Cotton Research & Development Corporation

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Spotlight on Cotton R&D

Autumn 2009

New Crop Rotation Guide

Australian Government
Cotton Research and Development Corporation

Autumn, March 2009

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
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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 Growers' Research Association (ACGRA). CRDC is responsible to the Australian Government through the Minister for Agriculture, Fisheries and Forestry, Tony Burke MP.

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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Spotlight

Bruce Finney Executive Director, CRDC

Late last year many of the researchers, in whom CRDC invests, presented final reports on the outcomes of their research projects. The researchers demonstrated not only their capability and commitment to their endeavor but the importance of the research outcomes in keeping the Australian cotton industry and cotton growers ahead of the pack. It is highly rewarding and reassuring to see the ongoing development of talented researchers that support our industry.

These research projects have generated new information and innovation across all facets of the industry, which will protect and improve cotton production in Australia. In this edition of Spotlight we have included reports on the outcomes of a selection of these projects; the remainder will be covered in the June issue.

You will also have received with this March issue the new Crop Rotation Guide, produced in conjunction with the Cotton Catchments Communities CRC.

This document has been a truly collaborative effort and again highlights the depth and breadth of research being undertaken by the industry to further sustainable and profitable farming practices.

So much research has come to light since the release of the first guide some seven years ago and we hope growers and consultants will make the best use of this guide to aid in creating the most suitable farming systems possible for their individual enterprises, knowing that the information is based on and backed up by sound research.

In this edition we also take the opportunity to bring readers up to date with a series of articles on the latest research and activity in CRDC's value chain research program. Our goal in this area is to add value to the Australian cotton industry with premium products in improved routes to market. Research on defoliation timing and its effect on fibre quality is particularly pertinent at this time of year.

I would also like to encourage people to take advantage of the two bursaries CRDC is offering this year, to attend the Field to Fabric course in Geelong and secondly to become part of the Cotton Production Course.

Both courses offer participants the opportunity to upskill and improve understanding, and our investment is these bursaries is testament to the quality of the courses.

On behalf of all at CRDC I wish you a successful harvest, followed by a wet winter.

Contributors: Editorial and photographic contributions to Spotlight are welcomed. All intending contributors should in the first instance contact the Editor.

Cover Photo: Launching the new crop rotation guide recently at Moree are Sal Ceeney, Tracey Farrell and Dave Larsen. See story page 20.

Further information: ? Where this symbol appears, readers are invited to access further information from the identified source.

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Correction: In the Summer 20008 edition of Spotlight, the article on page 7 titled, 'WaterTrack, the Savewater! winner', inferred that industry's research investments had played a part in the WaterTrack Rapid and WaterTrack Optimiser product developments. Spotlight wishes to correct and apologise for any inconvenience caused by this inference and also note that the R&D for WaterTrack Optimiser and WaterTrack Rapid products were solely developed by Aquatech Consulting Pty Ltd.

Study finds strong R&D returns

CRDC R&D Investment Manager Bruce Pyke, (right) led a team of CRDC staff offering support for the entire evaluation. "The idea of the evaluation was to show the range of returns that can be generated on investments made by CRDC as a result of the federal government's support of rural research and development in Australia."

In 2008, CRDC participated with 14 other Rural R&D corporations in undertaking an independent study on the return on investment generated by industry and public investment in R&D.

Three random projects were selected and proved to be sound investments, according to independednt cost/benefit analysis undertaken in 2008. As a result of the initial study, CRDC, with other Rural RDCs has agreed to play its role in continuing a broader pioneering project that is heralded as leading the world as a unique example of evaluating returns on investment in government–industry R&D partnerships.

The three projects examined in 2008 were the Women in Cotton network (Wincott), Soils R&D and Fibre Classification. A triple bottom line (TBL) evaluation method was used.

CRDC R&D Investment Manager Bruce Pyke led a team of CRDC staff offering support for the entire evaluation and said the idea of the evaluation was to show the range of returns that can be generated on investments made by CRDC as a result of the federal government's support of rural research and development in Australia.

CRDC engaged BDA Group to carry out this evaluation of its investment in three randomly selected sub-programs.

The cost benefit analysis looked at economic, environmental and social benefits that could be attributed to the CRDC investment and provides an objective assessment of the returns that the CRDC has been able to generate for its levy payers and Australia more broadly.

"The BDA results will also be used by the Council of Rural Research and Development Corporation Chairs to demonstrate the range of returns that has been - and might be - generated as a result of the federal government's support of rural research and development in Australia," Mr Pyke said.

CRDC investments point to strong returns

Of the three projects, the cost effectiveness of the Wincott investment was estimated to be $25 per member per year on the total investment made by CRDC. The estimated return on government funds, taken as part of matching contributions, was estimated at $13 per member per year.

It was found that the soils research sub program would deliver a return to levy payers of $24m, or $26 for every dollar invested by levy payers. The return on matching funds provided by the federal government was estimated at $10 for every dollar invested.

And on the fibre classification program, the BDA Group estimated that CRDC's investment will deliver an expected return to levy payers of $10 million, or $12 for every dollar invested by them. The return on matching funds from the federal government was estimated at $6 for every dollar invested.

"So all three CRDC projects have proved to be financially successful," Mr Pyke said.

"Originally CRDC commissioned BDA Group to undertake the Hero Study, which evaluated two programs of CRDC's choice.

These were R&D support provided for the successful deployment of Bt transgenic cotton and the second project studied was the development of tools and techniques (primarily Irrimate) for more accurately measuring water use efficiency.

"A final report was submitted to CRDC in November 2007, and in that report it was estimated that a minimum return of $13 on every dollar invested by Australia cotton growers had been achieved. It was also estimated that a minimum return to Australia of $30 was achieved on every dollar of matching funds provided by the commonwealth.

"These new figures will be a useful yardstick with which to go forward."

Soils research

Soils research has been a major component of CRDC's investment portfolio over many years. For the 2003 to 2008 Strategic Plan, the focus of the research shifted to improving nutrient management and soil quality.

Research completed to date has shown that the average volume of nitrogen fertiliser currently applied to cotton crops can be reduced without any significant loss in cotton yields.

"Some of the benefits we found included reduced greenhouse gas emissions, as lower application rates result in less nitrogen being converted to either pure nitrogen or nitrous oxide."

Fibre technology

CRDC has supported CSIRO in the development of new technologies to measure fibre fineness and maturity. If successful, such technologies would support changes to the traditional classification system for cotton and better identify and reward cotton with superior fibre characteristics.

"Some of the benefits found here included increased economic

Continued page 4 ...

rural R&D CORPORATIONS

Rural R&D

There are 15 Rural Research and Development Corporations (RDCs) covering virtually all of the agricultural industries. The RDC for the cotton industry charged with investing in innovation and productivity tools to compete in global markets is Cotton Research & Development Corporation (CRDC).

The Rural Research and Development Corporation model of joint industry and government funding has been a vital element in the success of Australia's R&D effort for 20 years.

RDCs currently invest around $540 million per year in R&D (including marketing) to improve the profitability and sustainability of rural industries and communities.

An extensive evaluation undertaken by the Rural RDCs on projects completed between two and five years prior to 2006-07 examined 36 highly successful projects together with 32 randomly selected projects. Ongoing evaluation work is continuing on randomly selected research projects from among the 15 RDCs in 2009 and beyond.

Results

Results from the first year of analysis show significant benefits from the investments by the RDCs.

- A sample of 36 highly successful projects representing all of agriculture will return $10.5 billion in quantified benefits
- On the $10.5 billion in quantified benefits, $5.5 billion will be private benefits accruing to rural industries while the remaining $5.0 billion were benefits captured by consumers, other participants in the supply chain and the wider public
- A range of significant social and environmental benefits were identified which are broadly distributed to the Australian community.
- Details of returns from the cotton industry projects evaluated are discussed in this Spotlight report.

R&D returns

CRDC board member, Juanita Hamparsum, and CSIRO scientist, Dr Stewart Gordon, discuss CRDC value chain investments and how development of new technologies to measure fibre fineness and maturity would if successful, support changes to the traditional classification system for cotton and better identify and reward Australian cotton producers.

opportunities in regional Australia and the emergence of Australia as an internationally recognised leader in the development of objective fibre measurement technologies for cotton," Mr Pyke said.

Aimed at benefitting both the industry and the wider community, the evaluation exercise was set up by the CRRDCC in 2007, to provide the government and industry with a demonstration of the value that the RDCs deliver to their industries and the broader community, as a result of investment of the industry and public funds. This is the largest independent evaluation of R&D undertaken so far in Australia.

And the evidence from parts of the evaluation exercise so far has shown a successful return of $29 for every $1 invested in highly successful projects which yielded a total of $7.6 billion.

"Broadly, we looked at 36 projects which we dubbed as 'highly successful' as part of this year-long exercise," said Mr Pyke.

First round results

The aim of the CRDC evaluation was to show the range of returns generated on investments made by CRDC. Now this new report will show the results of the first round of an annual program of evaluation.

Representatives of the RDCs met in November to further review the results and decide the next steps.

"While the highly successful project studies represent a total investment of $265 million for the 36 projects identified and quantified in monetary terms, significant public benefits have also been generated from these," Mr Pyke said.

"Although these benefits have not been quantified in dollar terms, they have generated important environmental and social improvements for Australia. The schemes we called 'randomly selected' represent 34 projects with a total investment of around $72 million from RDCs."

The report shows the results from the first year of this program of review. Further work by the RDCs over the next two years will build on these results and identify areas of development on which to focus their evaluation program.

Industry partnership

The RDC model is an effective working alliance between government, industry and research partners. It is a unique example of government–industry partnership benefitting both the industry and the wider community. The Australian RDC Model is envied by competitors in North America.

Given the enormous and multidimensional current and future challenges in rural industries, this model forms an important part of the innovation process in Australian agriculture, fisheries and forestry industries.

