided a huge opportunity for information exchange between the people growing the plant and those researching, improving and protecting it. Providing greater 'unstructured' access to researchers is proving popular and beneficial in developing greater understanding from a growing as well as a researching perpective.

The 16 touring cotton industry researchers from the Australian Cotton Research Institute (ACRI) are involved in all areas of cotton production including soil science, weed management, pest and beneficial management/Integrated Pest Management, crop nutrition, plant physiology, water management and diseases and disorders of cotton. They travelled to farms at Maules Creek and Boggabri where they were quizzed by over 20 local cotton growers and consultants.

"The day was a great concept – connecting growers and researchers," said host Darren Eather, "Bellvue" Maules Creek.

"It was very informative, with some information that was new to me, as well as the cementing of my current understanding of other issues

"I particularly liked the information about root rot and its management, a discussion which arose from one of the fields we walked in on the day."

Connecting industry

Co-organiser Sandra Williams says it was a very informal day that "connected researchers to growers and exposed researchers to the practicalities of commercial cotton production systems".

"The tour allowed growers and consultants to 'set their own agenda' discussing topics of their choice. This was a big reason the day was seen as so successful based on the feedback we received.

"Lewis Wilson said it was a fantastic way to see it first-hand what is happening in the field and some of the challenges that growers are faced with.

"Michael Braunack was pleased to see the interaction between growers and researchers, he said the topics raised were local and of concern to

NSW DPI's Dr Robert Mensah is a Principal Research Scientist and Centre Director of the Australian Cotton Research Institute. He is a leading researcher in the fields of integrated pest management, habitat diversification and conservational biological control, biopesticides, semiochemicals and spray oils in pest management. He has developed two alternative products for pest control, Magnet and Plant X.

those growers who attended, while it helped to identify extension issues in irrigation scheduling and crop nutrition for Rose Brodrick.

"It is easy to see from the comments that these types of interactions have positive benefits for both researchers and growers and the flow on to the industry at large, as we provide opportunities for researcher-grower interactions," says Kirrily, who is employed through AgVance and Upper Namoi Cotton Grower Association, with support from CRDC as a pilot project under its Grass Roots Grants program (see Page 14).

Successful facilitation

Kirrily is an experienced facilitator and is skilled at listening effectively, asking the right questions and using open ended questions.

"At the same time she has a high level of knowledge in agronomy and also makes a point of knowing what researcher is doing what," Sandra Williams says.

"We went with this successful unstructured approach as we'd done a similar thing a couple of seasons ago and it worked very well, and by going unstructured the growers could discuss what they wanted."

Kirrily said the day certainly helped her collect her thoughts on where grower or industry understanding may vary from what research is showing – and "hence areas that may need more work (from me) in regard to delivering research findings and trials".

"The issues raised while at Darren Eather's were regulating cotton growth, cotton nutrition, variety performance, disease management, early season aphid management, weed management and cotton stubble management.

"The main discussion at Andrew Watson's was around irrigation scheduling, specifically relating to his new lateral move irrigation system."

The tour group enjoyed lunch in the garden at "Kilmarnock", with thanks to Queensland Cotton for catering and the Watsons for the location, which provided the perfect setting for further discussion with the researchers.

Touring researchers were CSIRO's Mike Bange, Michael Braunach, Rose Brodrick, Katie Broughton , Graham Charles NSW DPI, Loretta Clancy CSIRO, Nicola Cottee, CSIRO's Sharon Downs, Nilantha Hulugalle NSW DPI, David Johnston, Karen Kirkby NSW DPI, NSW DPI's Robert Mensah, Ian Rochester CSIRO , Mary Whitehouse and CSIRO's Lewis Wilson.

"THE TOUR ALLOWED GROWERS AND CONSULTANTS TO 'SET THEIR OWN AGENDA' DISCUSSING TOPICS OF THEIR CHOICE."

GROWER ANDREW WATSON EXPLAINING HIS LATERAL MOVE IRRIGATION SYSTEM AT "KILMARNOCK" BOGGABRI IN NORTHERN NSW.

"The best part of the day was that researchers were able to appreciate directly the issues that growers are concerned about. Growers were able to question researchers about any specific issue they are trying to make work on their farm. Such questioning helps to inform the researchers for the time when they come to plan their research, such that they can specifically address 'grower-in-paddock' issues. It was great to have input from researchers like CSIRO's crop physiologist, Michael Bange, who are fully involved in the industry and through their in paddock trial work are able to give a real 'touch and feel' answer," Andrew said.

MEET YOU AT THE SHED...

HAVING ACCESS TO LEADING RESEARCHERS THROUGH INFORMAL ON-FARM DISCUSSION GROUPS OPENS A VALUABLE TWO-WAY INFORMATION FLOW.

One of the industry's best known entomologists, Lewis Wilson travelled to "Sappa" just north of Moree with researcher Tanya Smith, where 25 agronomists, consultants, growers and other industry people were gathered. Lewis's visit was requested by the Redmill Area Wide Management group who had reported large numbers of aphids in winter crops and so felt they could benefit from up-to-date information on management, chemical groups and resistance.

The afternoon was then facilitated by Sally Dickinson of regional landcare facilitator with Gwydir Valley Irrigators Association, who has been working with local area wide groups.

"By tailoring these meetings directly to the needs of growers and consultants is what makes them successful," Sally said.

"This type of meeting provides a forum where information goes not only from researcher to grower but also from the farm level back to researchers, meanwhile there is also grower to grower and consultant interaction.

"It's a good 'catch up' which can often serve to recognise any emerging trends, discuss management decisions and in the case of an identified issue, develop area-wide action plans.

"The afternoon also facilitates people coming together where all sorts of issues can be discussed – not just what's on the agenda and there's nothing like good old fashioned face to face conversation with leaders in their field.

"We are so fortunate here to have access to researchers and scientists like Lewis – they are a real draw card."

Lewis said he found the meeting beneficial for many reasons.

"As a researcher it is always good to go to an industry generated meeting and talk to a group that has identified an issue and is really interested to hear what you have to say and is willing to push you out of your comfort zone a bit," he said.

"Sally does a great job and the way she went around the group and drew out the concerns was excellent – it gives me a good picture of what is happening, the level of understanding of the issues and really helps me target what I say more to what they want to know about.

"The two way interaction is very valuable – particularly the questions – because this helps me surface areas where our knowledge is good and areas where it is weak and needs more research or more backup reading, or contact with someone else that knows more.

"Australian growers and consultants are pretty switched on and really pick up on any new information. Sally did a survey around the room at the end and I was amazed at how each person had picked up on a particular point that was new or valuable to them.

"It was the first time my research assistant Tanya Smith had been to this sort of meeting also enjoyed the chance

ABOVE: Sally Dickinson and Auscott "Midkin" manager Owen Berry.
BELOW LEFT: Consultants Mal McNiven and Ben Dawson has a chance to swap notes at the afternoon get together.

"THE TWO-WAY INTERACTION IS VERY VALUABLE – PARTICULARLY THE QUESTIONS – IT HELPS IDENTIFY WHERE OUR KNOWLEDGE IS GOOD OR WEAK."

CSIRO Entomologist Lewis Wilson explains the finer points of aphid identification and management.

to pass on some of her knowledge.

Lewis liked the smaller groups because there is more interaction and it's better for building relationships.

"Meanwhile, I have also had long associations with many of the people at the meeting, for example, I met Jeremy Kitchen within weeks of coming to Narrabri when I was doing work out at "Noonan Plains" west of Moree, so it is good to catch up about other issues and trends as well."

REFORMING GROWER GROUPS

SALLY DICKINSON AND GWYDIR VALLEY COTTON GROWERS ASSOCIATION (GVCGA) HAVE BEEN WORKING TO HELP RE-ESTABLISH AREA WIDE MANAGEMENT GROUPS IN THE GWYDIR VALLEY.

These groups play an important role in identifying area-wide issues and developing a regional response to the issue and then carrying it out.

Sally said the groups played a crucial role in organising a flood recovery response, by using the network to assist in identifying needs and disseminate information about crop management post flooding.

The "Midkin" group have used the network to address feral pigs and co-ordinated control methods, with great success.

Informal networks of growers are now at "Redmill", South Moree, "Midkin", "Keytah"/"Tellerega", Mungindi and Rowena, which constitutes a large area of cotton growing areas in every direction around Moree.

"With further support from Gwydir Valley Irrigators Association and CRDC, I have been able to offer a facilitation role.

"These groups are grower-driven – the group sets the agenda, time, date place if there is a need for a meeting to discuss issues.

"I help provide the link between the group and industry, so am able to, for example organise information from researchers and scientists in response to the needs of the growers."

CSIRO's Mike Bange, Ian Rochester and Lewis Wilson, with David Lester (Qld DAFF) have all visited the various groups and have been invaluable in their presence.

Representatives from CSD, agribusiness and other stakeholders also attend meetings or workshops to offer information and support for growers and consultants, organised through the area wide groups.

"These really informal networks of growers/consultants are expanding and evolving, we still have people coming on board, and would like to see more," says Sally.

Interested in the benefits of becoming part of a grower network?

Contact your local CGA, cotton industry Regional Development Officer or Cotton Australia representative.

Sally Dickinson 0427 521498

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email us

GETTING BACK TO NATURE

A GUIDED NATURE TOUR WHILE LEISURELY KAYAKING ALONG THE NAMOI RIVER WAS THE PERFECT WAYS FOR LOCAL LANDHOLDERS TO SURVEY THEIR SURROUNDS.

The Cotton Growers Working Together for a Sustainable Landscape project is bringing growers together to contribute to the ongoing conservation and protection of biodiversity in their districts. This exciting project is trialling new ways to engage growers and their families to better understand and manage natural assets on cotton farms. The contribution cotton farms can make nationwide to arresting biodiversity decline is poorly understood and projects such as this enable us to better measure our performance and tell our story or the wonderful diversity on cotton farms.

In the Namoi engagement has focused on families using existing social networks and has proven to be very successful.

A spotlighting night along the Namoi was also well supported, with just over 100 people turning up for the enjoyable and educational events. The warm, spring conditions were perfect for both events, and the kayakers were lucky enough to spot plenty of wildlife as they paddled down the river, including water rats, snakes and a wide variety of birdlife from small finches to large eagles.

Stacey Vogel of the Namoi Catchment Management Authority (CMA) and Cotton D&D NRM Technical Specialist organised the initiatives.

"Renowned ecologist Phil Spark was the guest presenter and captured a wide variety of local wildlife, including eight types of frog, six species of bats and lots of reptiles, to amaze all with the animals that live in our own backyard," Stacey said.

Phil said the area along the Namoi River has rich diversity and an abundance of wetland and woodland fauna."It is the only location where I have recorded the three owls –barking owl, boobook owl and barn owl together, and it is particularly significant for its population of pale-headed snakes and abundance of brushtail possums," he said.

"Unfortunately the riparian habitat is threatened by numerous exotic weeds which are rapidly invading and displacing native plants."

"The events were a good way to showcase to landholders some of the amazing diversity of native animals and plants we have here," Stacey said.

"Targeting social networks gives you a group to work with that feel comfortable around each other and enjoy getting together, I am just providing the event "

CRDC NRM Program Manager Jane Trindall says "Our partnerships with CMAs and Landcare have been a good platform to build on to improve biodiversity on cotton farms. In the different regions delivery can be guided by local situations, priorities and preferences."

Spotlight night unearthed all sorts of creatures for Jack Lennon who is holding a red naped snake while Dan Haire looks on.

This project is funded through the Australian Government's Caring for our Country program and supported by CRDC, Namoi Catchment Management Authority, Gwydir Valley Irrigators Association, New England North West Landcare and the Border Rivers Gwydir CMA.

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BE ALERT AND REPORT

PEOPLE WORKING ON COTTON FARMS ARE AT THE FOREFRONT OF AUSTRALIA'S BIOSECURITY AND DISEASE CONTROL, AS THEY ARE THE EYES OF THE INDUSTRY 'ON THE GROUND'.

To minimise the harm from cotton pests and diseases, CRDC is encouraging growers, consultants and agribusinesses to use the free and confidential information service from professionals if they see something they are unable to, or have trouble identifying. This service, PathWAY, is available for cotton disease enquiries, identification and advice.

Pathologists and cotton specialists from NSW DPI, CSD, Qld DAFF, CSIRO and Cotton Australia are working together under the newly developed PathWAY system which facilitates the collection of enquiries, quantifying the nature of enquiries and the action taken. Pathologists are kept up to date with all enquiries received, enabling early detection of disease and pest threats and/or trends from an individual farm level, area-wide and industry-wide perspective. On the spot information facilitates industry and growers to respond quickly with appropriately targeted and co-ordinated response.

"As the season moves along, enquiries to industry experts are increasing, and I would really like to encourage growers/consultants to take advantage of this very helpful and important service, if they have any queries at all," said NSW DPI pathologist Dr Karen Kirkby, who developed PathWAY.

D&D Specialist on Geospatial Technologies and Mobile Apps Peter Verwey and D&D Marketing Manager Rohan Boehm have been working with the D&D team to convert the Cotton Symptoms Guide into a mobile application, which will be available for download in February next year from the *my*BMP website.

"We have received 32 enquiries since we started collecting information in July and the nature of enquiries has been varied, with general enquiries such as emergence problems and fertiliser burn to isolating pathogens.