CRDC was part of the statutory and industry owned RDCs which took part in the project, along with bodies such as the Grains Research and Development Corporation, Forests and Wood Products Australia and the Fisheries Research and Development Corporation.

Rural Research and Development Corporations (RDCs) play a unique role in identifying, coordinating and funding agricultural innovation in Australia.

"Part of the government's rationale for the RDC model at the time it was set up was to provide the Commonwealth's matching of up to 0.5 per cent of GVP as incentive or 'seed money' to encourage industries to invest more in R&D," Mr Pyke says.

"Over the past 17 years, for every $1 that the Commonwealth Government has contributed, industry has contributed $1.50 on average.

"This provides significant leverage to deliver enhanced public outcomes, including natural resource and environmental management."

The Rural RDCs have invested approximately $200m of government funds and $300m of industry funds each year in rural R&D. This accounts for around 50 per cent of the R&D in the agricultural, fisheries and forestry industries undertaken in Australia.

The RDCs communicate the value and returns of this investment to their industry and to government stakeholders individually, and as a group through the Council of Rural Research and Development Corporation Chairs (CRDCC).

On top of this, the RDCs are looking to develop frameworks for measuring social and environmental benefits.

On the economic front, Mr Pyke said there were key benefits for agriculture. Around $490 million were attributable to reducing costs from eight projects and $189 million from increasing yield from six projects.

The projects also identified a range of non quantified economic benefits including reduced costs, labour savings, capital savings, improved markets and market development, increased yields and improved productivity.

"When we took the results from both the highly successful and the randomly selected project groups into account, we found that significant public benefits were generated from these projects, including important environmental and social improvements for Australia," he said.

"These included improved biodiversity and increased carbon sequestration, reduced soil erosion and improved water quality and improved biodiversity and biosecurity, to name but a few."

Another important factor in the success of the RDCs is collaboration. The RDCs invest around $540 million per year in agricultural innovation and research organisations and industry partners also make significant cash and in-kind contributions.

Around 29 per cent of both the highly successful projects (44 per cent) and 30 of the randomly selected projects (88 per cent) involved working together with funding partners.

"The rate of productivity growth in agriculture has been slowing over the past decade," Mr Pyke explained.

"Innovation and investment in research, development and extension are the key drivers of this and this growth is also a result of input from the Rural Research and Development Corporations which currently invest around $325m of industry levies and $216m of Australian Government funds per year. So for every $1.00 contributed by the Commonwealth in 2005-06, the industry contributed $1.50.

"We are aiming at further work by the RDCs over the next two years so that we can build on these results and identify areas of development on which to focus the evaluation program. And looking ahead, the RDCs are planning to develop frameworks for measuring social and environmental benefits.

"They are likely to work together on areas where there are gaps in ability to measure results and they will quantify in dollar terms those that are most significant.

"Part of the path forward will be to identify more significant areas where this situation occurs and examine options for addressing them. It is likely that RDCs will be leaders in Australia - and possibly the world - in this endeavour."

"We aim to increase collaboration between researchers and extension staff to improve the uptake of research by industry to ultimately help improve farm productivity, profitability and sustainability," says Plants and Soils NPT leader James Hill.

Recently a soil biology field day was held at Warren as part of the plants and soils team's extension activity.

Photo courtesy Sal Ceeney.

By James Hill, Sal Ceeney

Plants and soils a priority

The Plants and Soils National Priority Team is a group of extension staff prioritising the extension of research information with a plant and soil focus including nutrition, cotton physiology and crop rotations.

It is made up of Cotton CRC regional extension officers and partner staff including NSW DPI & Qld DPI&F, CRDC and Cotton Australia. The role of the team is to work closely with growers and researchers to extend timely and relevant research material to the wider grower and industry audience.

How does the team help industry?

- Assists with the development of extension plans to deliver research findings to industry.
- Assists with trials in regional areas including locating and implementing trials and collection of trial data.
- Promotes plants and soils related research work through cotton tales, fact sheets, media releases and other publications.
- Facilitates workshops, field days and farm walks to promote research and current industry best practice.
- Provide feedback to research on current industry issues.

The team's current activities include:

Nitrogen Use Efficiency

The plants and soils team has been working with Dr Ian Rochester and coordinating with regional extension officers over the past two seasons to benchmark Nitrogen Use Efficiency (NUE) in the cotton industry and this work is continuing in 2008/09.

Management recommendations for improving NUE and reducing greenhouse gas emissions have been developed by researchers and the team, including guidelines for soil and tissue testing and recommendations for managing nitrogen in crop to reduce losses. These various fact sheets and grower case studies are available on the Cotton CRC website and in regional *Cotton Tales* newsletters.

Soil health

Research is being conducted in central and southern NSW looking at alternative products to improve surface soil structure and soil ameliorants by industry-funded PhD students James Quilty and John Bennett. The team is supporting this research by organising field walks at the sites and working with the researchers to develop management recommendations from the research findings.

Soil testing protocols have been developed in conjunction with researchers and promoted by the team through *Cotton Tales* newsletters and fact sheets available on the Cotton CRC website. The team is assisting researchers from Qld DPI&F and coordinating with regional extension officers looking at improving the characterisation of soils with phosphorus and/or potassium deficiencies.

Crop rotation practices

Members of the plants and soils team, along with other members of the National Cotton Extension Team have updated the Cotton Crop Rotation Poster which provides a useful guide to the advantages/disadvantages and general points to consider when producers are considering different rotation options with cotton crops.

With the renewed interest in green manure crops as alternative sources of nitrogen and improving soil organic carbon levels, the team is working on updating legume rotation information, focussing on vetch in particular, for distribution through the regional *Cotton Tales* network and promoting the fact sheets and grower case studies already available on the Cotton CRC website.

Cotton physiology

The team is undertaking a range of activities to improve the understanding of cotton physiology through:

- publication of information on cotton plant-soil water relations;
- promotion and assistance in using the various management tools available on the Cotton CRC website in CotASSIST. These tools such as the Last Effective Flower Tool use cotton physiological information to help producers make management decisions;
- publication of a summary of the row space configuration trial work that has been conducted, focussing on 15" cotton; and
- promotion of research that is occurring in better understanding the movement of nutrients throughout the plant.

? If you would like to know more about any of the team's activities or research results, or for general advice, contact one of the team members:

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NUE nitrogen use efficiency

Monitoring nitrogen use efficiency in your region

Ian Rochester (CSIRO), Sally Ceeney (NSW DPI), Susan Maas (Qld DPI&F), Rod Gordon (formerly Qld DPI&F), Lauryn Hanna (formerly NSW DPI) and James Hill (NSW DPI) Cotton Catchment Communities CRC

Summary

- About 50kg N/ha too much N fertiliser was applied on average over all crops monitored in a study of 2007-08 crops
- Half the crops examined were over-fertilised by an average 90kg N/ha
- By reducing N fertiliser inputs to cotton crops, we may improve yields while reducing costs and substantially improve gross margins.
- N use efficiency index was high in one crop (under-fertilised), optimal in 11 crops and low in 11 crops
- Low N use efficiency index is a consequence of excessive N fertiliser application
- The appropriate N fertiliser rate for cotton can be predicted by soil testing and using a tool such as NutriLOGIC.

A study of nitrogen (N) use in cotton production has shown that we could safely reduce N fertiliser inputs by 15-25 percent on current usage levels, or, some cases, reduce input costs by $200/ha.

This is good news for growers' hip pockets and the environment, in the face of increasing N fertiliser costs and increased focus on greenhouse gas emissions, which has prompted greater attention to the efficient use of N fertilisers.

The Cotton Nutrition Research Group and the Plants and Soils National Priority Team (see page 5) say growers and consultants already recognise the importance of these issues as well as the need to optimise fertiliser inputs to meet the nutritional requirements of high-yielding cotton crops.

This is backed up through a study by the above groups who monitored nitrogen use efficiency in several regions during the 2007/08 cotton season.

This study and other recent studies have shown that N fertilisers can be used much more efficiently within the Australian cotton industry than they are currently being used.

The team determined crop N use efficiency (NUE) in 23 commercial cotton crops in six valleys in the 2007/08 season and compared these measurements using a relationship formulated over the last five seasons in a cropping systems experiment at ACRI Narrabri.

Crop Nitrogen Use Efficiency Index (NUEI)

NUEI is determined by dividing the lint yield by the crop N uptake (i.e. kg lint produced per kg N uptake).

This indicates how effectively a crop produces lint yield from the N that it has accumulated. The crop NUEI does not discriminate between soil N or fertiliser N sources but it does give some insight into whether inadequate, sufficient or excessive amounts of N fertiliser were applied.

Crop N uptake refers to the amount of N (kg N/ha) taken up and contained in the crop. Measuring crop N uptake involves taking one square metre of crop (whole plants) after cut-out and approximately three weeks before defoliation (about 20-25 percent bolls open) and before leaf starts to drop. These plants are then dried, weighed, milled and analysed for N content. This process is very time-consuming and labour-intensive.

NUEI – what value are we aiming for?

A relationship between N fertiliser use and NUEI (Figure 1) has been determined from the past five years data of a long-term cropping systems experiment at ACRI.

Crop NUE indices between 10.9 and 12.9 indicate that N fertiliser rate was sufficient. Values less than 10.9 indicate excessive rates of N fertiliser may have been applied. Values greater than 12.9 indicate insufficient N fertiliser may have been applied, or that the crop was drought-stressed or another nutrient deficiency limited crop growth.