"In October we received 19 enquiries regarding early season diseases, emergence problems, replanting, fertiliser burn and insect damage to roots.

"Earlier in September there were four enquiries encompassing researchers, consultants and agribusiness, on methods for isolating pathogens, rating diseases and amendments for disease suppression.

"We also had enquiries in July and August, which are traditionally thought of as 'quiet times' as far as people looking for this type of information or advice."

Karen has encouraged growers and consultants to familiarise themselves and their staff with the symptoms of diseases and disorders of Australian cotton.

"The *Cotton Symptoms Guide* is a great resource that is now available in both in hardcopy from industry agribusiness partners and as an electronic download that can be used on tablets from the *my*BMP website," she said.

WHAT TO DO IF YOU SUSPECT SOMETHING...

- Resist the urge to immediately remove plants from the field as this may spread the problem. Take a photo and mark the location, so that you can return to sample the plants if required.
- Make a note of the distribution, incidence, and severity of the symptoms, as well as the crop stage and contact your state cotton pathologist.
- Don't forget that on leaving the field, thoroughly clean down your boots and equipment such as shovels and restrict further access until results are confirmed.
- The pathologist can then advise the best way to collect and send the samples, and will also ensure that there will be someone available to receive and diagnose the samples.
- All inquiries are handled confidentially, with results only released to the submitter and, in the case of an exotic pest, the relevant state authority.

WHO TO CONTACT?

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For a copy of the Cotton Symptoms Guide go to www.crdc.com.au and for the Cotton Farm Biosecurity Manual, contact Cotton Australia www.cottonaustralia.com.au or Plant Health Australia www.phau.com.au.

For further information regarding on-farm biosecurity see the farm biosecurity website www.farmbiosecurity.com.au.

see our website

GRASS ROOTS FUNDING LEADS TO IMPROVED EFFICIENCY AND KNOWLEDGE FOR INDUSTRY

Tandou Gin has used the CRDC Grass Roots Grants to address reusable energy sources and gin efficiency. Pictured is gin manager Steve Jessett.

WITH A RELIANCE ON LPG AND ITS COST CONTINUALLY RISING, COUPLED WITH A WIDER PUSH TO IMPROVE ITS CARBON FOOTPRINT, TANDOU GIN IS INVESTIGATING RENEWABLE ENERGY SOURCES.

After a five year hiatus due to drought the Tandou Gin was fired up again in 2011. Situated at Lake Tandou, it uses two upland saw gins stands and eight Pima roller gin stands, exclusively for cotton produced by Tandou Farm. The 36,000 bale crop in 2010 was the farm's largest through the gin since 2004.

With cotton ginning relying heavily on LPG to dry cotton and the price of LPG gas rising 90 percent over the past six years, Tandou Gin, located near Menindee in the south west of NSW, undertook a feasibility study into using ginning by-products in a biomass burner to offset the cost of LPG.

The study was supported by CRDC through its Grass Roots Grants program, which is tailored for local groups such as cotton grower associations to undertake projects.

"The Grass Roots Grant was used to commission an engineer to conduct a feasibility study into installing a biomass burner at Tandou Gin," says Tandou's Environmental Manager David McClure.

"I can highly recommend other CGAs contact the CRDC with any ideas that may lend itself to a Grass Roots Grant as our experience has been very satisfactory.

"The grant process was pretty straight forward and support was always available if I had any questions in regards to the grant application process."

"FIVE YEARS AGO I CAN'T REMEMBER ANYBODY TALKING ABOUT THE COST OF ELECTRICITY AS A MAJOR INPUT, BUT TODAY IT IS COMMONLY DISCUSSED"

David McClure

The Tandou study indicated that a biomass burner can successfully utilise gin trash to provide the necessary heat for most ginning situations, but also highlighted that our gin was using more LPG than the industry average to process our crop.

"Given that it was our first year back in the industry for some years it was decided that upgrades and modifications inside the gin took greater priority over directing resources to as yet unproven technology," David said.

"These upgrades and modifications have been very successful and our LPG usage has been greatly reduced. Furthermore the study has led to Tandou committing resources to conducting an energy audit over its entire operation in an effort to highlight opportunities for improvement in regards to its energy use.

So while the biomass project is on the "back burner" for now, there are federal subsidies available for alternative, or complementary energy projects, which may reduce the capital expenditure required and make the biomass burner more economically viable.

David said in order to access these funds it is necessary to complete a

Tier 2 Energy Audit under the NSW Government's Energy Saver program. This audit encompasses all of Tandou's activities and operations and they are currently about halfway through this process.

"It is envisaged that among other energy saving projects resulting from the audit will be a business case that we can submit to the relevant federal authority for assistance in constructing and commissioning a biomass burner at our gin," David said.

"Using energy more efficiently is only going to become more important in the future.

"Five years ago I can't remember anybody talking about the cost of electricity as a major input for agricultural production, but today it is commonly discussed," he said.

"The indications are that large increases in retail and network electricity charges are already pencilled in for the next couple of years – so the discussion is only going to become more important.

"The Energy and Input module in the *my*BMP program is a good reference tool for growers concerned about their energy use."

In the initial biomass burner feasibility study, cotton gin trash, upland cotton seed, Pima seed and cotton stalks were all assessed for use.

Gin trash was identified as the most suitable as this by product is found at the point of use, is relatively easy to handle, has in excess of the energy required and is a waste product that otherwise has to be disposed of. The design concept was that the biomass burner would supply base heating up to 70 degrees Celsius at which time the existing LPG burners would cut in if required.

The study showed that waste streams produced as a by-product of ginning allow a move away from the reliance on LPG for heating needs. The technology to produce a hot air stream is not complex or overly capital intensive and hence risks employing this approach are minimal as the gin retains its existing design.

For more information on how to apply for a grant contact Sally Hunter at FundBase 0459 944 778, sally@fundbase.com.au or Bruce Pyke at CRDC on 02 6792 4088, bruce.pyke@crdc.com.au

email us

OPPORTUNITY THROUGH FUNDING

CRDC's Grass Roots Grants Program is an innovative program designed to stimulate grower-led projects to build capacity of growers and other industry people at the 'grass roots' level and improve the communities in which they operate. All Cotton Grower Associations and other informal grower groups are encouraged to apply. CRDC's Program Manager Bruce Pyke said they would ideally like to have an application from each of the 14 CGAs across the industry, with grant of up to $10,000 available.

"The grant criteria are deliberately broad to encourage a range of projects from across the regions," he said.

"I would really like to invite all CGAs to think about a need or project they would like to address.

"Experience in handling funding and projects is not a pre-requisite, as we have Sally Hunter of FundBase available to talk them over and get them going."

Grass Roots Grants is seeking projects that:
1. Help with ground truthing and testing of R&D findings
2. Help improve the levels of adoption of R&D outcomes
3. Help improve the levels of adoption of *my*BMP
4. Grow the skills and knowledge base of cotton growers and their communities
5. Grow the economic and/or social base of cotton grower groups and their communities
6. Increase networking between growers, consultants and researchers
7. Encourage new growers to the cotton industry
8. Strengthen collaboration across communities, across industries and regions.

"I WOULD REALLY LIKE TO INVITE ALL CGAS TO THINK ABOUT A NEED OR PROJECT THEY WOULD LIKE TO ADDRESS."

ABOVE: Sally Hunter (right) is helping grower associations navigate through the grant and project application process on behalf of CRDC. Sally helped Upper Namoi CGA successfully obtain a grant to help employ Network Development Officer Kirilly Blomfield to support new growers in the lower end of the valley.

Examples of projects already undertaken are the purchase of a weather station allowing Walgett Growers to participate in the IrriSAT Project, the employment of a Network Development Officer to facilitate information/knowledge exchange between existing and new growers across cotton and grain farming systems in the Upper Namoi; and the Macquarie Cotton Growers Welcome Back Project, in response to an increase in new grower numbers aimed at promoting engagement in the industry.

Applications are open until June 2013 with the maximum funding level $10,000, however projects that demonstrate collaboration with more than one partner or that cover a wider geographical area may be considered for higher levels of funding.

Potential applications are encouraged to discuss their proposals with Sally Hunter of FundBase in the first instance.

Sally Hunter 0459 944 778
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MONITORING TO MANAGE

RESULTS FROM LAST SEASON'S RESISTANCE MONITORING PROGRAM OFFER GROWERS AND CONSULTANTS MANAGEMENT INSIGHT FOR THIS SEASON.

NSW DPI entomologist Dr Lisa Bird is interested in hearing from landholders who may have experienced control failures in order to determine whether selection for resistance has occurred.

NSW DPI entomologist Dr Lisa Bird leads the CRDC-funded project *Helicoverpa insecticide resistance: monitoring, management and novel methods of Helicoverpa control on Bollgard II cotton* which focuses on monitoring resistance frequencies in field populations of *Helicoverpa armigera* and *Helicoverpa punctigera* to key insecticidal chemistries used within the cotton farming system. The monitoring program is based at the Australian Cotton Research Institute (ACRI) near Narrabri.

Results from last season (2011-12) show very low resistance frequencies (<1 percent) in *H. armigera* to organophosphates, indoxacarb, emamectin benzoate and rynaxypyr.

"This indicates that these products will continue to be effective in the control of *H. armigera* this season," Lisa said.

"Nevertheless, the cotton IRMS (Insecticide Resistance Management Strategy) should be followed to ensure that selection pressure applied by any one of these chemical groups is minimised across multiple generations of Helicoverpa."

The IRMS recommends:

- Avoiding repeated applications of products from the same group.
- The use of chemical rotations even when targeting different pests.
- Compliance with maximum number of recommended sprays for any one chemical group.

Resistance to carbamates remains widespread and stable in *H. armigera* with resistance frequencies continuing at moderate levels. This indicates field performance of methomyl against *H. armigera* may be highly variable.

Pyrethroid resistance increased significantly for the first time in many seasons. There has been an increase of 30 percent for both general pyrethroid resistance and bifenthrin resistance compared to the previous year. The frequency of resistance to general SPs is now 90 percent while bifenthrin resistance frequency is 40 percent.

"These levels indicate that the use of general synthetic pyrethroids (SPs) will give unsatisfactory results against *H. armigera* and that the performance of bifenthrin may also be variable. However, *H. punctigera* remains fully susceptible to SPs and will continue to provide effective control for this species," Lisa said.

"Therefore it is important to consider species composition before applying these products in order to maximise the economic benefits of the application."

As well as correct insect identification sustainable pest management is also underpinned by crop monitoring and the use of recommended pest thresholds. More information is available on pages 68 – 71 of the current Cotton Pest Management Guide.

Growers and consultants are encouraged to take advantage of the NSW DPI's Helicoverpa speciation service for providing information relating to on-farm species composition.

"We would also encourage growers and consultants to provide information that could assist with developing a greater understanding of insecticide resistance, particularly for the more selective chemistries to which resistance has not yet developed," Lisa said.

"We are interested in hearing from landholders who may have experienced control failures in order to determine whether selection for resistance has occurred.

"Early detection of insecticide resistance in the field is key to the success of the IRMS because it allows implementation of tactical responses to reduce pest damage and minimise the spread of resistance genes in the insect population."

Reports can be made or information obtained by contacting Dr Lisa Bird on 02 76992428 or e-mail lisa.bird@industry.nsw.gov.au.

email us

The insecticide resistance monitoring program is part of a larger pre-emptive management strategy aimed early detection of resistance in the Helicoverpa population.

"The earlier we can detect resistance in the field the more effectively we can manage the risk before field failures start to occur" Lisa said.

"The fact that insects have an enormous capacity to evolve and become so superbly adapted to their environment in such a short time provides great challenges for pest management, but also provides great opportunities for scientific outcomes in terms of characterising resistance and using this information to formulate robust strategies to mitigate future resistance risk."

Helicoverpa egg sampling each season extends from central Queensland to southern NSW with egg collection teams at Emerald, Darling Downs, St George, Goondiwindi, Mungindi, Namoi Valley, Macquarie Valley and the Riverina. Eggs are collected from all known hosts including weeds, cotton, sorghum, maize, sunflower, chickpea and other pulses.

The eggs are then tested at ACRI near Narrabri where they are reared to larvae and tested with a dose of insecticide known to kill susceptible insects. Survivors of the discriminating dose are deemed resistant. The range of insecticides tested incorporate key insecticidal groups, with data used to determine regional resistance status and identify any changes in resistance frequencies.

CSIRO Researcher Sharon Downes has been monitoring Heicoverpa's resistance to the enw additional gene in Bollgard III, a vegetative insecticidal protein (Vip3A). "Some Helicoverpa in the population already carry the gene for Vip3A resistance, so the industry will still need to carefully manage resistance by this pest to Bollard III," Sharon says.

RESISTANCE REALITY

AS WE EDGE CLOSER TO THE RELEASE OF BOLLGARD III, INDUSTRY EXPERTS DISCUSS THE PREVALENCE OF VIP3A RESISTANCE GENES ALREADY IN HELICOVERPA AND WHAT THIS MEANS FOR MANAGEMENT OF THE TECHNOLOGY.

The insecticides engineered into transgenic cotton come from a soil bacterium called *Bacillus thuringiensis* (Bt) which produces several different types of toxins. The two toxins in the current variety of Bt-cotton are crystalline or Cry toxins (Cry1Ac and Cry2Ab).

Genes that enable resistance to Cry toxins were detected by CSIRO in populations of *Helicoverpa* species even before these insects were exposed to Bt cotton. In Australia there have been no reports of field failures of Bollgard II due to resistance but the proportions of *Helicoverpa* spp. which can withstand the Cry2Ab toxin has increased since the cotton variety expressing this toxin became available.

"Although *Bacillus thuringiensis* produces many distinct types of Cry toxins, Helicoverpa species are only susceptible to those in the Cry1 (eg Cry1Ac, Cry1Ab, Cry1F) and Cry2 (eg Cry2Ab, Cry2Aa, Cry2Ae) classes," CSIRO Entomologist Sharon Downes said.

"Within each class, it is likely that insects which are resistant to one toxin are also 'cross' resistant to others.

"This means that if resistance emerges to the Cry1Ac or Cry2Ab toxins in Bollgard II, there are limited alternative Cry toxins for plant breeders to exploit.

Vegetative insecticidal proteins

"Vegetative insecticidal proteins (Vips) are also produced by *Bacillus thuringiensis*. They are toxic to *Helicoverpa* species, and are structurally quite different to Cry toxins.

"This means that Vip toxins can be effective against insects that are resistant to Cry toxins, and provide a third Bt class that could be used in transgenic crops."

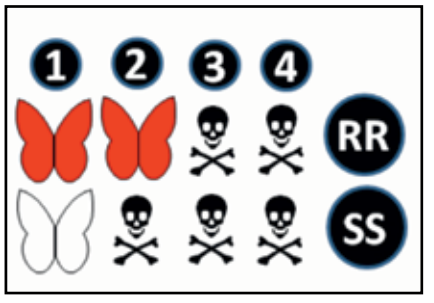
Vip3A is being added to the existing Bollgard II cotton platform to create a third generation Bt cotton, called Bollgard III, which is due to be released in Australia around 2015/16.

"Crops with multiple toxins should be robust because it is unlikely that insects will be resistant to more than one toxin, especially if the toxins being 'stacked' to kill insects in different ways," Sharon said, "but the resilience of a stack depends on how well each toxin controls larvae and the levels of resistance to each toxin at the time that the variety is introduced."

How much resistance to Vip3A?

CSIRO screened populations of *H. armigera* and *H. punctigera* during the 2009 and 2010 cotton seasons to find out the initial levels of resistance to Vip3A and establish a baseline frequency for this toxin before Bollgard III was introduced.

Not only did they find the first examples in any insect worldwide of genes allowing resistance to a vegetative insecticidal protein, they also discovered that a larger than expected



proportion of individuals in populations of both *Helicoverpa* species already carry a gene that allows them to tolerate Vip3A.

"The data for *H. armigera* gives a frequency of the resistant gene that translates to about one in every 20 moths carrying a copy of the Vip3A resistance gene," Sharon said.

"Genes that allow *H. punctigera* to resist Vip3A occur at a frequency that translates to about one in every 50 moths carrying a copy. These frequencies are higher than expected, and they are greater than the initial frequencies of insects carrying a resistance gene to Cry2Ab when Bollgard II was first introduced.

"Given the high frequencies detected prior to any commercial, large scale plantings of Bollgard III, it is virtually impossible that selection by Bt plants is responsible.

"This suggests that perhaps something else has selected for tolerance to Vip3A. It is also possible that acciden-

tal changes (called mutations) occur exceptionally frequently in the gene that determines survival against Vip3A, which means that resistant individuals are regularly introduced into the population."

Levels of concern

Could Vip3A resistance genes increase in frequency to levels that are of concern?

There are several characteristics of Vip3A resistance that are important considerations for its potential to increase within the population.

So far only preliminary information is available but a CRDC-funded project is examining these issues in detail to inform the development of a Resistance Management Plan (RMP) for Bollgard III.

Early investigations

Early investigations suggest that within each species there is one common form of Vip3A resistance at a relatively high frequency in both species rather than several different types of resistance at lower frequencies. Vip3A resistant larvae show no cross resistance to Cry1Ac or Cry2Ab. This means that when Bollgard III expresses Cry1Ac and/or Cry2Ab optimally, Vip3A-resistant insects should be controlled.

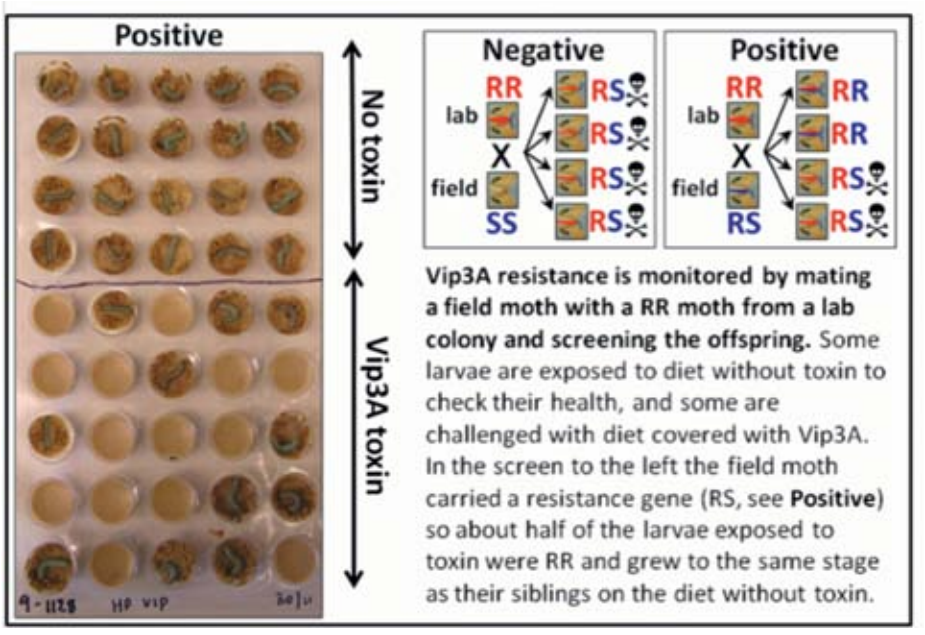
Vip3A resistant colonies are not dose responsive, and can tolerate very high concentrations of toxin. Larvae that are resistant to Vip3A can survive concentrations of Vip3A toxin that are 34 to 51 times the maximal levels reported in Vip3A cotton plant tissues without any effect on growth.

"Early work suggests that the resistance is recessive, which means that insects must carry two copies of the resistance gene to be able to survive toxin and heterozygotes (RS) are killed by the toxin," CSIRO Researcher Tom Walsh said.

"This is particularly fortunate because when resistance is recessive, field-scale resistance evolves much less rapidly than when dominant.

"Another factor that may affect how fast resistance frequencies increase within a population is the presence of fitness costs.

"For instance, Vip3A resistant insects may have a great advantage on cotton that expresses Vip3A, but on non-Bt crops they may grow more slowly or have fewer offspring than susceptible insects.



"Early research suggests that, in the laboratory, *H. punctigera* may suffer a fitness cost to carrying a resistance gene, but *H. armigera* are less affected. If significant fitness costs are present, increases in resistance are less likely."

Will Bollgard III be effective?

The researchers say that if Bollgard III expresses Cry1Ac, Cry2Ab and Vip3A toxins optimally, any Vip3A resistant *Helicoverpa* that feeds on it should be killed by one of the Cry toxins.

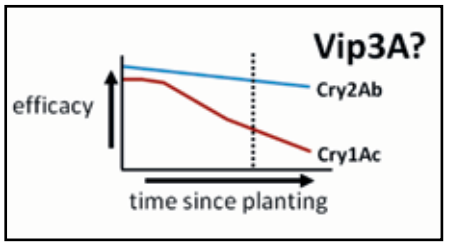
"Unfortunately, protein levels of Cry1Ac have been variable in the Bt-cotton varieties released to date, especially later in the season, and this will almost certainly also be the case in Bollgard III," Sharon said.

Research conducted from 2001-03 showed that the ability of Vip3A plants to control susceptible larvae declined as the season progressed but not as markedly as for Cry1Ac-expressing plants (Ingard).

"Also, especially during flowering, occasional fields of Bollgard II support larvae that are susceptible to Cry toxins and can survive to pupation, presumably during these episodes the expression of both Cry toxins declines to below toxic levels," Sharon says.

"Cry2Ab expression is more stable throughout the season than Cry1Ac expression so there are probably times where only Cry2Ab is effective which could select for moths that carry Cry2Ab resistance genes.

"This means there is enormous value in protecting the susceptibility of Helicoverpa species to Cry2Ab until Bollgard III becomes available.



If Cry2Ab is ineffective when Bollgard III becomes available the Vip3A toxin may be exposed to selection in a similar fashion to what we assume currently occurs for Cry2Ab in Bollgard II."

Research target

A current CRDC-funded project, which involves collaboration with Monsanto, is examining the detailed expression profile of Vip3A in Bollgard III plants. Closer to the commercial release of Bollgard III, this information will be used with detailed findings on the characteristics of Vip3A resistance, and the frequencies of resistance to Cry1Ac, Cry2Ab and Vip3A, to develop a robust RMP for Bollgard III.

"So, although Bollgard III should be very effective against Helicoverpa species, we don't yet know the finer details on the risk of resistance developing to this toxin," Sharon said.

"Because the industry began screening populations for Vip3A resistance before the release of Bollgard III, a firm baseline frequency will be established prior to any selection occurring which will allow any increases in resistance to be detected."

Acknowledgements

The authors Sharon Downes, Rod Mahon, Tom Walsh, Bill James, and Sally Ceeney greatly appreciate the support of cotton growers who permit access to crops to collect eggs used in our research. We also thank numerous technicians, and the Crop Consultants of Australia for collecting eggs for the work. Expert technical assistance was provided by our colleagues, Janine Gascoyne, Joel Armstrong and Tracey Parker.

"AUSTRALIAN RESEARCHERS FOUND THE FIRST CASE IN THE WORLD OF AN INSECT WITH GENES ALLOWING IT TO BE VIP RESISTANT – AND ALSO DISCOVERED HIGHER THAN EXPECTED RESISTANCE LEVELS IN BOTH HELICOVERPA SPECIES".

Vip3A resistant moths are killed by Cry1Ac and Cry2Ab. The diagram shows the mortality of Vip3A resistant moths (RR) and Vip3A susceptible moths (SS) moths exposed to no toxin (1), Vip3A (2), Cry1Ac (3), and Cry2Ab (4).

Current research is examining the efficacy of Vip3A in Bollgard III plants. The below diagram indicates that although Cry1Ac is present in Bt-cotton late in the season, it may be at a level that does not control Helicoverpa. This provides a potential window of opportunity for Cry2Ab resistant moths to survive on Bollgard II. Information on the efficacy of Vip3A in plants is critical for determining the risk of resistance developing to Bollgard III.

The planting window concept was originally part of the voluntary Insecticide Resistance Management Strategy (IRMS) and was based on a scientific understanding of the ecology of *Helicoverpa.*

WINDOW OF OPPORTUNITY

INDUSTRY SPECIALISTS EXPLAIN HOW PLANTING WINDOWS ARE BASED ON SCIENCE AND ARE A MAJOR WEAPON IN THE FIGHT AGAINST RESISTANCE IN HELICOVERPA.

Development and Delivery Team Bt and Insecticide Stewardship Specialist Sally Ceeney, CSIRO Sharon Downes, CRDC's Farming Systems Investment Manager Tracey Leven and CRDC's Senior Disease, IPM and Biosecurity Specialist Susan Maas have come together to provide this insight.

Bollgard II is arguably the most valuable technology the cotton industry has ever known, guarding itself with insecticidal toxins all day, every day. The cotton farming system has changed in response to this product, in ways that were not predicted before its release.

"MANAGING RESISTANCE TO BOLLGARD II IN THE LEAD UP TO COMMERCIAL RELEASE OF BOLLGARD III IS CRITICAL FOR THE INDUSTRY TO GET THE BEST LONG TERM VALUE FROM THE NEW THIRD GENERATION TECHNOLOGY."

Existence of this shift is the preparedness now of growers to drive crops on later into the season to compensate for an early or mid-season set back. Confidence to utilise the last of the autumn heat to fill late fruit wasn't a viable proposition with non-Bt cotton when pests often had the upper hand.

However while industry reaps the rewards of this technology, behind the scenes resistance researchers face the enduring fact that constant expression of the Bt toxins constitutes a massive selection pressure event each season, which tests the voracity of the technology and invites the industry's nemesis, *Helicoverpa armigera*, to evolve to survive.

"Managing resistance to Bollgard II in the lead up to commercial release of Bollgard III is critical for the industry to get the best long term value from the new third generation technology," stresses TIMS (Transgenic and Insect Management Strategies) Committee Chair, Andrew Parkes.

"The lower the resistance frequencies are when Bollgard III is introduced, the more confidence the TIMS Committee will have to support changes to the Resistance Management Plan."

Why use planting windows?

Planting windows are a key component of the Resistance Management Plan (RMP) for Bollgard II which was established to mitigate the risks of resistance developing to either of the proteins contained in Bollgard II cotton.