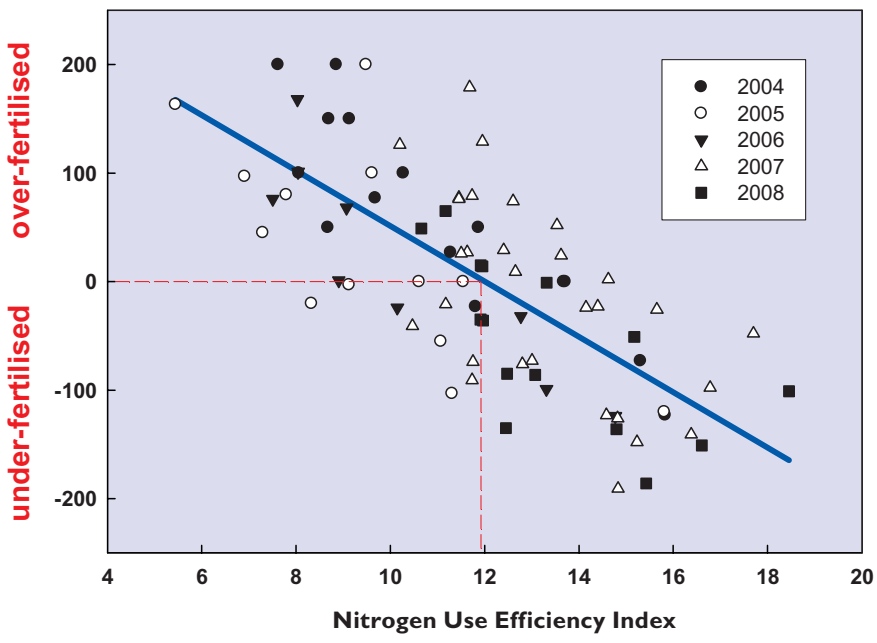

Figure 1. Crop N use-efficiency index (NUEI) measured in a crop rotation experiment at Narrabri where numerous N fertiliser rates (0-200kg N/ha) were applied to identify the optimum N fertiliser rate. Over-fertilised crops have low NUE indices whereas under-fertilised crops have high NUE indices.

Survey of commercial cotton crops – 2007-2008

The study determined the crop NUEI and estimated the N fertiliser requirement for each commercial cotton crop, as shown in Table 1. The relationship in Figure 1 was then used to determine whether the crop was under- or over-fertilised with N.

Nitrongen Use Efficiency (NUE)

As in 2006/07, most of the commercial crops surveyed were to some degree over-fertilised with N. Only those crops deliberately unfertilized showed high NUE indices. Compared with 2006/07, crop DM and N uptake were 16 percent higher, yield was nine percent higher but NUE index was five percent lower, indicating that in 2007/08, crops were more over-fertilised than in 2006/07.

Several crops exceeded the ideal crop N uptake figure (200-250kg N/ha) that is sufficient to maximise lint yield.

N fertiliser excess or inadequacy

This survey indicated that there is scope to improve N use efficiency industry wide: we can safely reduce N fertiliser inputs by 15-25 percent.

One-half of the crops surveyed had excessive amounts of N applied (ie 90kg N/ha too much on average). The lowest NUE indicated the crop was over-fertilised by 125kg N/ha. This would add more than $200/ha to the growers input costs. By reducing N fertiliser inputs to cotton crops, we may improve yields while reducing costs and substantially improve gross margins.

Excessive N fertiliser application increases the emission of greenhouse gases (especially nitrous oxide) from fields. In the near future, the price of N fertiliser may include a "carbon tax" to account for greenhouse gas emissions.

The appropriate N fertiliser rate for cotton can be predicted by soil testing and using a tool such as NutriLOGIC. Your local extension officer can help if you are not familiar with this technology. It is critical to determine if soil N levels have built up over time, especially where high N fertiliser rates have been used in the past.

Future research

Because the measurement of crop NUEI is time-consuming and labour-intensive, the Cotton Nutrition Research Group and the Soils and Nutrition Priority Team have investigated alternative means of determining NUE.

Fortunately, the N concentration in cotton seed is closely related to crop NUEI (Figure 2). If it was possible to test fuzzy seed (at the gin) for N concentration, NUEI can be very quickly and easily estimated and growers informed of their apparent use of N fertiliser. No commercial laboratories are currently able to offer this service, so it would be neeed to first gin a sample of seed cotton.

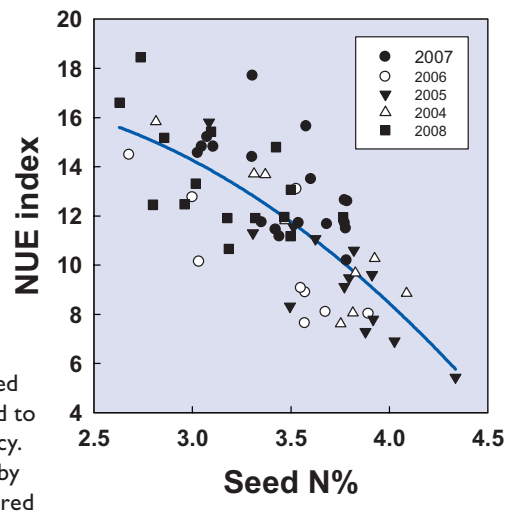

Figure 2. Cottonseed N content is related to crop N use efficiency. Excess N taken up by the crop can be stored in the seed.

Alternatively, use could be made of satellite imagery. A collaborative effort is being made to correlate our data with satellite images taken through the growing season. This research is in its infancy but shows some promise.

The NUE monitoring program is continuing through the 2008/09 cotton season in most areas. This data will be published later in 2009.

Table 1. Crop dry matter (DM), crop N uptake, lint yield, N use-efficiency index (NUEI) and estimated amounts of N fertiliser (kg N/ha) applied in excess (or insufficiency) for 23 cotton crops examined in 2007/08.

Valley	Crop DM t /ha	N uptake kg N/ha	lint b/ha	lint kg/ha	NUE index kg N/kg lint	Fertiliser excess
Emerald	14.2	241	9.4	2125	8.8	81
	8.0	184	8.4	1901	10.4	41
	13.9	312	9.8	2215	7.1	125
	10.5	261	9.8	2215	8.5	89
	10.9	244	9.4	2131	8.7	82
	8.5	130	6.1	1385	10.7	33
(unfertilised)	8.0	139	9.4	2124	15.3	-87
	12.6	281	8.4	1906	6.8	133
(unfertilised)	9.2	126	8.4	1906	15.2	-83
	12.5	227	9.8	2227	10.6	36
Macintyre	14.4	256	10.5	2378	9.3	68
	16.0	320	11.8	2681	8.4	92
	13.9	250	12.0	2732	10.9	26
	15.4	182	10.9	2468	13.6	-42
(unfertilised)	10.0	134	9.9	2244	16.8	-125
	13.9	266	13.1	2965	11.1	21
	9.6	200	8.8	1996	10.9	59
Gwydir	13.7	303	11.3	2565	8.5	90
Namoi	10.5	183	8.08	1834	10.0	49
	9.6	212	8.32	1889	8.9	78
	11.4	255	12.85	2917	11.4	13
	13.0	284	12.40	2814	9.9	52
	12.0	224	11.80	2679	12.0	-1
	12.5	264	6.6	1494	5.9	38
Macquarie	13.1	255	10.8	2445	9.6	61
	13.1	338	13.1	2977	8.8	81
	9.6	200	8.8	1996	10.9	59
Murrumbidgee	14.3	268	12.9	2928	10.9	26
All sites 2007/08	12.4	244	10.4	2366	10.0	51
2006/07	10.6	211	9.5	2166	10.5	39

? If you are interested in this nitrogen use efficiency assessment program, please contact your local Regional Cotton Extension Officer.

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Further reading

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Research aims to maximise yield and quality

The key to how cotton plants take up and distribute nutrients around the plant is being investigated by CRCD supported PhD student Merry Errington in the hope of identifying the most 'timely' process of fertilising to maximise yield and quality.

By Merry Errington

Cotton plants require a range of nutrients to support growth and development, and the management of these nutrients is an essential factor in achieving high yields of good quality lint.

Nutrients are taken up by roots and partitioned between various plant structures. At boll filling, when the demand for nutrients is greatest due to the development of seeds and lint, nutrients from vegetative plant parts are mobilised and redistributed around the cotton plant.

My project, which has now been in progress for a year and a half, aims to investigate the mechanisms of this nutrient redistribution from vegetative to reproductive plant parts, establish the timing of this nutrient movement and if these physiological plant processes can be manipulated through agronomic management of the plants.

This process of nutrient uptake and redistribution has not before been studied in detail in transgenic cotton varieties.

This process of nutrient uptake and redistribution has not before been studied in detail in transgenic cotton varieties.

A better understanding of this process could aid in the development of timely and effective fertiliser programs for maximising yield and fibre quality of high yielding cultivars and could lead to novel ways to predict and monitor nutrient deficiencies during crop growth.

The main aims of the project are to:

- Establish a model of nutrient uptake, distribution and redistribution in transgenic cotton plants;
- Assess the significance of and timing of nutrient redistribution in supplying developing bolls with adequate nutrition and the factors influencing this process; and
- Examine and assess methods of manipulating redistribution processes and fertiliser regimes to maximise nutrient efficiency within the plant over time.

In the 2007-08 season three major experiments were carried out, and currently at ACRI several experiments are in progress building on the information gathered last year.

Plant tissue samples are taken over time, as well as samples of the phloem sap, which is the main method of nutrient transport within the stems and petioles.

Phloem and tissue samples have been taken from plants exposed to various levels of nitrogen, water and phosphorus stress. By comparing the sap content with the nutrient accumulation in the leaves, stems and bolls a model of nutrient flows in stressed and non stressed conditions can be developed.

At present data is still being collected weekly modelling nitrogen, phosphorus, potassium and zinc uptake and flows around the plant.

High, medium and low yielding plants have shown similar patterns of nutrient uptake and distribution and it is hoped that by exposing plants to various levels of stress, the impact of plant agronomic management on nutrient flows can be established.

? More information – James Hill – Plants and Soils NPT leader, Regional Extension Officer, Sthn NSW, NSW DPI, Cotton CRC, 02 6993 1608, 0447 773 791, james.hill@dpi.nsw.gov.au

Sally Ceeney, Regional Extension Officer, Macquarie, NSW DPI, Cotton CRC, 02 6883 7101, 0407 952 056, sally.ceeney@dpi.nsw.gov.au

Growers from the Warren district trial the new internet–based BMP system during a recent tour of cotton growing regions to road test the program.

Changing face of BMP

"This electronic system is an excellent revision of the previous hard copy version. I found this version easy to navigate, with some useful, additional modules, for example, human resources and grower's forum. Congratulations to the BMP/CA team, they have produced a valuable industry tool."

Barb Grey, Mungindi.

Best Management Practice is changing in the cotton industry, with the aim to make the system more user-friendly and offer more benefits for growers who take on the management system.

In early February more than 60 growers and consultants from all cotton growing regions participated in a trial of the revised web-based BMP Program.

The 'BMP Roadshow' travelled for two weeks from Emerald to Hillston to trial the new system with growers and consultants.

Trial sessions were run by BMP General Manager Louise Adcock, System Developer Manager Dan Hickey and the Cotton CRC's Knowledge and Extension Manager Letitia Cross.

"The overall response to the new direction of BMP was very positive," Louise Adcock said.

"We would like to sincerely thank all those who attended the trial for providing some very useful suggestions to help improve the web based system and content".

The new web based system will provide growers with the opportunity to self assess their business performance in areas that align with their farm business priorities, and compare their performance against regional, state and industry performance in key areas.

The new system is also designed to help growers by providing tools and templates which can be adapted to their own business and provide direct links to information to assist them. Growers will still have the capacity to be certified if they choose.

The new web system is a more dynamic way of providing up to date information, integrating new research, promoting coming events, sharing ideas, and a more cost effective mechanism for delivery of BMP. It also provides the industry with a better mechanism to demonstrate the trends of improving practices over time, and value of R&D adoption on farm.

"It is exciting to see the progression of the second phase of the BMP program being focused around practical management options supported by emerging science and knowledge," Letitia Cross said. "The extension team is focused on how to best provide the technical support which can help each grower implement this system within their own enterprise."

Feedback from the trials will be integrated into the new program before industry wide release when the new system is fully proven.

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Megan Hamilton of Moree, Anna Louise Cross, Bundaberg, Phil Davis of Narrabri and Lisa Clarke, Kempsey, are studying cotton production at UNE, pictured here at cotton's big day out field day at "Keytah" recently.

Study cotton production in 2009

There has never been a better time to enrol in further education with CRDC offering scholarships to study the Cotton CRC's Cotton Production Course at The University of New England.

UNE is now taking mid-year undergraduate and graduate enrolments for the Cotton CRC's Cotton Production Course.

The course is a set of four units that cover the production, crop protection, and environmental management of cotton crops in the Australian industry.

It was developed by the Cotton CRC and is offered through The University of New England.

The cotton units neatly combine to form a Graduate Certificate in Rural Science (majoring in cotton production) or can be used towards a series of agriculturally oriented degrees, diplomas and masters programs. The first unit in the series 'Cotton Production' is also offered through the University of Sydney and the University of Queensland in some undergraduate courses.

Irrigation and crop nutrient management are integral parts of the course which culminates in an on-farm consultancy covering production, environment and farming business issues.

The units that make up the Cotton Production Course are:

- COTT300/500: Applied Cotton Production
- COTT301/501: Cotton Crop Protection
- COTT302/502: Cotton and the Environment
- COTT303/503: Cotton Farm Systems and Technology Transfer

The course has been designed to suit growers, consultants, agronomists, those working on cotton farms as well as school leavers, both in the way the course is structured to study from home and the method of delivery and evaluation.

It has flexible delivery, and each course has a one-week only residency, designed to fit into busy lives and can be specially tailored to be undertaken at home over a one to two year period, depending on personal or time commitments.

Opportunities to include the Cotton Production Course units in your studies are many and varied.

CRDC's scholarship covers the cost of the units only, valued at $2800 in total.

"Past students have been very positive about this course and the practical aspects it brings to growing and managing cotton in a farming system," says Helen Dugdale, CRDC's Program Manager R&D Implementation.

"CRDC believes in supporting people keen to learn more about cotton, and also in supporting the Cotton Production Course as another forum for disseminating information about this wonderful industry, especially in times of climatic and economic hardship."

For more information about the course, contact Dr John Stanley, the Cotton Course Coordinator at UNE and for scholarship information, CRDC Program Manager R&D Implementation Helen Dugdale

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Training $$ for Qld producers

Queensland cotton producers now have the opportunity to access new training funds.

A 90 percent subsidy is available under the Queensland Productivity Placement Program for training targeting management level qualifications.

"The cotton industry applied for the funding to assist producers to undertake recognition of prior learning interviews to acknowledge their skill sets," said Mark Hickman, National Cotton Training Coordinator, Cotton CRC/Qld DPI &F.

"Any grower who was previously considering gaining recognition for their BMP skills and are interested in particularly the new industry award known as a Certified BMP Farm Manager should take advantage of this development."

Stu Higgins from Jandowae, Jason Sinclair from Condamine and Brian Strand from Dalby were presented with their BMP Farm Manager awards at the Australian Cotton Conference last August. They were three of the first six managers who have qualified for the award.

The awards add value to the existing BMP program and provide a pathway for individuals to receive BMP acknowledgement for their personal skills.

A Recognition of Prior Learning interview is a formal assessment method used in the vocational education and training sector to capture the skills a producer develops through a life-long process of learning and implementing practice change.

If successful, growers will be acknowledged by a formal qualification known as a Diploma of Agriculture (specialising in cotton production).

"I would recommend all farm managers undertake the award," Jason Sinclair says.

"When you are undertaking BMP on a day-to-day basis anyway, why not become accredited yourself.

"BMP is part of our natural management plan, so this was not a big task - it is not time consuming."

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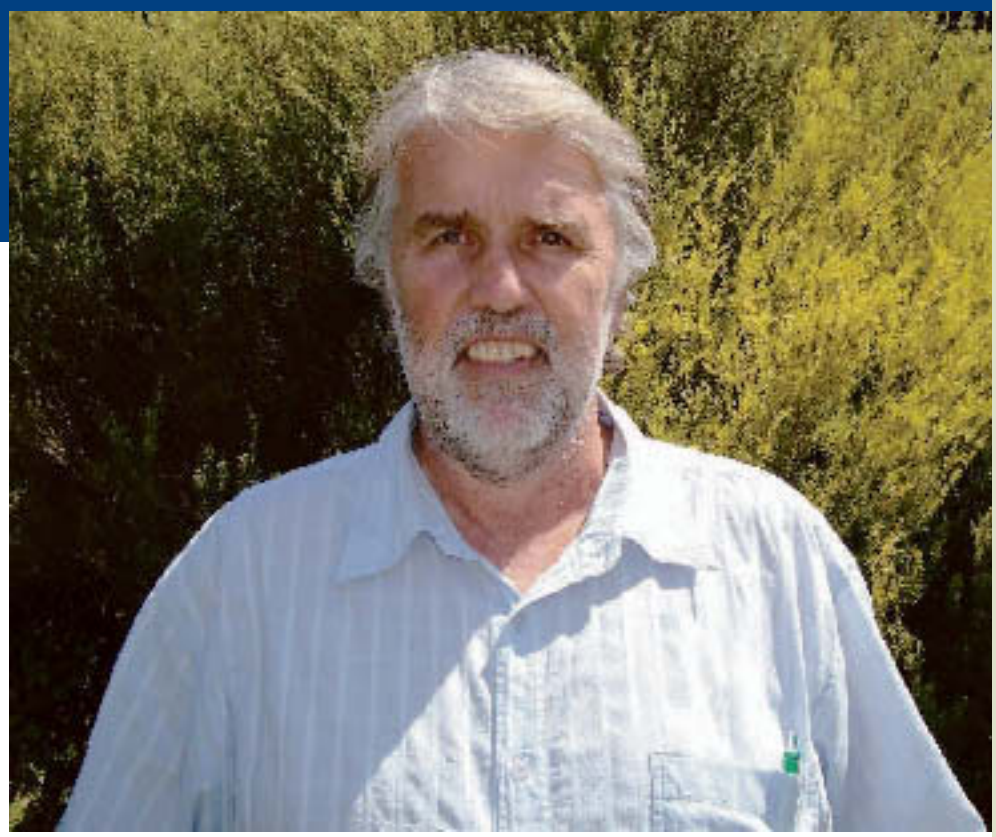
Broadening the link between secondary schools and the cotton industry is underway.



A new initiative in Queensland to include cotton units to high schools' curriculum is being headed by John Martin, with the aim of attracting students to and better preparing them for careers in the industry.

Highlighting career opportunities for young people

With support of CRDC, John Martin from DETA (Dept of Education Training and the Arts) working in partnership with Qld DPI&F is exploring opportunities for establishing links with selected secondary schools in Queensland to incorporate the Cotton Basics and Cotton Seed Programs into their curriculum which aligns to furthering the vocational education training initiative.

Students will gain valuable experience in the industry while still at school, providing them with the tools and knowledge to make informed decisions about training and employment upon leaving school, and at the same time raising the profile of careers in the cotton industry

"These courses could have real impact in schools particularly in cotton growing areas and provide real life learning experiences for students while still at school. It would help equip them with the skills necessary to find good employment in the industry when they finish schooling," Mr Martin said.

"This initiative – 'Gateway Schools to Agribusiness' with Queensland secondary schools was developed in response to skills shortages across agribusiness industries and the need to attract and retain a skilled workforce across the sector for our future."

The gateway schools project, and the cotton-related courses, aim to help young people make a successful transition from school into further education and/or employment in the industry.

The project also encourages meaningful collaboration between schools, training (VET), universities and industry to provide career opportunities for young people.

Farrer Memorial Agricultural High School at Tamworth is involved with the Cotton Seed pre-vocational program, with some students going on to find immediate employment in the industry as a result.