The purpose of planting windows is to confine crop development and maturity to limit the number of generations of *Helicoverpa* exposed to Bollgard II cotton each season. This measure effectively restricts the selection pressure on key pests to develop resistance to Bollgard II.

"Limiting selection pressure is a primary principle of any resistance management strategy," says Sally Ceeney.

"An extended growing season increases the length of time that *Helicoverpa* spp. are exposed to the Bt toxin, thereby increasing the risk of resistance.

"The planting window concept was originally part of the voluntary Insecticide Resistance Management Strategy (IRMS) and was based on a

CURRENT STATUS OF BT RESISTANCE

How many moths in the field carry a gene for resistance to the Bt toxins in Bollgard II?

Cry1Ac: 1 in 2000 (both spp.)

Cry2Ab: 1 in 15 (both spp.)

How many moths in the field carry a gene for resistance to the new toxin in Bollgard III?

VIP3A: 1 in 20 (H.armigera)

1 in 50 (H.punctigera)

"Limiting selection pressure is a primary principle of any resistance management strategy," says Development and Delivery Team Bt and Insecticide Stewardship Specialist Sally Ceeney.

scientific understanding of the ecology of *Helicoverpa*.

"The start date of the planting window is based on the date that moths are likely to emerge in a region using long term temperature data and the window length is one lifecycle of the pest, based on daily temperatures around the start date, which is about 42 days.

"Imposing a start date is especially important in warmer regions where pupae do not necessarily enter a diapause over the winter and where there is no climatically driven restriction on when planting can begin."

Additional pressure

There are usually three to four generations of *Helicoverpa* in a cotton growing season, depending on temperatures for that year, so the risk strategies around the RMP have been developed based on these numbers. In recent years however, seasonal conditions have led to extremely late crops with up to six generations of *Helicoverpa* spp. exposed to Bt cotton in a region, placing additional pressure on the technology.

It is important to note that the presence of Bt volunteers and ratoon cotton on farms outside of the growing season also effectively extends the season length and increases the risk of resistance. Because there is not always a climatic limit on how long crops can be grown, the RMP now includes an end date for crops in Central Queensland, and all Bollgard II and associated trap crops must be destroyed by July 31.

Biology and planting windows

The population biology of *Helicoverpa* also informs the relationship between planting windows in different regions. Research has shown that *H. amigera* from different regions on the east coast of Australia are from the same population, rather than individual colonies, and moths can fly very long distances.

This means that moths exposed to Bt cotton in one region can have offspring that encounter Bt cotton in neighbouring regions. So although there is some variation and flexibility in planting windows among regions within the RMP, resistance risks are assessed at an industry level.

CRDC's Farming Systems Investment Manager Tracey Leven said CRDC is investing in research aimed to review and assess the effectiveness of using planting windows as part of a pre-emptive resistance management strategy so that the industry can be better informed when establishing future RMPs.

Protecting our future

"When the RMP for Bollgard II was developed the frequency of resistance to both of the toxins that it expresses (Cry1Ac and Cry2Ab) was expected to be low," says Susan Maas.

"Screening for resistance in *H. armigera* and *H. punctigera* began around the time Bollgard II was commercially released, revealing frequencies were much higher than anticipated.

"While in both *H. armigera* and *H. punctigera* the first isolations of alleles conferring resistance to Cry1Ac were recently detected, these alleles remain rare (< 1 in 1000). But, since developing the RMP for Bollgard II, CSIRO's monitoring has shown that in both of the main target species resistance to Cry2Ab is present, is higher than expected, and is probably increasing.

"AT THIS STAGE IT IS ALMOST CERTAIN THAT WE WILL NOT BE DEVELOPING A BOLLGARD III RMP WITH A CLEAN RESISTANCE SLATE."

"This is the case not only for *H. armigera* which has a track record of developing resistance to conventional insecticides, but also for *H. punctigera* which has shown limited ability of evolving resistance to conventional insecticide sprays."

Third generation technology

The industry's third generation Bt technology is being developed. CSIRO's Sharon Downes said it is based on the same platform as Bollgard II but with a new protein (Vip3A) added.

"An important question for developing the RMP for Bollgard III is the frequency of Vip3A resistance genes in the population before exposure to cotton with this protein," Sharon said.

"For the past three seasons CSIRO performed screens against Vip3A in *H. armigera* and found that the frequency of alleles conferring resistance is around one in 20.

"Not only is this higher than expected, it is much greater than the starting frequencies for Cry2Ab. Vip3A resistance alleles have also been detected in *H. punctigera* at a frequency that is higher than expected, and higher than the starting frequencies for Cry2Ab.".

Work is underway to characterise this Vip3A resistance.

"This information, along with data on the efficacy of Bollgard III against Helicoverpa (also underway), will be used with information on the frequencies of Cry1Ac, Cry2Ab and Vip3A to determine the RMP for Bollgard III," Sharon said.

"At this stage it is almost certain that we will not be developing a RMP with a clean resistance slate."

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TAKING REFUGE AGAINST RESISTANCE

REFUGE CROPS ARE AN INVESTMENT IN COTTON'S FUTURE

With more than 90 percent of the Australian cotton grown in 2012 utilising Bollgard II technology, it is arguably the most important technology the industry uses.

Sinclair Steele, farm manager at Auscott, Warren, recognises its importance and told *Spotlight* that while pigeon pea management can create some challenges, not having access to Bt technology due to resistance would create far more complications to their farming system.

"We see establishing and managing a healthy refuge as an important part of our operations," says Sinclair.

"Pigeon pea refuges are inoculated at planting, and residual herbicides are used to help ensure refuge crops are healthy and weed free. The location of our refuges is also really important.

"Where possible, we plant all refuges upwind of the prevailing wind direction to minimise potential Roundup Ready herbicide drift onto pigeon pea, and also to make sure refuges aren't impeding Roundup sprays on our cotton fields.

"Having healthy, attractive refuges means we are doing our bit for resistance management."

Cry2Ab resistance a reality

And the risk to the technology is real. CSIRO entomologist, Dr Sharon Downes told *Spotlight* that CSIRO's resistance monitoring research has shown that in both of the target species, *H. armigera and H. punctigera*¸ resistance to Cry2Ab is higher than expected and is probably increasing.

"Refuge crops are a mandatory component of the BGII Resistance Management Plan (RMP) and integral to the protection of the technology for future use," Sharon said.

"The aim of a refuge crop is to generate significant numbers of susceptible moths that have not been exposed to the Bt proteins.

"Moths produced in the refuge crops will disperse to form part of the local mating population where they may mate with any potentially resistant moths emerging from Bollgard II crops, delaying the development of resistance.

"This strategy works because resistance to the Bt proteins has so far been found to be recessive so if a resistant individual (rr) from the Bollgard II crop mates with a susceptible (ss) from the refuge, the resulting offspring (rs) are also susceptible to the Bt toxins."

Refuge management

The current RMP options for irrigated Bollgard II refuges are 100 percent sprayed cotton, 10 percent unsprayed cotton or five percent pigeon pea (relative to Bollgard II cotton area grown). Almost 70 percent of refuges grown are pigeon pea.

"These options were initially derived by resistance modelling that showed that in order to delay Helicoverpa resistance by 20 generations, the susceptible moth population needed to be 10 times that of the resistant population and to accomplish that a refuge of 10 percent unsprayed cotton was required," Sharon said.

"Research conducted by CSIRO on other refuge crops determined that pigeon pea was, on average, twice as effective as unsprayed cotton in producing susceptible moths, so only half the area is required to produce the same amount of moths

Sinclair Steele, farm manager at Auscott, Warren says good refuge management is integral to the future viability of Bt technology, which is present in just over 90 percent of cotton grown in Australia.

(five percent pigeon pea refuge)."

Optimising effectiveness

No matter which refuge is grown, it is important that they are well managed to optimise attractiveness to *Helicoverpa* moths throughout the cotton growing season. Dr Colin Tann, CSIRO, has been working on a CRDC-funded project looking at refuges.

"Research has shown that refuge productivity varies considerably in space and time, both between and within individual crops and also seasons," Colin says.

"Not every dedicated refuge may perform well in producing susceptible moths, but they need to have the capacity to potentially do so.

"Some refuges simply may not be colonised by moths (ie chance events). Other refuges may be subject to high levels of the natural enemies of *Helicoverpa* (.g parasites and diseases).

"CSIRO's research at St George has clearly shown that only a small number of refuges within a landscape (¬ 25%) may produce most (>50%) of the refuge-derived moths.

"It is the collective performance of refuges within landscapes that is paramount to success."

Managing resistance on farm

Spotlight also spoke to CSIRO's Dr Mary Whitehouse to find out what growers can do to contribute to the performance of their refuge within the landscape. Mary outlined how overall management can impact on resistance management.

"For any one refuge to be most effective, it must be planted in close proximity (within two kilometres) to the Bollgard II crop to increase the likelihood that moths emerging from the refuge are more likely to mate with those potentially resistant moths emerging from the Bollgard II," Mary said.

"*Helicoverpa* are capable of migrating long distances, but during the cropping season a significant part of the population will remain localised on preferred hosts and move only a few kilometres."

RMP responsibilities

As part of the RMP it is a grower's responsibility to ensure refuge crops receive adequate nutrition, irrigation water (in irrigated refuges) and are managed for weed and pest control (excluding *Helicoverpa* sprays) so that they remain attractive and perform as a viable refuge throughout the Bollgard II growing season.

An important factor of mandatory refuges is their synchronicity with the corresponding Bollgard II crop.

"The timing of refuge planting is dependent on the timing of Bollgard II cotton planting so that the refuge is flowering (both pigeon pea and cotton refuges) at the same time as the Bollgard II," Mary says.

"Ideally, refuges should be as or more attractive to *Helicoverpa* than the corresponding Bollgard II crop to ensure females lay eggs in the refuge crop."

Vegetation's role

Mary also recognises that other crops and natural vegetation play an important role in resistance.

"*Helicoverpa* are feed on a wide range of host crops and vegetation, including cotton," she said.

"It has been shown that unstructured refuges, such as other crops and natural vegetation are important contributors of non Bt exposed moths within landscapes and play an important role in resistance management.

"However these other crops and natural vegetation cannot be relied upon with surety as the only source of non Bt moths as their effectiveness as a refuge and synchronicity and area planted is highly variable."

Mary Whitehouse putting together one of 300 cages that will be used this coming season to collect moths and test assumptions underlying the Resistance Management Plan's refuge strategy.

Protecting a valuable resource

It is a crucial time for resistance management. CSIRO's resistance monitoring data has shown a concerning trend in resistance to both proteins in Bollgard II. In addition, CSIRO has performed screens against the new protein in Bollgard II (Vip3A) in *H. armigera* over three seasons and found that the frequency of alleles conferring resistance is around one in 20.

Not only is this higher than expected, it is much greater than the starting frequencies for Cry2Ab. Vip3A resistance alleles have also been detected in *H. punctigera* at a frequency that is higher than expected, and higher than the starting frequencies for Cry2Ab.

Work is underway (see Pages 16-17) to characterise this Vip3A resistance. This information, along with data on the efficacy of Bollgard III against *Helicoverpa* (also underway), will be used with information on the frequencies of Cry1Ac, Cry2Ab and Vip3A to determine the RMP for Bollgard III. "Mandatory refuges are a critical component of the current RMP, providing a reliable source of susceptible moths to dilute the population of resistant individuals," Sally said.

"While there are economic costs to the farm in establishing and maintaining a healthy and viable refuge, it is an investment in protecting the future of Bt cotton in Australia, the value of which is the industry's continued access to the technology.

"We cannot afford to not take refuges seriously, and all Bollgard growers have a responsibility to grow and manage their refuge well."

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WHITEFLY CONTROL: HOW NOT TO WING IT

SILVERLEAF WHITEFLY (SLW) ARE SURVIVORS, SO SUCCESSFUL IN FACT THAT THEY RANK IN THE TOP 100 WORST INVASIVE SPECIES IN THE GLOBAL DATABASE, AS CRDC'S SUSAN MAAS REPORTS.

SLW's feared international recognition is due to their small size, ability to fly and disperse long distances, tendency to rapidly develop extremely high populations and perhaps most concerning, its ability to rapidly develop resistance.

With such a tiny, yet formidable enemy, luckily for growers and consultants, Zara Hall of Qld DAFF, told *Spotlight* the industry's SLW guidelines have taken any guess work out of SLW management.

"Successful SLW management needs a long term approach," Zara said.

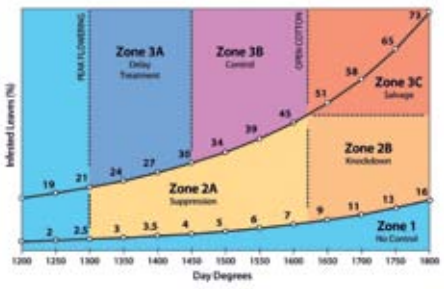
"Every pest decision, and how you manage weeds, can impact not only on the SLW population you need to manage this year, but with their ability to rapidly develop resistance, impact on how you are able to manage populations in the future.

IMAGE COURTESY RICHARD LLOYD.

SLW adults.

"SLW are known as the 'IPM Enforcer' for a very good reason."

Zara said that SLW management begins long before the SLW matrix can be used. The availability of a continuous source of hosts over winter is the major contributing factor to a severe whitefly problem. Even a small area of a favoured host can maintain a significant whitefly population.