In 2005 Cotton Australia initiated the project - the Cotton Industry Skills Development Pilot Project, aimed at training qualified cotton industry workers and providing pre-vocational training opportunities for potential employees.

Farrer's Agricultural Head Teacher Graeme Harris in collaboration with industry developed the schools' component of this project.

As part of the Farrer Higher School Certificate studies, students spend time on cotton farms, experiencing first hand the various stages of the planting, growing and harvesting cycles.

It is the only such high school offering the program at this time.

And now, Mr Martin says, encompassing the industry-wide recognition of the courses will give students the full benefit of their study in terms of finding employment in cotton, thus making the programs more attractive to students.

He would also like to see a cross-curriculum approach to the study of the cotton industry as a result of the 'gateway school' project with units and activities incorporated across curriculum areas as engineering and general sciences so as to provide a holistic learning experience for students.

"Gateway Schools in Agribusiness will work together in the sharing of information, ideas, teacher professional development and resources as well as strengthening their partnerships with agribusiness industries," he said.

"From these partnerships, opportunities for work experience, structured work placements and school based traineeships or cadetships with Agribusiness industries at all levels become increasingly possible.

"Agribusiness encompasses the vast variety of exciting career pathways and jobs associated with on-farm production and then the various stages of distribution, value adding, processing and marketing the product right through the supply chain until it is ultimately purchased by the consumer."

Mark Hickman, the National Cotton Training Coordinator with Qld DPI&F and Cotton CRC says he is pleased with the potential benefits this program offers the industry in terms of preparing young people for careers within it.

Mr Hickman will deliver Professional development to teachers later in the year, in preparation for a 2010 roll out of the project.

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New team member brings wealth of knowledge to CRDC role

Tracey Farrell joined CRDC as Manager, Farming Systems Investment early this year. CRDC executive director, Bruce Finney, says the entire organisation is thrilled to have secured Tracey's knowledge and experience for this position.

Tracey's broad and in-depth knowledge of cotton and grains farming systems is well regarded in industry, he said.

"Beyond that is Tracey's expertise in entomology, crop diseases and weeds which puts her in good stead to tackle the complexities of the farming systems investment management role she has taken on at CRDC."

"She is well versed in the technical aspects of industry research and how this research becomes practical knowledge that is applied on farm and all aspects of the production chain.

"She has been actively involved in a range of research projects as district agronomist in the past five years at the Australian Cotton Research Institute. Tracey was an obvious choice for this role.

"In light of the forward-looking R&D Plan for CRDC and the industry, we know she is the right person for the right time. Farming systems research has a new focus where grains and even livestock research will have significant linkages with our future farming systems. A very high level of expertise is demanded across these fields together with the practical know how to ensure industry is equipped to focus on rapid delivery and uptake of new technologies.

Years of interaction with growers has led Tracey to understand and respond to their needs for information. Tracey was the author and producer of the Cotton Pest Management Guide and NSW Summer Crop Protection Guide while working with NSW DPI at the Australian Cotton Research Institute.

She was also instrumental in fostering collaboration between the cotton and grains industry. This resulted in a valuable R&D project, "High Yielding Irrigated grains in Cotton Farming Systems". This was a joint-investment by cotton and grains R&D, and required high-level engagement with the state primary industry departments in NSW and Queensland.

As a 2008 Cotton Industry Young Achiever of the Year nominee, Tracey demonstrates a commitment to question and improve the knowledge available to the cotton and grains industry.

"Her excellent reputation with growers means we are all proud to have her on board."

Cotton Snapshot Competition 2009

Be inspirational! Be imaginative! Be creative!

Be part of the cotton industry's most exciting creative showcase!!

Categories for entry are ...

A. Natural Environment/ Climate Change
B. Fashion and/or Fabric
C. Science in Action
D. Under 18's (any cotton subject)

Great prizes to be won!!

Photographs will be on display and winners announced at the Cotton Trade Show in May

How to enter: Simply submit your photograph, along with a completed entry form (below) to:

Cotton Snapshot Competition c/o CRDC
PO Box 282, Narrabri, NSW, 2390
Entries Close: 15th May 2009

Australian Government
Cotton Research and Development Corporation

Cotton Catchment Communities CRC

Name ..... Category A B C D please circle

Address ..... Photo Title .....

..... Signed .....

..... (if under 18 parent/guardian must sign)

Phone ..... E mail .....

Each entry must be a 6x4 unmounted photo submitted along with this form to the address above. Please write your name and address on back of each photo.
* All photographs entered will become the joint property of the CRDC and Cotton CRC.

Many know the story of the Alamo which is located only a couple of minutes walk from the Beltwide Conference venue, in San Antonio, Texas, says Bruce Pyke, who attended the conference last year. Historically, San Antonio has a huge claim on the establishment of Texas.

Beltwide offers insight into US industry

Bruce Pyke

San Antonio claims to be the 7th largest US city. For anyone visiting, it is a very pleasant city with its famous "Riverwalk".

The Beltwide Cotton Conference was held from January 5-9 in San Antonio, Texas. As usual it showcased the US cotton industry, its research and development and trends in production as well as commercial and technological developments.

CRDC General Manager for R&D Investment Bruce Pyke was part of a contingent of Australians to attend the conference.

Among these Greg Constable was invited to give a keynote address to the Agronomy and Physiology Conference, a tradition for recipients of the Cotton Physiologist Award which was awarded to Greg at the 2008 Beltwide Cotton Conference. In addition Mike Bange and Stephen Allen from ACRI and Stuart Gordon and Andrew Abbott from CSIRO Geelong also gave presentations to their relevant conferences.

Although the conference was well attended with 3000 delegates, this number was a reduction in numbers from previous years.

"This probably reflects the significant decline in US cotton acreage that has taken place over the last few years in response to higher grain and soybean prices, particularly the demand for corn to provide feedstock for the biofuel industry that has expanded to meet the US renewable fuel targets," Mr Pyke said.

"In many states where good soybean and corn yields can be obtained, cotton now ranks a poor third in crop choice based on returns to the grower.

"While it was difficult to get a feel for the likely planting intentions from the speakers who gave keynote regional summaries, it is evident that US cotton growers are leaving their planting decisions much later than they once did as a result of the change in the value cotton relative to the other crops they grow.

"In general, however, many states are indicating the plantings for the 2009 crop will be similar to 2008 at best and more likely to decline especially in the south east, mid south and west.

"Although in the west any declines will be with upland cotton, Pima plantings are expected to increase. In the southwest, big producing regions like the Texas High Plains are less likely to see a decline in the area planted."

The conference itself ran over four days with the bulk of sessions and presentations held in just two and a half days. With more than 290 presentations, up to 13 concurrent sessions running and 130 posters, the Beltwide is a big event and it can be difficult to choose which one of several concurrent presentations to attend.

One of the key note speakers was Mike Johans the US Federal Secretary for Agriculture who indicated the US is likely to change its current position in relation to farm subsidies for American cotton producers as a result of ongoing negotiations in the WTO.

During the conference, Cotton Incorporated presented a summary of a recently completed survey of US cotton growers to members of the National Cotton Council.

The survey obtained responses from 1500 cotton growers (covering around 16 percent of US cotton acres).

"Natural resource management was the major theme of the data presented," Mr Pyke said.

"The number one issue of concern to the cotton growers who responded was weed resistance to herbicides. During the technical sessions many US researchers revealed that weed resistance now stretched over a rapidly expanding number of counties particularly in the southeast and mid south, due in large part to part an over reliance on GM technology (soybean, corn and cotton) and glyphosate without effectively applying integrated weed management (IWM) practices."

It was revealed that up to 10 weeds could now be resistant to glyphosate in these areas, with one in particular, Palmer amaranth or Palmer pigweed (*Amaranthus palmeri*), being classed a s super weed by some because of it's rapid growth habit, massive seed set and possible capacity to spread resistance through pollen transfer.

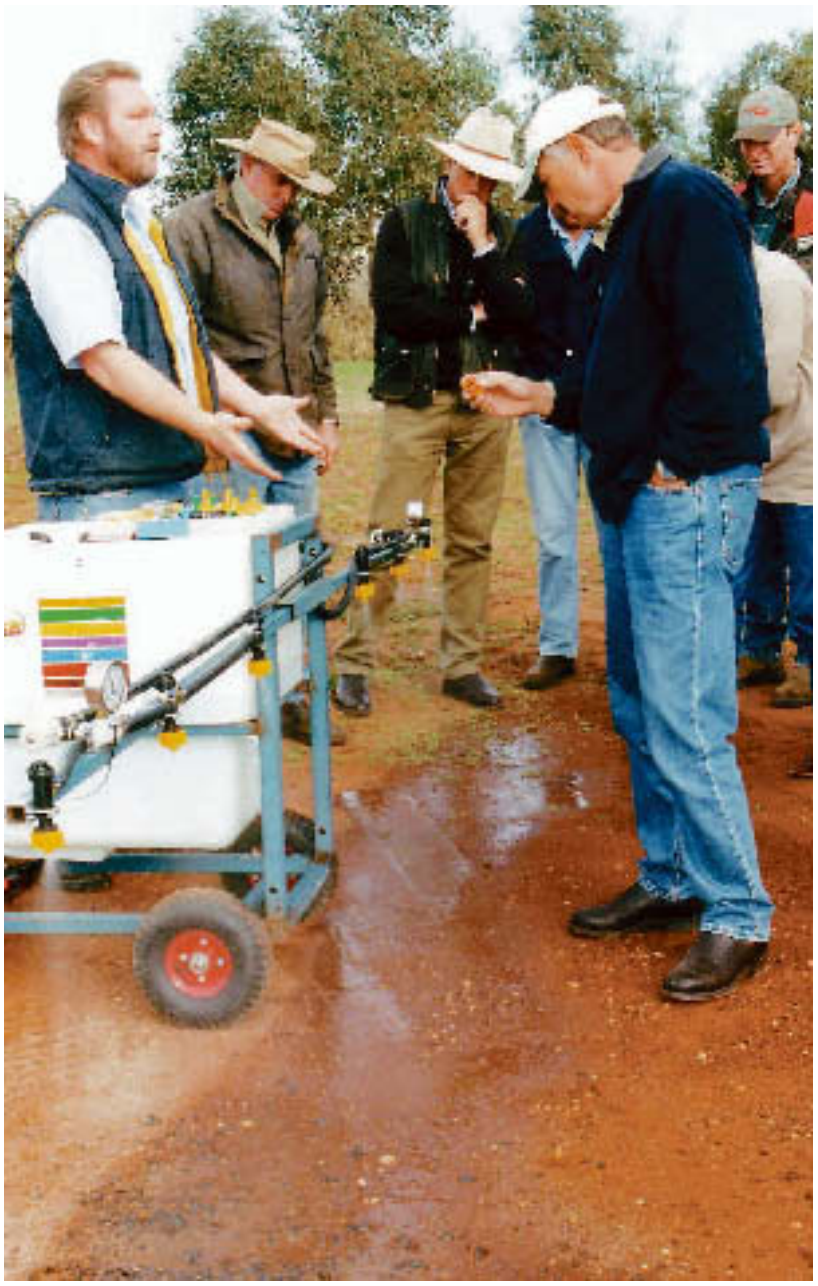
"There is a strong message here for Australian conservation farmers and GM herbicide crop growers," Mr Pyke said, "Don't rely too heavily on glyphosate for weed control, apply good stewardship of GM herbicide tolerant crops and apply IWM when growing these crops and zero till production systems.

"There were many good presentations at the Beltwide conference and there was an opportunity to hear about some of the new technology, particularly biotechnology, coming along the pipeline."

However, Mr Pyke says, from an Australian perspective we can continue to draw a great deal of comfort in the knowledge Australian cotton growers are in a much better position from agronomic, efficiency and many NRM perspectives compared to their US counterparts.

"This can be attributed to our strong R&D model, where a real partnership exists between industry, the research fraternity and government," he said.

"We should continue to work hard to maintain that successful partnership."



A group of Brigalow-Jimbour Floodplains Group farmers on the Darling Downs attending a spraydrift workshop run by Bill Gordon.

Incentives drive adoption of best practice

Spray drift events have been virtually eliminated in the Jimbour area, through a proactive approach by the Landcare group known as the Brigalow-Jimbour Floodplains Group Inc (BJFG).

The scheme is incentive based, with rebates and support available once participants reach certain levels of competency in spray application, such as rebates on nozzle purchase and boom spray modifications.

Group co-ordinator Nevin Olm says spray drift became a social issue in the area about four years ago, which created angst in the community and court action taken in relation to 2,4-D drift.

"We weren't unlike many other areas," Mr Olm said.

"But we decided to do something as a group and as a result we've seen about 280 people go through the course and more or less eliminated damage from herbicide drift in this area.

"There are very few farmers in the area now who haven't completed the workshop."

Mr Olm said through bringing in technical expertise and offering an incentive based scheme to accelerate the adoption of best practice and sustainable farming were the keys to the success of the scheme.

He said incentives can be claimed once participants have achieved a certain level of competency, based around workshops run by spray application expert Bill Gordon.

Apart from rebates on coarse nozzle purchases, BJFG has partly funded participants to purchase stationary and hand held weather stations as well as to modify and upgrade spraying equipment.

"As well as equipment upgrades, the key to adoption is knowledge and skills to mitigate drift events and this process has worked extremely well," Mr Olm said.

Spray application expert Bill Gordon was enlisted to run the spray workshops for the group and he has also played an integral part in education about spray application in many farming areas.

His workshops receive unanimous acclaim from participants, in helping to understand more about how drift occurs and simple methods to guard against it.

Bill has also been running a series of workshops and presentations for the past three years under a CRDC/GRDC joint project, Drift Management Extension Strategy for the Northern Region.

In that time he has run more than 120 workshops in the Northern Grains Region and all of the cotton catchments to educate people about spray technology and drift management.

In the last few weeks alone he has reached more than 300 people in two field days, at Edgeroi and Moree.

"I appreciate growers taking the time to attend workshops and meetings to update their skills and knowledge, I learn as much from what they do as they learn from me," Bill said.

"More than 80 percent of the people who attend one of my workshops change how they spray.

"The greatest difficulty I have is getting the people that most need to improve their practices to actually attend."

In the future, he will take his spray workshops to the Southern Regions, working in Victoria and South Australia throughout March, in an effort to introduce the knowledge to that area.

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How can the problem be reduced?

- Read the product label and follow the guidelines
- If you night spray you must know what sensitive crops are being grown in the lower parts of the flood plain
- Monitor and record conditions at least every 20 to 30 minutes – if the wind stops at night – stop spraying immediately
- Reduce boom height
- Avoid using wetters that increase drift such as non-ionics
- Use the coarsest nozzle that will provide efficacy

(Courtesy Bill Gordon, Bill Gordon Consulting)

Dr Eva Bennet Jenkins, Les Davies APVMA 2,4-D Reviewer and Namoi valley Grower Gary Eason inspect damage during a recent tour by the APVMA representatives of phenoxy-affected cotton crops.

Drift damage prompts tougher usage guidelines

In terms of phenoxy herbicide, by mid February, Cotton Australia had direct grower reports of drift damage to cotton crops of 15,685ha - representing 10.4 percent of the Australian crop.

There has been an estimated 510ha abandoned (ploughed out), all in the Lower Namoi region representing an estimated lost value of production of about $8.9 million.

"Possibly the most worrying number is the proportion of the crop damaged in the Lower Namoi where 74 percent of the crop has symptoms of phenoxy herbicide drift," says Cotton Australia's Greg Kauter.

"In this region we have (written) reports of 10 farms that have had more than one drift event."

The Australian Pesticides and Veterinary Medicines Authority (APVMA) has since advised it will endeavour to introduce label changes on phenoxy herbicides by the middle of this year.

"APVMA is aware of continuing reports of damage to commercial crops and native vegetation arising from off-target drift of herbicides, particularly the phenoxy group of chemicals, from both aerial and ground spraying operations," APVMA CEO Dr Eva Bennet-Jenkins said.

"It is concerned that regulatory actions to strengthen label controls do not appear to have significantly reduced the incidence of adverse experience reports."

Because of a large number of reports of phenoxy damage to cotton this season, Dr Bennet-Jenkins, together with the Head of APVMA's Chemical Review and Adverse Experience Reporting Program Dr Les Davies, Advisory Board Chairman Mark Allison and Principal Scientist Dr David Loschke, visited Narrabri in late January 2000 to meet with cotton growers and see the problem first hand.

The visitors inspected a cotton crop on the property of a Pilliga farmer, evidently one of the most severely damaged GM cotton crops in the region.

"The visitors noted the evenness of the damage across the crop – it appeared that the crop had suffered several 'hits'," Dr Bennet-Jenkins said.

"At the Australian Cotton Research Institute (ACRI) just out of Narrabri we viewed damage to cotton plants in experimental breeding plots. Here the damage looked more like what one might expect from a spray-drift event – that is, a gradient of damage across the plot with the most damaged plants closer to the direction of the prevailing wind.

"Interestingly, the fact that younger (hence shorter) cotton plants had suffered no damage was a possible indication that the damage was due to fine droplet drift rather than vapour drift, the spray droplets being captured by the higher, more mature plants before they reached the younger plants."

Discussions were held over lunch with staff at Cotton Seed Distributors in Wee Waa.

"Perhaps the most important part of the day was a 'Solutions Forum' which was held at the ACRI," Dr Bennet-Jenkins said.

"Invitees included the APVMA visitors, representatives from Cotton Australia, CRDC and the Qld DPI&F, as well as cotton growers from a number of districts, cotton consultants and cotton researchers."

The APVMA noted that any regulatory measures put in place would need to be both practical and effective.

It advised that it will endeavour to introduce label changes on phenoxy herbicides by the middle of 2009.

Label changes on products (which will reflect the published APVMA operating principles in relation to spray drift risk, (see http://www.apvma.gov.au/new/public_consultation.shtml) will include the imposition of enforceable downwind no-spray (buffer) zones.

"It is intended to address the issue of neighbour notification of spraying intentions and a requirement that users keep appropriate spray application records (for subsequent audit if necessary) on labels," Dr Bennet-Jenkins said.

"However the issue of an appropriate definition of 'neighbour' is still under consideration."

In the latter half of 2008 APVMA had consulted widely with stakeholders on possible regulatory approaches to the problem of off-target spray-drift.

This included a meeting in July with state/territory authorities responsible for control-of-use of agvet chemicals (see http://www.apvma.gov.au/about_us/RLC_meetings.shtml) and a forum on October 31 (organised by the APVMA, the National Farmers' Federation and CropLife Australia) attended by a number of industry stakeholders to discuss APVMA's regulatory proposals as well as a primary industry education plan put forward by the NFF and CropLife.

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VALUE CHAIN

Achieving the quality product

Collaborative research between CSIRO researchers from the cotton plant breeding, agronomy and processing sectors has provided some must-know facts for growers about the linkages between crop management, environmental effects and fibre quality.

Australian cotton fibre is exported into a dynamic and competitive market and there are ongoing efforts to improve quality to meet spinners' demands. This means that fibre quality is just as important for maintaining the viability of the industry as cotton yield.

This need is being addressed through the project, Linking Farming Systems to Fibre Quality and Textile Performance, initiated by the CSIRO, Cotton Catchment Communities CRC, and CRDC and is improving knowledge of how crop management, environment and variety can affect fibre quality that leads to differences in textile quality.