Using natural enemies

"Natural enemies can play a vital role in the successful management of whitefly," Zara said.

"Early season pest management for other pests can be the difference between triggering the need to control SLW or not.

"Adhere to recommended industry thresholds and select the softest options where control is warranted (see Table 3 in the *Cotton Pest Management Guide*).

"Avoid the early season use of broad spectrum insecticides, particularly synthetic pyrethroids and organophosphates.

"Parasitism is especially important in SLW management. While the population management guidelines, including the threshold matrix, inherently account for parasitism, it is still worthwhile monitoring nymphs and levels of parasitism.

"Whitefly population growth can be greatly delayed by high levels of parasitism." Conversely, if the whitefly populations start higher or if natural enemies are disrupted, then the population is more likely to rapidly increase into the control zone.

Threshold matrix

Qld DAFF entomologist Dr Richard Sequeira developed the SLW threshold matrix to assist in the interpretation of population monitoring data. The matrix includes separate thresholds for early season suppression, control and knockdown late in the season is based on rates of population increase relative to the accumulation of day degrees and crop development.

"It is important to follow the sampling procedure described in the *Cotton Pest Management Guide*," Richard advises.

"The thresholds are based on sampling the main stem leaf from either the third, fourth or fifth (preferred) node below the terminal of the plant. As the population of whitefly varies throughout the plant, sampling outside of the described zone, may give a false high reading.

"The SLW matrix was developed five years ago now and has proven to be a useful tool in deciding the best option to manage this difficult pest. For the 2012/13 season we have updated the matrix to include Movento and endosulfan has been removed.

"It is important to note that the SLW threshold matrix is designed to manage a population that builds gradually in the crop and could not be relied on for decisions in situations where large numbers of adult SLW migrate into crops with open cotton."

Mass immigration case study

Richard, Zara, Dr Paul Grundy (Qld DAFF) and Dr Lewis Wilson (CSIRO), collaborated to develop a late season SLW mass immigration case study to help with decisions for this situation (see table).

Following consultants' reports of late season whitefly migrations onto crops delayed by flooded damage in Moree, the researchers outlined guidelines to help in this situation, where the matrix is not applicable. Lewis Wilson told *Spotlight* that decisions for management where a mass immigration of adults occurs need to consider time of season, time to defoliation and evidence of honeydew.

"We are currently researching the fate of honeydew on lint in different environmental conditions. This will help to ensure that Australia maintains its reputation for quality cotton," Lewis said.

Crop with low or no SLW experiences a mass immigration of SLW adults	>3 weeks till leaf drop	Eggs may have time to develop to nymphs that could produce honeydew	Little or no honeydew on leaves in lower canopy	Monitor
			Heavily speckled leaves in lower canopy	Control (Admiral or Movento)
	>2 weeks till leaf drop	Too little time for nymph population to develop so manage adults	Little or no honeydew on leaves in lower canopy	Monitor
			Heavily speckled leaves in lower canopy	Knockdown &/or defoliate early &/or delay picking if bolls contaminated

SILVERLEAF WHITEFLY

KEEP CALM & CARRY ON DOING THE RIGHT THING

INSECTICIDE RESISTANCE IS FREQUENTLY ONLY DISCUSSED WHEN THERE IS A BAD NEWS STORY, HOWEVER SUSAN MAAS FINDS THAT WITH CONTINUED ADHERENCE TO INDUSTRY GUIDELINES, THERE IS A GOOD STORY TO TELL.

Qld DAFF entomologist Zara Hall told *Spotlight* that when it comes to SLW insecticide resistance, the cotton industry's pre-emptive Insecticide Resistance Management Strategies for SLW are working well, although cautions "resistance remains a very real risk".

Zara said the 2011-12 season was generally a low pressure year with the exception of the Moree region and parts of the western Namoi. Whitefly were generally below action thresholds in the Emerald, Burdekin, Biloela, Theodore and Darling Downs regions. Low to moderate whitefly pressure at St George resulted in approximately 15 percent of fields being treated with insecticide. Suppression of low-moderate infestations was achieved by using Pegasus or Admiral.

"Moree had very high pressure with almost all irrigated cotton treated for SLW with some fields requiring more than one application," Zara said.

"This was due to unfavourable crop development caused by flooding as well as late season whitefly migrations. Insecticides used included Admiral, Pegasus, Movento and/or Talstar."

Zara reported that after five years of monitoring, SLW are still susceptible to Admiral in cotton dominated regions, however high levels of resistance exist in Bowen and the Burdekin due to intensive usage for fruit and vegetable production.

"Admiral remains the cornerstone of effective management of high density infestations. It is essential the cotton industry continues to adhere to the maximum of only one application of Admiral per season," she said.

Zara's research has also shown that SLW remain susceptible to Pegasus and Movento.

"These products are useful options for whitefly management from a resistance perspective," she said.

"As these products are also registered for mite and/or aphid control consideration should include all three pests as there is a high risk of developing resistance.

"The best way to avoid developing resistance is to minimise the use of any one mode of action group. Both products are limited to no more than two applications per season in the IRMS, regardless of the target pest."

Bifenthrin (eg Talstar) has elevated resistance factors in cotton and this has been confirmed as resistance in one sample from St George.

"Bifenthrin is generally not recommended as a product for SLW management except for circumstance where late season pest abundance may warrant its use just prior to defoliation," Zara said.

"The earlier use of bifenthrin for SLW is not recommended as it has very marginal efficacy and is highly disruptive to beneficial insects and often results in subsequent re-flaring of SLW numbers within weeks of application."

Zara encourages growers and consultants to contribute samples to the SLW resistance monitoring.

"I would like to thank Geoff Cornwell, Chris Monsour and Gail Spargo for collecting whitefly for the resistance monitoring project and to Jamie Street, Steve Madden and Rob Holmes for assisting in locating whitefly for collection."

Please contact Zara on 07 46881436 for more information.
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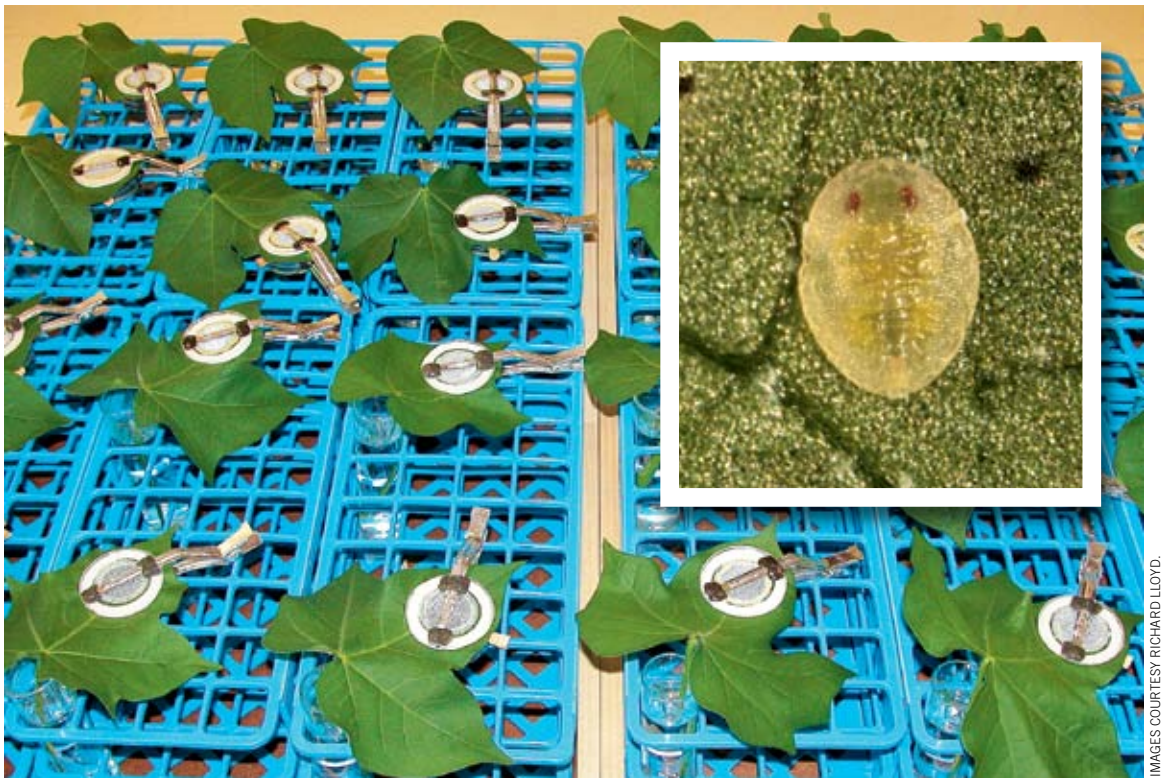
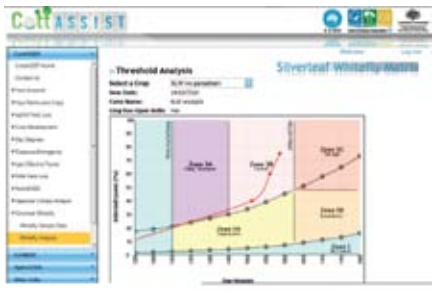


IMAGES COURTESY RICHARD LLOYD.

Full dose response bioassays are conducted against Silverleaf whitefly for all the insecticides registered in cotton. In this bioassay adults are exposed to insecticide in clip cages on cotton leaves and at the completion of the bioassay they are assessed for mortality to determine if there is any resistance present.

INSET: SLW nymphs.



If the whitefly populations starts higher or if natural enemies are disrupted, then the population is more likely to rapidly increase into the control zone.

Whitefly population growth can be greatly delayed by high levels of parasitism.

ENERGY RESEARCH ON THE RISE

WHAT CAN WE DO RIGHT NOW TO REDUCE ON-FARM ENERGY CONSUMPTION, WHAT ALTERNATIVE ENERGY SOURCES EXIST AND HOW MIGHT THEY APPLY IN THE FUTURE? NCEA'S GARY SANDELL REPORTS.

NCEA researchers Gary Sandell and Phil Szabo (pictured) are trialling a pump performance monitor they have developed, to provide data which will be used to examine pump efficiency.

"This is an interesting question and The National Centre for Engineering in Agriculture (NCEA), with funding from CRDC are looking in detail at exactly this," says NCEA Director Craig Baillie.

"We are investigating the two biggest energy users on farm – tractors and pumping and would like to get the word out to growers that there are real savings to be made in both areas, especially in pumping, which is typically 60 to 70 percent of total on-farm energy use.

"Growers will shift a significant amount of water in a season, and how efficiently this happens varies significantly between individual pump stations. Individual pumping stations can vary in efficiency anywhere between 50 and 70 percent.

"Put simply, savings of 10 to 20 percent of your pumping diesel (or electricity) bill are possible, more in some cases.

"These figures can amount to tens of thousands of dollars per season for many growers; savings in tillage are possible also."

Monitoring pump performance

NCEA researchers Gary Sandell and Phil Szabo have developed electronic pump performance monitoring equipment which will accurately measure the performance of a pumping system. The system includes sensors for suction and discharge pressures as well as water flow rate.

"These sensors allow us to calculate what the energy requirements would be for a perfect system with no losses," Gary explains.

"With the addition of fuel flow sensors we can measure what energy the system is actually using. We find that some pump stations use around 1.4 times the theoretical energy requirement (70 percent efficient) and others use twice this (50 percent efficient).

"In other words, some pumping systems use a lot less diesel to shift the same amount of water over the same lift."

So how can the average grower get their hands on these savings?

Craig Baillie believes there are a number of ways to reduce energy costs.

"The NCEA with CRDC are developing the on-line tool Energy Calc so growers can assess energy use for themselves. EnergyCalc Lite is an iPad app which will be available soon.

"Fuel switching using diesel- gas conversions is one option, but there are other options as well, like looking at different tariffs and demand switching and also variable speed drives if you have electricity.

"It's about a change of practice or a refinement of current practices.

"Work has also been underway at NCEA on tractor performance monitors and pulling together some equipment for pump performance monitoring."

Benchmarking energy use

NCEA have been working with growers from Breeza through to Emerald to benchmark energy use in cotton production.

So far energy use measurements have covered nearly a quarter of a million hectares of cotton production across three seasons and include a range of operations, such as pupae busting, grain harvesting, spraying and conventional and round bale picking, just to name a few.

"What this means is that the grower can go online and compare their figures to some quality benchmark figures for a huge range of cotton operations," Craig said.

Alternative energy options

It is no surprise that fossil fuels are a limited resource, which means that the cost of diesel and electricity is set to rise into the future. The NCEA with the CRDC are investigating alternative energy sources now so that the cotton industry is better placed to meet these challenges as they arise into the future.

To investigate this, the NCEA is using a sophisticated fuel laboratory to measure the performance of different fuels. The fuels include cotton seed oil and other biodiesels and coal seam gas. The testing includes measuring the fuel properties before running them through an engine under load to measure power and torque as well as emissions properties.

"The NCEA is casting its net wider with a scoping review of conventional and alternative energy technologies currently available in Australia to find out which ones might be useful to the cotton industry," Craig said.

"The report, available soon, summarises the pros and cons of each conventional and alternative energy source and compares the life cycle carbon dioxide emissions."