Involving Drs Michael Bange and Robert Long and other researchers based at ACRI in Narrabri and CSIRO Materials, Science and Engineering Geelong, specific research is being undertaken to identify management practices to reduce neps, lower micronaire and assess the performance of Australian varieties from a textile production perspective (spinning, weaving and dyeing). Neps (fibre knots), short fibre (fibres shorter than 0.5 inches) and high micronaire are some of the issues of concern for spinners of Australian cotton.

Information on fibre quality and processing performance is vital to breeders and agronomists so that they can determine which varieties and crop management practices are most beneficial in producing a quality product. Knowledge of the textile performance of new varieties can also be used strategically in marketing.

This research effort is progressing well with improved understanding of the impacts of practices that effect crop maturity (such as defoliation) effecting the level of neps; validation of a micro-spinning protocol that allows for smaller samples of cotton to be spun into yarn for testing; and assessments of current and candidate future varieties compared for their textile performance.

Ongoing and future research is investigating means to influence micronaire, improve fibre consistency, and understanding of management and environmental effects on fibre maturity and fineness. This project is also employing the use of new fibre quality instrumentation developed by CSIRO with the support of the CRDC and CRC.

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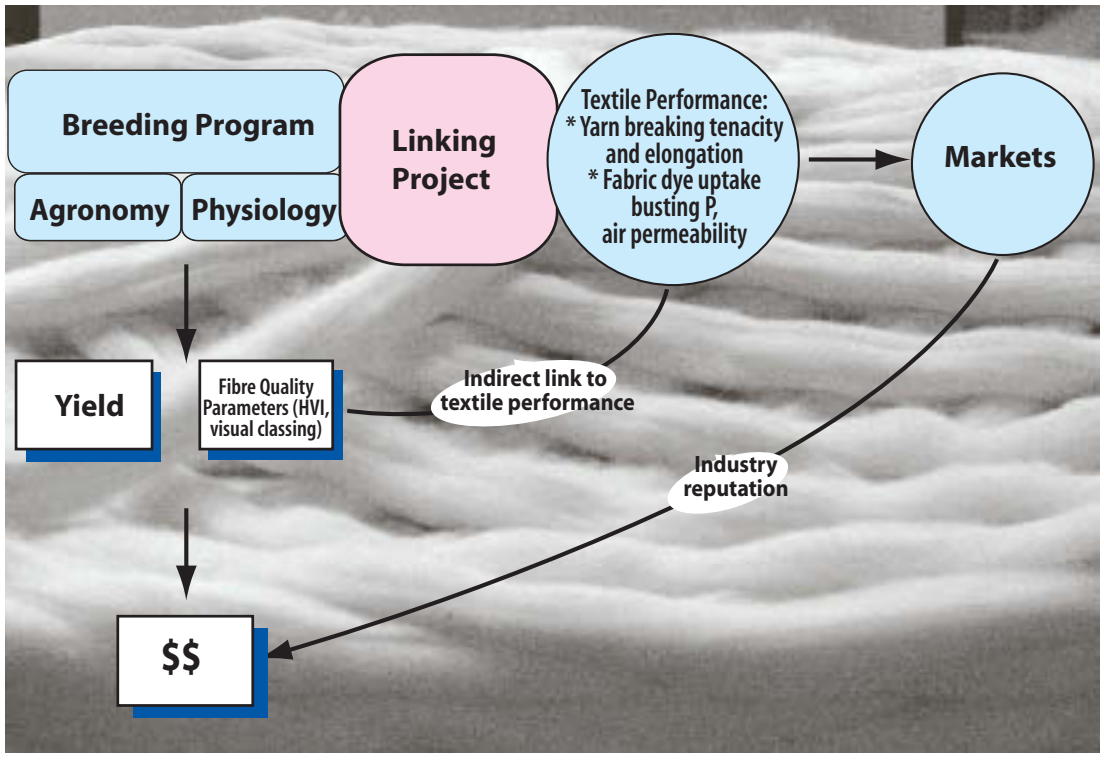

Defoliation timing and fibre quality

In recent years there have been concerns relating to high levels of neps in Australian cotton. The Linking Farming Systems with textile performance project is examining the defoliation timing on nep levels and its impact on textile performance. Crops that are defoliated early have been shown to increase neps.

A study of the impact of defoliation timing on fibre quality and textile performance has shown that overall, the management practice of defoliating cotton from 60 per cent open bolls appears to have no impact on textile performance.

Preliminary findings

– Preliminary studies have shown that yield was significantly less for defoliation applied early.

– The effect of defoliation timing has less effect than the impact of lint cleaning. Lint cleaning generated neps at approximately 100 counts per gram per lint cleaner passage.

– Defoliation timing had no effect on yarn strength.

– Dye uptake in knitted fabric was significantly less for defoliation treatments applied up to 42 per cent open bolls which was due to less mature fibre (lower fineness and micronaire) in the early defoliated treatments.

– Results to date support the recommended management practice of defoliating from 60 per cent open bolls. Research is in progress to evaluate the impact of management practices within a broader range of climatic conditions.

While currently there is no discount to growers when there is a high incidence of neps, it can affect the overall industry reputation when cotton arrives at the mill. Immature fibres will have may be more prone to nep formation during harvesting and lint cleaning.

Neps typically absorb less dye, appearing as 'flecks' on finished fabrics, and fibre immaturity has also been associated with non-uniform dyeing of fabrics. There are concerns that management practices that force open immature bolls to be included in the harvest to increase yield or to reduce micronaire may increase the incidence of neps and immature fibre.

Preliminary field experiments have been conducted that systematically vary the timing of defoliation, with the intention of generating different amounts of immature fibre and neps at harvest. The harvested samples were then subjected to additional lint cleaning passages. The effects were assessed in terms of fibre quality and textile performance.

Research by Drs Mike Bange and Rob Long is continuing to assess this management practice in a broader range of climatic conditions.

? These articles are extracts and the enitire documents can be found at www.cottoncrc.org.au/content/Industry/Publications/Fibre_Quality

Dallas Gibb, right, CRDC Program Manager - Value Chain, with CRDC staff and board members and CSIRO Materials Science and Engineering staff at the Belmont, Victoria, textile research facility where much of the premium fibre research is underway.

Mills join premium cotton initiative

The Australian cotton industry is seeking long term partners in the milling sector for the development of premium uses of long staple Australian Upland cotton such as Sicala 350B as part of the CRDC/ Australian Cotton Shippers' Premium Cotton Initiative.

This initiative follows on from the Premium Cotton Pilot Project, a collaboration between CRDC, ACGRA, ACSA, CSD and CSIRO, which began in late 2007 to develop a niche product to compete with the world's best cotton fibres.

The idea for the project was born with CSIRO Plant Industry's release of Australia's first commercial long staple (LS) Upland variety - Sicala 350B, a Bollgard II variety exhibiting extremely long fibre length (> 1 1/4 inches). The fibre is also typically finer and with excellent breaking tenacity.

Sicala 350B was trialled over the past two seasons and this year under the Premium Cotton Initiative, there are five growers who will produce about five containers of 350B.

"We hope to place this with up to four mills and run commercial trials utilising the product as both a blend with other quality cotton types or use as a stand alone product," said Dallas Gibb, who heads CRDC's Value Chain Investment Program.

"We will be working from a small production base of elite fibre quality, and placing this with selected mills, however the initiative also aims to run larger scale commercial trials to verify and identify premium uses of this cotton fibre, ahead of larger scale raw cotton production."

The initiative has two major aims. Firstly to understand the advantage this type of cotton offers mills and secondly to better undersatnd how to best capture premiums for the cotton.

Developmental Australian Upland lines are producing consistent high quality cotton for use by mills specialized in production of fine yarns and fabrics which is ideal for high quality fine knit and woven apparel fabric.

Mill trials conducted by CSIRO indicate this fibre does not negatively influence yarn quality and efficiency when used in an ELS blend for fine count yarns (>60 Ne or 10 tex) yarns,which can be produced at a substantial lower cost, and as a stand alone product for 50-60 Ne (12 to 10 tex) yarns.

"We can now gain leverage from research by CSIRO Materials Science and Engineering, showing good results blending with Pima – and replicate these trials commercially," says Pete Johnson, Chair of the Premium Cotton Initiative Working Group.

"We will provide mills with direct access to this state of the art Australian spinning industry research and personnel, in a value chain initiative that is one of a kind for the industry.

"CSIRO textile researchers will assist in developing processing trials to fit a mill's program which could provide improvements and will be on hand during the spinning process to take objective measurements of fibre, yarn and possibly fabric performance and to ensure that the trials are conducted according to agreed procedures."

Apart from the quality assurance benefit, involvement will ensure these mills are at the cutting edge of premium fibre development - and can take maximum advantage of the efficiency savings and productivity gains available.

A spinning trial at CSIRO Materials Science and Engineering's commercial short staple spinning mill has found that blending Sicala 350B with with Pima cotton would save mills significant costs.

"The pathway will also be open for two-way feedback and analysis of the spinning process and yarn performance between researchers and mill staff who can then identify new areas for textile research for the continued advancement of our fibre quality," Mr Gibb said.

Potential benefits

The potential benefits for the Australian cotton industry lie in the fact that ELS/Pima production around the world is falling, says Pete Johnson.

"The challenge is that in the current global financial crisis – ELS demand has slipped a little (a high end consumable) and it is difficult to get mills to commit capital to a project that may not show them immediate returns," Mr Johnson says.

For growers, addressing the yield lag of 350B type cottons compared to the suite of high yielding CSIRO varieties and attracting a premium price for the higher quality product are the main issues.

However CSIRO initially released the variety more to provide fibre with novel properties for spinning tests than as a long term variety and the long term goal is to produce new varieties with genuine premium fibre quality and high yield which will create a more attractive option for growers.

VALUE CHAIN

Key Australian retail groups will be invited to discuss future trends in garment demands and fabrics at a forum to define opportunities for investment to add value to our industry.

Working together for higher premiums

The production of premium fibre quality has been the industry's key mechanism for building and securing its reputation across the value chain.