"THE SENSORS ALLOW US TO CALCULATE WHAT THE ENERGY REQUIREMENTS WOULD BE FOR A PERFECT SYSTEM WITH NO LOSSES."

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ENERGYCALC GOES MOBILE WITH A 'LIGHTER' VERSION

THE WEB ENABLED SOFTWARE TOOL ENERGYCALC, PREVIOUSLY DEVELOPED BY THE NATIONAL CENTRE FOR ENGINEERING IN AGRICULTURE (NCEA) NOW COMES IN A MOBILE VERSION, ENERGYCALC LITE.

Hamish Johnston, PrimeAg Goondiwindi, has been testing the EnergyCalc Lite application and is also part of CRDC's Energy Benchmarking Study being undertaken by Craig Baillie (National Centre for Engineering in Agriculture) and Janelle Montgomery NSW DPI.

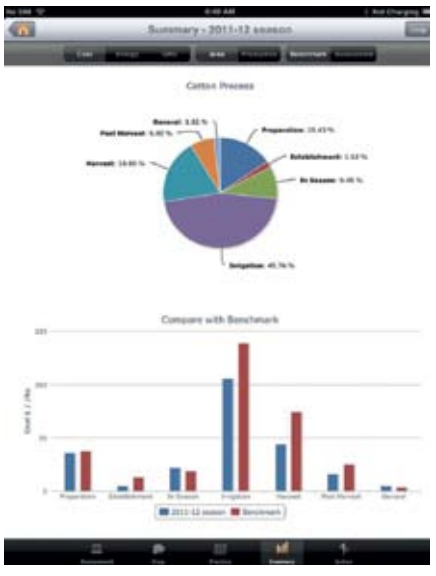
Similar to its predecessor, EnergyCalc Lite is able to undertake on farm energy assessments, to identify opportunities for energy savings, reduced operating costs and reduced greenhouse gas emissions, according to NCEA Director Craig Baillie.

"It is an easy to access and easy to use tool, which is farmer friendly and accessible (field) for undertaking on farm energy assessments.

"Developed to complement the existing web version as an entry level tool, EnergyCalc Lite has been developed to run on an iPad, which simplifies the data collection process and allows users to quickly work through an energy assessment."

The key features include:

- Calculate on farm energy usage, cost and greenhouse gas emission
- Evaluate energy usage through comparison with industry and/or regional benchmarks.
- Comparing energy assessments with historic data
- Provide a simplified/mobile method of data collection for energy assessments
- Align with *my*BMP so that users subscribe to *my*BMP via an action plan



*my*BMP ready

EnergyCalc Lite is *my*BMP ready and will interact with the *my*BMP website to automatically download business and other details while also being able to upload recorded data to eliminate data re-entry. If users subscribe to *my*BMP they are effectively ready to start the energy assessment, otherwise some initial settings are required to be configured before commencing with the assessment. Once an assessment is ready to go the user defines a number of details (see below). EnergyCalc Lite can also automatically find your location if this represents the assessment site.

Assessing energy, costs and emissions

At the heart of EnergyCalc Lite are four calculators to assist the user undertake and energy assessment and determine energy inputs for different machinery operations. These can be used either within an assessment or separately to directly calculate energy use for a particular machinery operation of interest. The calculator interface is divided into three sections: i) top section is for selecting energy and changing costs ii) middle section is used to input values and iii) the bottom section display the specific result for the calculation (read only).

There are also sub-calculators built into the main calculators. To open these sub-calculators, tap the small calculator icon (indicated by number 2). Some parameters allow multiple units, to change tap the unit (number 3).

Summary of Results

Once data has been compiled for the enterprise a graphical summary of the results is provided to the user. At the top of the summary page, a toolbar provides the user with options to summarise the results in terms of cost, energy or emissions. The user can also view these results per ha or per bale. The user is also able to compare their performance with industry averages as a benchmark of performance.

Action Plan

Having identified areas for potential improvement the user can scroll through useful energy saving practices and tips linked to *my*BMP. The user can tap on those items currently adopted on farm and then send to the *my*BMP website to update their profile.

Combined these features provide a handy tool and resource to improve on farm energy use while at the same time being automatically compliant with *my*BMP.

To download Energycalc Lite, go to www.crdc.com.au or phone Rohan Boehm on 02 6792 4088.

see our website

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SEEKING CLIMATE-SAVVY PRODUCERS

CRDC IS LOOKING FOR TWO CLIMATE-SAVVY COTTON GROWERS TO JOIN THE NATIONAL CLIMATE CHAMPION PROGRAM.

The program involves 37 farmers from different regions and enterprises across Australia who work with scientists to bring climate research to the paddock and tell climate researchers what farmers need for the future.

"We know that the better the industry can understand weather and climate, the more able growers will be to take advantage of seasonal and marketing opportunities," says CRDC Program Manager Allan Williams.

"CRDC is eager to make sure they keep in touch with the industry to understand growers' most important weather issues.

"The investment in Climate Champions by CRDC is part of a larger planned investment in the national Managing Climate Variability R&D (MCV) program. The MCV program is looking at a number of critical issues, including:

- improving seasonal forecasting – its accuracy, lead-time and ease of use;
- providing farmers with tools and information for managing climate risk; and
- increasing the number of farmers and natural resource managers managing their climate risk

The MCV program has been running for 10 years, and has helped to ensure that the needs of agriculture are incorporated into the on-going development of the models used to make weather forecasts, for example by having forecasts available at both the scale and timing that are most relevant to farmers.

CRDC believes grower participation in the Climate Champion program will help generate ideas for further R&D investment in managing climate variability that are tailored to the needs of cotton growers.

CRDC believes that participation by cotton growers in the Climate Champion program will also help to generate ideas for further R&D investment in managing climate variability that are tailored to the needs of cotton growers – for example, improving the robustness of soil temperature forecasting at planting, and prediction of frosts during defoliation.

Farmers in the Climate Champion program are improving their communities' understanding of climate variability and the impacts of increasing variability by talking to other farmers about their successful on-farm management practices.

Climate Champion participant Peter Holding, a mixed cropper at Harden (NSW), says that interacting with fellow innovative Climate Champion farmers is of great benefit.

"Many people I talk to are now prepared to look at techniques that might be useful in managing climate. I'm trying to incorporate research I've learned about in my own enterprise, and I myself have gained many new ideas about cropping and grazing," he says.

Climate Champion growers have access to the latest weather and climate tools, and are supported through training and some remuneration to look at research, present information about climate research to their networks, showcase their own practices and farming systems, and speak to the media.

Growers interested in applying to become a Climate Champion should complete the 10-minute form at www.surveymonkey.com/s/CottonCC.

The closing date for nominations is January 18, 2013.

For more information contact Allan Williams 02 6792 4088, allan.williams@crdc.com.au or Sarah Cole (Climate Champion program manager) 07 3846 7111 sarah@econnect.com.au).

email us

"MANY PEOPLE I TALK TO ARE NOW PREPARED TO LOOK AT TECHNIQUES THAT MIGHT BE USEFUL IN MANGING CLIMATE."

DEVELOPMENT AND DELIVERY TEAM SPECIALIST DUNCAN WEIR AND IAN ROCHESTER OF CSIRO PLANT INDUSTRY EXPLAIN WHY MONITORING IS SO IMPORTANT TO DETERMINING TIMELY IN-CROP FERTILISER REQUIREMENTS.

TIMELY IN-CROP NUTRIENT MANAGEMENT

Monitoring a crop's nutrient status from pre-squaring to peak boll fill can play an important role in identifying potential nutrient deficiencies and help calculate in-crop fertiliser requirements.

This will help growers optimise crop growth, achieve high nutrient use-efficiency and maximise yield within the constraints of the growing conditions.

Petiole and leaf tissue testing are the in-crop monitoring tools available to growers which have been scientifically validated and successfully adopted in commercial cotton production to monitor crop nutrient status. They have different applications and limitations, but when used correctly can provide valuable diagnostic information to enable growers to make timely fertiliser management decisions to ensure the crop nutrient demands are met.

Crop Nutrient Uptake

Understanding crop nutrient uptake patterns helps to manage crop nutrition and meet crop nutrient demands in a timely manner. Although nutrients are taken up by the cotton crop throughout the growing season, the rate (quantity of uptake per day) varies greatly depending on the crop growth stage. Nutrient uptake generally follows the increase in crop biomass and the developing boll load.

Figure 1 illustrates the pattern of nutrient uptake through the growth of a cotton crop. In this case, the rate of nutrient uptake increased rapidly from 65 DAS (days after sowing) which correlates to about 775 day degrees, the start of flowering. The daily nutrient uptake rate declines as the crop matures.

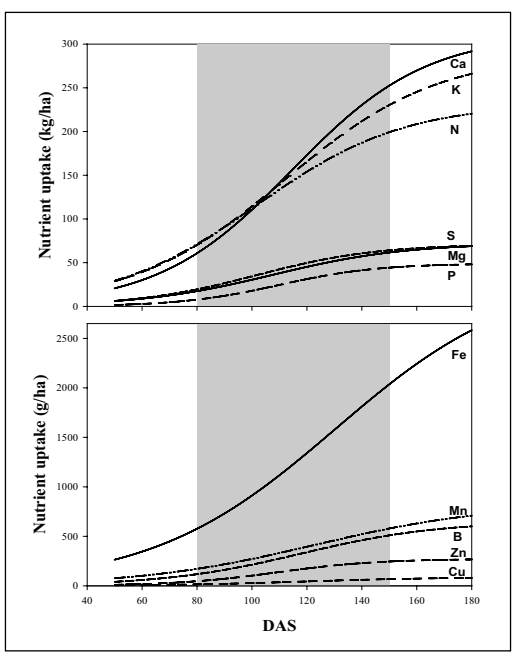
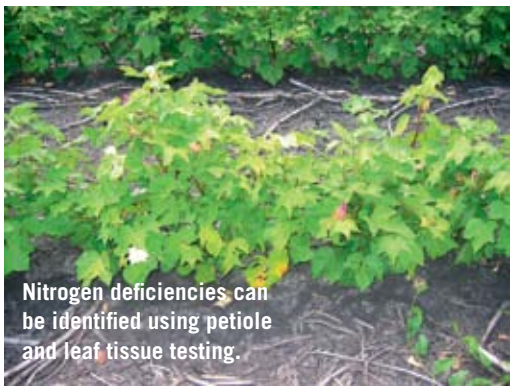


Figure 1. The pattern of cumulative nutrient uptake during the growth of an irrigated cotton crop that yielded 10 bales/ha at Narrabri.
(DAS: days after sowing)



Nitrogen deficiencies can be identified using petiole and leaf tissue testing.

Early monitoring of crops can help identify nutrient deficiencies before they are seen in the crop

IMAGES: DUNCAN WEIR

Figure 2 illustrates the average daily uptake of the four main nutrients N, P, K and S. Peak maximum daily uptake correlates to first open boll (about1500 day degrees or 110 to 120 DAS). Nitrogen and sulfur uptake peaks before mid-flowering, whereas potassium and phosphorus uptake peaks a little later.

In-Crop Nutrient Management

Nutrient deficiencies can limit the growth and yield of cotton, particularly when they occur during the flowering and boll-fill period. Hence, growers should minimise the risk of a nutrient deficiency developing during this growth stage.

Soil analysis before sowing and developing and implementing a fertiliser plan, play pivotal roles in meeting crop nutrition demand. In concert with this, in-crop nutrient monitoring also provides valuable information to growers to correct nutrition problems before there is an economic impact on the crop.

Petioles

Petiole analysis is designed to measure the nitrogen (and potassium) status of a crop, early in its development. Results allow time to adjust nutrient management programs and correct deficiencies before crop development is substantially affected. (Petiole testing is not recommended for other nutrients as nutrient levels in petioles are normally only a fraction of the levels present in leaves.)

Results are greatly influenced by prevailing weather conditions making them less reliable when the weather is unfavorable (ie cold, water logging, water stress, heat stress). Petiole nitrate and K concentrations decline quickly through late flowering making them less useful than leaf blade testing. Much less data is currently available to indicate nutrient deficiencies or imbalances with petiole analyses, compared with leaf blade analyses.

Petiole testing should start as early as possible. It requires a minimum of three samples approximately 10 days apart. Sample the youngest mature leaf (4-5th unfolded leaf) and when environmental conditions are similar i.e. soil moisture content, clear days, plant not stressed etc.

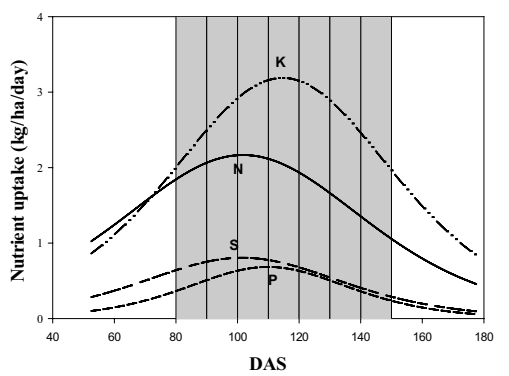


Figure 2. Average daily nutrient uptake of N, P, K and S of an irrigated crop that yielded 10 bales lint/ha at Narrabri.

Leaf blades

Leaf blade analysis is calibrated for all nutrients. Critical concentrations at all stages of crop development have been determined, making it a valuable management tool to compare nutrient concentrations throughout the growth of each cotton crop. Sampling should begin as early as possible in order to identify possible nutritional deficiencies. Leaves can be sampled from first mature leaf (which occurs around squaring), through to boll fill. When sampling the crop shouldn't be stressed and the petioles need to be removed from the leaf blade.

For more detail on petiole and leaf blade testing, their applications and limitations go to http://tinyurl.com/cmbpbok

see our website

Using the NutriLOGIC program

NutriLOGIC can be used to determine whether each nutrient is within the optimum concentration range to maximise yield. For leaf analysis, separate calibrations are used for each nutrient, which relates the leaf nutrient concentration to the time of growing season. Some nutrients increase in concentration over time, while some decline.

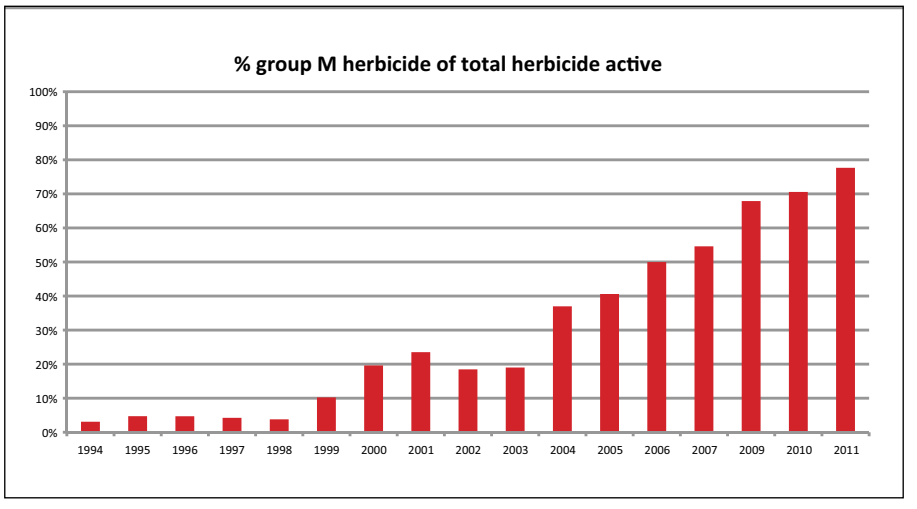
For petioles, NutriLOGIC determines if the nitrate concentration is within the optimal range to maximise yield.
http://tinyurl.com/cg7o4o6

see our website

RESISTANT BARNYARD – Surviving glyphosate resistant awnless barnyard grass plants among dead susceptible plants along with dead plants of other species. Barnyard grass is the only documented case of a glyphosate resistant species in an Australian cotton farming system.

CAN WE MANAGE FOR RESISTANCE IN A HIGH GLYPHOSATE USE SYSTEM?

CRDC SENIOR TECHNICAL SPECIALIST **SUSAN MAAS** ASKS 'HOW MUCH DO YOU RELY ON GLYPHOSATE?'



Analysis of historical Crop Consultants Australia quantitative survey data has shown that in 2010/11 group M (glyphosate) herbicides made up 78 percent of the total infield herbicide usage. There has been a rapid trend upwards since the late 90s where glyphosate usage had made up only around five percent of actives applied.

Armed with this data, CRDC Senior Biosecurity, Disease and IPM Specialist Susan Maas spoke to Qld DAFF Research Scientist Dr Jeff Werth about whether we are on the cusp of complete failure of glyphosate, or whether the industry could and was doing enough.

"If one or only a few herbicide groups are continuously applied to a weed population, a high selection pressure is placed on that population thus increasing the risk of resistance development," Jeff said.

"Herbicide resistance is an ever growing problem.

"The cotton growing regions are closely aligned with the northern grains region. Across this area there are 16 weed species that have developed resistance to at least one herbicide mode of action.

"There has only been one documented case of glyphosate resistant species in an Australian cotton farming system. This case of barnyard grass (*Echinocloa colona)* was found in a dryland cotton rotation system.

"Glyphosate will still be useful for most weeds even when it is no longer effective for barnyard grass control, so I don't think 'complete failure' is quite right, nor will it be for a while yet. If we find another common species (eg sowthistle) has developed glyphosate resistance in the next couple of years, we will be much closer to it.

"Species shift, such as to feathertop rhodes grass, gets us closer still.

"But I don't think we're there yet. Of course as more non-glyphosate methods are needed to provide good control for more and more weeds, the usefulness of the over-the-top technology will start to come in to question."

Jeff's colleague, Qld DAFF Research Scientist Dr David Thornby, has modelled the population dynamics of awnless barnyard grass under a range of management strategies for both dryland and irrigated Roundup Ready Flex cotton systems. The model estimates the timeframe for resistance development in continuous glyphosate-resistant cotton, planted every second year for dryland, and every year for irrigated.

"Simulations showed that when glyphosate was used alone that resis-

tance developed within 11 to 16 years in dryland and irrigated systems respectively," David said.

"However the good news is that planning and incorporating a number of key tactics into weed management programs can not only significantly delay and prevent glyphosate resistance development, but allow successful management of resistant populations.

"The model indicates a reduced risk of glyphosate resistance development for irrigated cotton systems compared to dryland systems.

"This is due to a number of factors. Firstly, crop competition is generally higher in irrigated crops. More importantly, in irrigated systems as they are simulated in the model, there are fewer summer fallows, so the in-crop weed control strategies (which typically contains both glyphosate and non-glyphosate tactics) are used more often than in dryland systems."

Controlling survivors

Monitoring and controlling survivors of in-crop glyphosate sprays is the most effective way to prevent and manage resistance. This is why this tactic is stipulated as a requirement in the Roundup ready flex crop management plan. In dryland situations when this is accompanied by a residual herbicide and double knock in every fallow, the models suggest that this is reliable prevention and long term seed bank control.

IWM fallows

No till is now adopted widely in both cotton and grains systems, putting severe pressure on glyphosate to keep weeds, particularly grasses, under control. The fallow creates an opportunity to use different herbicide groups.

"Simulations that included an early season fallow residual herbicide with a double knock (glyphosate followed by paraquat) on the largest awnless barnyard cohort (IWM fallow), delayed resistance by five years in dryland systems without any additional in-crop management,"

Combining in crop alternatives

Use of residuals has steadily reduced since the introduction and adoption of herbicide tolerant technologies. Residual herbicides are an important tool for reducing the numbers of weeds emerging and therefore being exposed to post emergent herbicides (glyphosate or other).

However the effectiveness of residuals can be variable dependent on a number of factors including incorporation and climate. It is important that they are not used as the only non-glyphosate alternative in a resistance prevention or management strategy.

Simulations have shown that over the long term, when residuals are the only alternative used, the delays in resistance development are minimal, particularly in dryland systems. However when a pre-plant residual was combined with a layby and an inter-row tillage, resistance was signficantly delayed. When this was combined with one or two non-glyphosate actions in the fallow the effectivness was further increased.

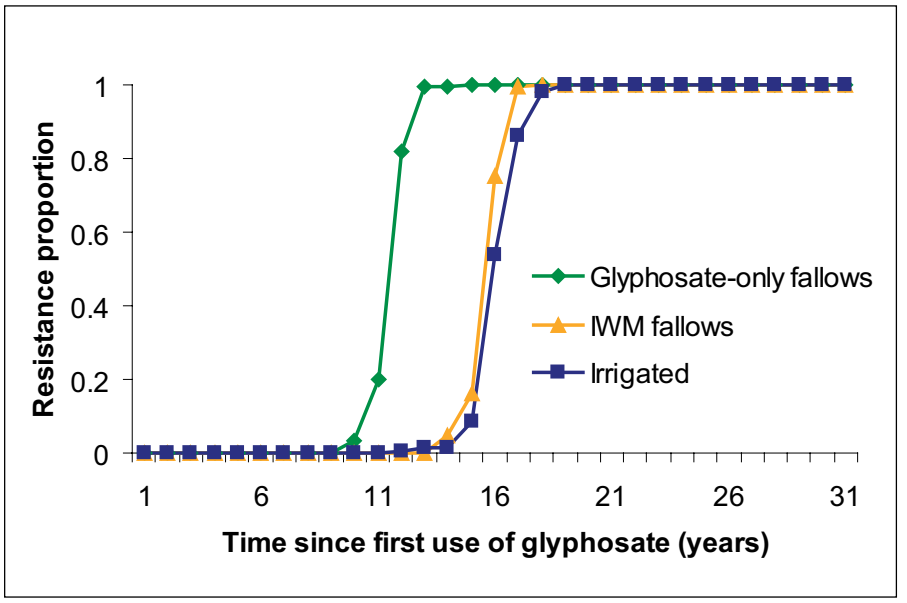
Seed Bank

Managing the weed seed bank is the most important component of weed management. This applies to resistance management as well as general weed management. The major feature that the simulations have shown is that the seed bank is reduced enormously when fallows contain at least two non-glyphosate alternatives, even after glyphosate resistance occurs.

"While the benefit of an IWM fallow seems minimal in terms of the resistance proportion, there is a significant reduction in the overall seed bank. In simulations that had no further action than glyphosate in the fallow, the seed bank was predicted to dramatically increase over time," Jeff Werth says.

"Seed bank reduction was consistent in all simulations with IWM fallows.

"It is important to understand that even if a seed bank has a high resistance proportion, if that seed bank is very small it is considerably easier to manage in the long term."



Timeframe for resistance development in continuous glyphosate-resistant cotton (every 2nd year for dryland, every year for irrigated) with glyphosate alone used in crop.

IWM FOR RESISTANCE CONTROL

Glenn Milne of Glencar Consulting Pty Ltd at Dalby told *Spotlight* that while it can be a little bit more expensive, integrated weed management helps manage weeds and will help to look after glyphosate in the long term.

"We are quite concerned about glyphosate resistance. We utilise a range of activities such as double knock, mixing herbicides and timely cultivations to actively manage this risk.

"We still have our problem weeds such as Feathertop, but having a good strategy helps."

Glenn even managed to put a positive spin on the current low cotton price, "We've been able to take advantage of more sorghum and other crops in the rotation, and used this opportunity to rotate herbicide groups".

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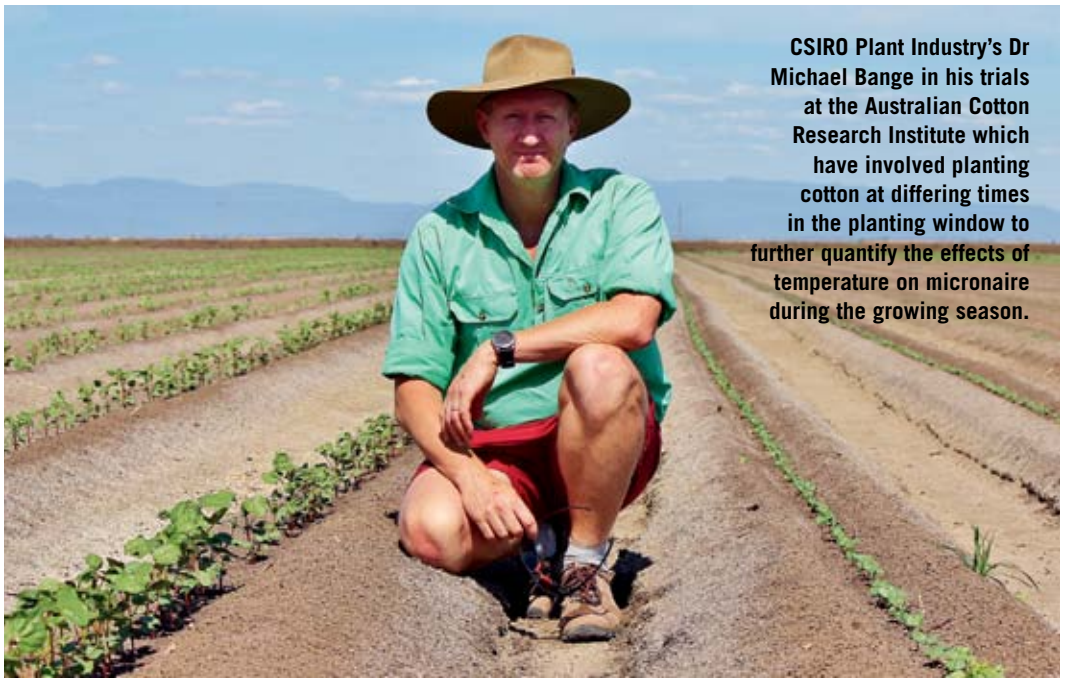
JEFF WERTH'S TAKE HOME MESSAGES

In Roundup Flex cotton systems it is critical that weed management strategies are planned in advance with a range of tactics, rather than taking a reactive approach.

Monitoring and controlling survivors of glyphosate and herbicide usage is very important, it is also important that survivor control is done regularly, rather than hoping for a brilliant result once.

MICRONAIRE PREDICTION TOOL ON ITS WAY

A STUDY ON THE IMPACTS OF TEMPERATURE ON COTTON'S MICRONAIRE WILL HELP INDUSTRY DEVELOP PREDICTIVE TOOLS TO INFORM CROP MANAGEMENT FOR IMPROVED FIBRE QUALITY AND RETURNS FOR GROWERS.



CSIRO Plant Industry's Dr Michael Bange in his trials at the Australian Cotton Research Institute which have involved planting cotton at differing times in the planting window to further quantify the effects of temperature on micronaire during the growing season.

This understanding coupled with knowledge of the degree of the effects of solar radiation, plant defoliation, and competition from bolls for carbohydrate within the plant will improve predictions as well as developing specific management practices to optimise micronaire, without impacting yield.

Differences in micronaire of cotton fibre can affect grower returns and influence textile quality. This study proposed a method for predicting seasonal crop micronaire by quantifying the response of micronaire to temperature during boll filling, and then assessed the methodology's ability to predict micronaire.

Undertaken by Dr Mike Bange and Dr Greg Constable of CSIRO along with Dave Kelly (formerly CSD), the study found that "a large amount of variation in micronaire across regions and seasons could be explained by the relationship of micronaire with temperature during boll filling".

"This understanding could then be employed to predict whole of season effects on micronaire at the time of harvest aid application and thus assist in determining the risks and costs associated with this practice impacting fibre quality," Mike said.

"For example earlier applications may lower micronaire substantially, increasing the chance of penalities."

Utilising existing data from sowing time experiments in Australia that spanned three decades, a linear response of micronaire to daily average were developed (r^2 =0.68; Figure 1).This response coupled with an estimate of temperature during the boll filling period when the majority of bolls were undergoing fibre thickening was then used successfully predict the micronaire on an independent dataset (r^2=0.42; Figure 2) despite no adjustment for other climate and management factors that may influence crop micronaire.

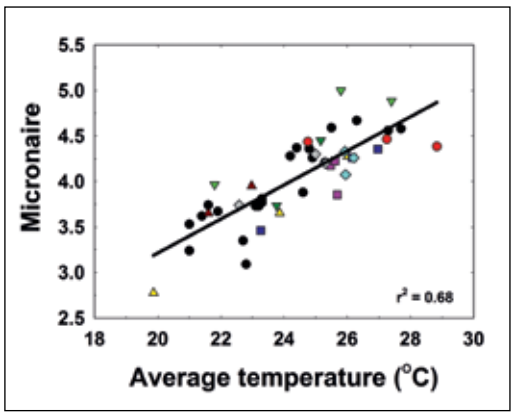


Fig. 1. The response of micronaire measured in sowing time studies to daily average temperature during boll filling. These studies were grown with full nutrition and water requirements with sowing time, season, and location, all contributing to differences in temperature experienced by the crop during boll filling. Regions include Narrabri, Breeza, and Hillston.

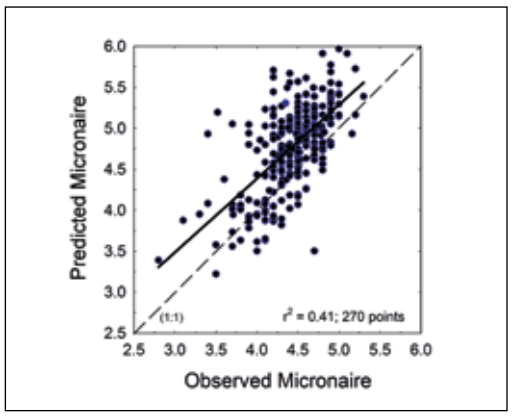


Fig. 2. Predicted micronaire versus observed micronaire for the fiber thickening period using Cotton Seed Distributor's (CSD) cultivar evaluation dataset for Sicot 71, Sicot 71B, Sicot 71BR, Sicot 71 BRF and Sicot 70 from 2000 to 2007 across all cotton regions: micronaire estimated using the linear response of micronaire to daily average temperature. Dashed line is the 1:1 line. The closer the points are to the 1:1 line the better the prediction of micronaire.

WHAT IS MICRONAIRE AND WHY IS IT IMPORTANT?

Micronaire of cotton is a fibre quality trait that reflects a combination of fibre linear density (often referred to as fineness) and fibre maturity. Too high micronaire (> 4.5) may indicate that fibre is coarse and is undesirable for spinners as it results in too few fibres in yarn cross section, reducing its strength. Too low micronaire (< 3.8) may mean that fibres are immature, leading to breakages in fibres within the yarn and poor dye uptake during textile processing. As a consequence growers may incur price discounts if micronaire of their cotton falls outside the optimal range (3.8 to 4.5).

The degree of fibre thickening or fibre maturity, contributes to differences in micronaire. When comparing fibres of similar perimeter the thicker the layers of cellulose lay down the more mature the fibre and the higher the micronaire. Since fibre is primarily cellulose any influence on net crop photosynthesis and carbohydrate production will have similar influence on fibre thickening.

It therefore stands to reason that as photosynthesis is highly influenced by temperature sustained changes in temperature during the fibre thickening period will lead to differences in micronaire.

The ability to predict temperature effects on micronaire will also be useful to assess reasons for seasonal and regional differences in micronaire and assess opportunities to modify micronaire with changes in management practices that influence the timing of boll development.

The CSIRO team at Narrabri are currently using this new understanding to develop an online micronaire prediction tool as part of the CottASSIST web tool suite. The predictor will be made available to a limited number of users this season for testing and validation.

Dr Mike Bange
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BMP RULES SUPPLY CHAIN

THE NEW HANDBOOK WILL ARM GROWERS WITH KNOWLEDGE TO HELP REDUCE FIBRE LOSSES AND DECREASE HARVESTING TIMES – WHETHER HARVESTING THEMSELVES OR ENGAGING CONTRACTORS, TO DELIVER THE BEST QUALITY COTTON POSSIBLE.

Best Practice Management for Harvesting, a best management practice (BMP) handbook for cotton harvesting, will be available to growers next season. Adopting the new harvesting guidelines will deliver significant benefits to cotton growers in terms of cotton yield, fibre quality and farm safety.

CSIRO textile technologist, René van der Sluijs, drafted the harvesting guidelines as part of the CRDC-funded Post Harvest BMP project. The guidelines were developed based on a literature review and significant input from people working in the industry.

The industry has BMP guidelines for on farm, classing and ginning, and draft guidelines for warehousing and despatch, but harvesting was the "missing link" in the supply chain.

The release of the guidelines is well timed for Australia's expanding cotton harvesting sector.

"Over the past couple of years, many new growers have entered the industry, along with more harvest contractors following the introduction of the round module-building harvester, and more growers do their own harvesting now," René said.

"With a larger national crop, it's important that we have guidelines in place so that everything is done correctly, in terms of fibre quality and safety."

While the on-farm BMP guidelines touch on harvesting practices, the new harvesting guidelines offer in depth information that cover many potential issues that compromise both cotton yield and fibre quality.

"When you are harvesting, potentially there can be quite a lot of fibre loss, up to five to 10 percent and the time that you harvest and other factors can determine the quality of the crop and how it performs in the gin," René said.

Monitoring moisture

For example, the relatively new harvesting technology, the round module-building harvesting system, has increased the importance of considering moisture levels in cotton harvesting decisions.

"Last season, approximately 80 percent of the cotton crop was harvested by round module pickers, and more of have come into Australia since then," René said.

"These harvesters can pick cotton for longer, but you should stop harvesting if moisture content approaches 12 percent because you will have problems down the line.

"Over the past two seasons, classing results have shown many of the round module harvesters picked the cotton too moist, which created ginning issues and resulted in lower grades for growers."

Staging

Staging modules correctly can address inherent variation within the field that can cause an issue for ginners.

"As the modules are produced, they should be staged correctly and transported to the gin in the same order that they were harvested, so they get ginned in the correct order," René said.

"It's important that you don't send cotton from either side of the field on a truck, because the cotton can change within the field."

Contamination

Another issue is that the round modules are covered in plastic, which presents a potential for contamination of the fibre. It's important to make sure that the plastic covering the modules remains intact when you are moving them to prevent contamination from the plastic wrap.

Transport and safety

Incorporating recommendations from Cotton Australia regarding transport and safety, growers will have a comprehensive document that covers all aspects of harvesting. The handbook is generic and does not refer to any specific machinery manufacturers, which broadens its usefulness.

René said he hoped that growers would adopt the handbook for themselves and any harvest contractors, to ensure harvesting is done correctly in terms of fibre yield, quality and farm safety.

"It's in the grower's best interest to optimise yield and to present the gin with the highest quality cotton possible, because the gin can only clean up the cotton; it cannot improve the natural fibre quality attributes," he said.

"That's where best management practices for growing and harvesting can play quite a big role."

Before being finalised in February the draft handbook will be circulated to growers and industry stakeholders for comment to ensure it is both useful and practical for growers and contractors.

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The new harvesting guidelines offer in depth information covering many potential issues that compromise both cotton yield and fibre quality.

NATURAL FIBRES IN A SYNTHETIC WORLD – WHAT IS COTTON'S FUTURE?

POLYESTER NOW DOMINATES THE GLOBAL FIBRE MARKET, WITH COTTON'S SHARE CONTINUING TO DECLINE.

Shaping sustainability in the cotton value chain globally is a key challenge for the industry as a whole as it considers the effect improved synthetic fibres is having on its market share.

It is expected that polyester fibre quality will improve and production capacity will increase. While cotton is the most important natural fibre with a global demand of around 25 million tonnes, the consumption gap with polyester has widened considerably in recent years. In 2011 cotton held 28.5 percent of the global market, synthetics held 58.5 percent.

The global cotton industry faces a significant challenge to compete with man-made fibres for many reasons. This challenge was discussed at the International Cotton Advisory Committee (ICAC) Plenary meeting in October, at Interlaken, Switzerland. The meeting was themed "Shaping sustainability in the cotton value chain". CRDC's Allan Williams, CRDC chairman Mike Logan, director Richard Haire and Cotton Australia Policy Officer Angela Bradburn were part of the Australian delegation.

The agenda presented a wide range of perspectives on sustainability from textile companies and manufacturers, agents, merchants, brands and retailers, non-government organisations and growers. Other updates and themes centred around world cotton supply and use, long term challenges with fibre demand, contract sanctity, plant breeding, cotton statistics and the role of government in facilitating the use of identity/ 'sustainable' cottons (Organic, Fair Trade, Better Cotton Initiative) – initiatives which featured strongly in the program and meeting discussions.

Challenges

Challenges for cotton were broadly framed around price competitiveness, volatility of cotton supply compared to man-made fibres, and other competitive drivers and trends to respond to, a prime example being sustainability. Cotton output is rising slower than global textile demand and as growing natural fibres requires arable land, and with more severe competition from food and fodder production and biofuels likely, expansion of natural fibre crops is less likely.

The issue of contract defaults has become a critical topic in global industry discussions. In looking at the correlation between cotton and man-made fibre prices, it is apparent that cotton is losing its price competitiveness with polyester filament and one of the reasons ascribed to this is the erosion of user market confidence in the actual trading system for cotton.

Competition from man-made fibre

It is expected that polyester fibre quality will improve and production capacity will increase, with man-made fibres winning on price point, consistency (in product and through the supply chain) and new fibre qualities. Increasingly man-made fibre industries are appealing to retailers and consumers using sustainability claims and promoting recycling and reuse, supported by strong lobbying and marketing efforts. These industries are shifting the focus from 'oil-based' chemical origin to that of recycling and re-use along with claims of lighter, sturdier, breathable fibre properties. A very strong polyester lobby has also succeeded in branching out into new market segments, using polyester's low price to secure market share. Polyester is competing aggressively not just with natural fibres but also other synthetics, capturing market share, for example, in motor vehicle air bags which were previously made from nylon.

ICAC recognised the competition posed by polyester in the global fibre market and instructed the Standing Committee to establish a working group of member countries to investigate these challenges, to reflect on the future of the global cotton industry, and to advise members of possible actions.

Dog eat dog world?

Differential marketing within the cotton industry that plays on its perceived negative attributes can play into the hands of the synthetic textile industry.

The challenge to improve cotton's declining global market share necessitates a significant, unified approach toward competing against synthetic fibres. It is more important than ever to use a unified approach in generic cotton promotion to appeal to the consumer and their love of cotton and compete against synthetics.

The International Forum for Cotton Promotion is a sub-committee of ICAC and exists to encourage increased consumer demand for cotton, act as a clearinghouse for exchange of ideas and strategies, and facilitate the establishment and expansion of demand enhancement efforts. ICAC supports all cottons and opposes dissemination of exaggerated and misleading information by those attempting to secure competitive advantage at the cost of other cottons.

Cotton's global position in sustainability

It is crucial that the global industry knows the position of cotton in comparison to competing fibre types and works to improve weak points in cotton growing and processing. There are already negative perceptions about the cotton industry and there is no reason to think these won't be targeted by competitors. To counter this, industry must provide evidence it is proactive in its quest for sustainability. To manage this effectively, the global industry needs to agree on a manageable set of indicators of sustainability around the big three – water, pesticides and labour. Retailers and brands are the lightning rods for activists targeting a product – if lobby groups see an issue in the supply chain they will target retailers, who can either try to address the problem or walk away from the product that is causing the consumer backlash.

As shown in the recently completed Third Environmental Assessment of the Australian Cotton Industry 2012, a focus on effective communication and demonstration of commitment and progress towards to sustainability/ environmental outcomes along with productivity is clearly important both domestically and internationally.

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