The majority of the industry's R&D investment has targeted the development of new varieties and management practices that presume that fibre quality.

"However with the continuing decline in terms of trade, it requires greater understanding of how best we can capture higher premiums for our fibre across all aspects of the value chain," says Dallas Gibb, who is heading CRDC's Value Chain Investment Program.

"CRDC's new strategic plan has recognised the importance of the value chain to the industry's future – Goal One under the new strategic plan is to 'add value to the Australian cotton industry with premium products in improved routes to market'.

To define opportunities for investment that can help achieve this goal, CRDC will work with industry partners including ACSA and Cotton Australia to hold a number of value chain forums throughout the first half of 2009.

The first value chain forum will be held in Sydney on May 13 and will have a focus on market development and consumer needs.

Other forums are being planned which will focus on ginning, storage and handling of cotton.

"In considering the objective of the first forum, it is recognised that the cotton industry can to learn from the experiences of other industries that have successfully marketed their products across the value chain," MrGibb said.

"At the forum, speakers will be invited from other agricultural and retail industries to detail how they have achieved success.

"The overall aim is to learn from other's experience in the value adding as well as provide a forum for discussing future opportunities for the cotton industry to develop new high value markets for Australian cotton.

"Presentations will be made on current industry programs to develop a new premium fibre market and BMP practices that secure the value and integrity of fibre."

While the cotton industry has seen its traditional customer as the spinner, future work with fully integrated mills provide the opportunity to better align our premium products with the need of garment producers and their retailers.

In this respect key Australian retail groups will also be invited to attend and discuss future trends in garment demands and fabrics.

"By sharing information about BMP and elite quality raw cotton, specific points of differentiation will be communicated directly to domestic brandowners and retailers at the forum," Mr Gibb said.

As 95 percent of Australian cotton is exported, the opportunity to develop partner ships for international collaboration will also be explored.

The forum will aim to develop the first stages of a supply chain map, whereby we can begin to understand the needs of specific customers of domestic spinners, fabric suppliers, brandowners and retailers.

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The first forum will be held in Sydney on May 13. Please contact Dallas Gibb or Pete Johnson if you would like to attend.

Field to Fabric with support from CRDC

Sub-titled *Managing for quality through the production chain*, the Field to Fabric course offers a unique experience for participants to gain an overview of the entire cotton pipeline from farm to predicting fabric performance and CRDC is offering a limited number of bursaries for interested participants to attend.

Students in the course are given technical, first-hand perspectives of the processes involved in taking fibre through to fabric. Expert speakers are drawn from CSIRO, NSW TAFE and industry organisations such as the Cotton Classers Association of Australia (CCAA) and the Australian Cotton Shippers Association (ACSA). To date over 170 students have attended the course since the first was held in August 2005.

Course manager Rene van der Sluijs joined CSIRO in 2003, and was named the ACGRA Researcher of the Year at the Cotton Industry Awards in August last year.

He understands the needs of the post harvest sector of the industry and the need to build strong links with it. Rene has rapidly become and remains a highly respected 'go to' person for the post harvest sector as a technical expert on the characteristics and benefits of Australian cotton. He is a strong advocate for Australian cotton and has represented Australia at international conferences and trade missions.

The researcher realised there was a gap in the information between growers, ginners and merchants and the spinners they supplied. Out of this came the 'Cotton Field to Fabric' course that focuses on the impact of fibre quality on textile quality and processing performance which was developed in conjunction with the Cotton CRC and National Cotton Training Co-ordinator Mark Hickman..

He believes this understanding is critical in meeting the customer's needs as Australia strives to maintain a position as a preferred supplier of high quality cotton to the international market.

This invaluable program will include the topics:
• global perspective • marketing • fibre properties • agronomy • picking • ginni ng • classing • yarn manufacture • fabric formation • dyeing and finishing • pri nting • quality assurance • environmental issues.

Managing for quality through the production chain will be held July 21, 22 and 23 at CSIRO Materials Science & Engineering in Geelong, Victoria.

To take part in this course through a bursary from CRDC, contact Helen Dugdale on 02 6792 4088, Helen.dugdale@crdc.com.au or for general enquiries, Rene van der Sluijs on 03 5246 4738 Rene.vandersluijs@csiro.au

Women's inspiration a positive for industry

Megan and husband Simon James at last year's Australian Cotton Conference. Megan is an advocate of the cotton industry and recently attended the Australian Regional Women Leaders Convention with support in part from CRDC, where she heard many messages of success and positivity which she says were pertinent to the family-run farming operation at Dalby.

Megan James admits when she walked through the doors of the grand Melbourne Town Hall to attend The Australian Regional Women Leaders Convention, she was feeling a little apprehensive.

"More than 350 women in one room…I wasn't sure what to expect," she said. However any fears were quickly replaced with the realisation that she was among a very inspiring group of people.

Megan attended the conference with the sponsorship of CRDC and BMO Accountants in Dalby, where the mother of three works part time in a marketing role as well as helping her husband Simon, and brother and parents on the family farm, all the while working as a freelance journalist.

"Everyone was there to share ideas, learn more about effective leadership and networking and be inspired by those who have overcome adversity and challenges to achieve success for themselves, their businesses, their families and their communities," Megan said.

"Importantly, the messages were relevant not just to women, but to men living and working in regional communities and industry.

"We could take home the messages and in my case implement them to help our farming operation become more successful and also integrate them more broadly into our lives.

"Speakers ranged from successful business women, to an Antarctic team leader, farmers, community leaders, authors, and media personalities who gave practical insight.

"Margot Spalding's story was inspiring. The former Australian business woman of the year built a furniture business with her husband from next-to-nothing to a multi-million dollar enterprise," Megan said.

"For me, Margot's key message was about embracing opportunity, overcoming adversity, taking educated risks and believing in yourself.

"Her ideas about employee culture were impressive and could easily be translated to an agricultural perspective, where attracting and retaining good staff has been an issue recently.

"They are regularly adding new company values and have in place health and leadership programs for staff."

Networking is a key element to success in any business and speaker Kelly Mills explained her 'seven habits for highly effective networking'. Be creative, be bold, be approachable, be memorable, be interested, be professional, be proactive.

"Kelly asked us to be mindful of the way that BUSY is becoming the new four-letter word.

"Even if we don't say it, we project it. If you project 'busy' to all your family and friends – they will start to exclude you and these networks are essential for life in rural areas."

Mungindi cotton farmer Barb Grey spoke about "her journey to discovery".

"Barb described how, when she found herself as an empty-nester she made the decision to work hands-on on the farm, and how this led to the establishment of an award-winning human resources business," Megan said.

"She talked about the elusive 'work–life balance' and indicated that the focus should really be on compromise to achieve success in both and the importance of relationships and how necessary it is to be true to your values."

The Mungindi area was again represented by Marg Harrison.

"Marg was instrumental in creating the Mungindi Music Festival – that saw a tiny community come together to successfully host a nationally-significant event.

"By being open to possibilities and 'be brave about life' Marg reminded us to prioritise what you really want out of life (instead of saying yes to everything) and make meaningful contributions."

From Mungindi to the Antarctic, Rachel Lamont (Australian Antarctic Division Station Leader) explained what it takes to be a leader in the most remote of locations and challenging of conditions.

"Rachel left me with the impression that leadership is not so much about directing people but rather drawing people together and making the most of their individual talents and building strengths as a team," Megan says.

"Through all the speakers it was clear that leadership qualities can be learned, and as author Marg Carroll rightly said "effective leadership is done by asking 'come with me' not 'follow me'."

- Involve children in the business activities at a young age – invite them to meetings to observe. In farming families we often involve children in physical labour but not in the "business" side of things
- Create a sense of belonging for employees – consider internal programs like health programs and leadership programs for your teams
- Continue to encourage young people in our industry – embrace those with an entrepreneurial spirit
- Be positive when you are talking to 'city-folk' about living in regional Australia – focus on what we have not what we don't.

CRDC's manager – farming systems, Tracey Farrell, and Sally Ceeney, industry extension officer, launched the 2009 Crop Rotation Guide at the 2009 Cotton Big Day Out farming systems workshop at Keytah, west of Moree on February 26.

New rotation guide supports crop choices

Making decisions about which crops to grow in cotton rotations has been made easier by combining years of research and all the latest information on crop rotations in an easy to read guide.

The most recent Crop Rotations poster was published in 2002. Because of ongoing research into farming systems in recent years, the new Crop Rotation Guide required a thorough review of the relevant research so that growers and consultants would be able to make informed decisions about future crop rotations.

CRDC's Tracey Farrell said the Guide offers a quick way to weigh up the pros and cons of a wide range of suitable rotation crops for cotton farming systems. The Guide aims to alert growers to issues that may not have been considered with the rotation crops they were planning.

"There has been so much research undertaken by the cotton and grains industries in recent years that has answered questions about the relationships between crop rotations and disease, pest and weed risks," Ms Farrell said.

"The impacts of these can be realized in the short to medium term. Research is also quantifying the longer term effects of rotations such as impacts on soil structure.

"The chart will help in the overall assessment of the value of a rotation crop for the cotton farming system.

"It is not intended that the chart be used as a stand-alone tool for rotation decision making but more as a first point of call. The chart helps to identify the types of information that require more detailed consideration as part of the decision making process."

Improvements to the handy reference chart include issues on individual crops are now rated under three colour coded classifications - Advantages, Cautionary Notes, and Disadvantages.

It also contains new comparison information on: planting overviews, reactions to salinity/sodicity, broader implications for nutrition management, nitrogen removal at harvest and harvest issues. All other original categories have been reviewed an updated with the latest information

Cotton CRC's Dave Larsen says the production of the guide has been a truly cooperative effort by the industry's R&D community.

The industry acknowledges the important input from Stephen Allen, Chris Anderson, Sally Ceeney, Graham Charles, Helen Dugdale, Tracey Farrell, Graham Harris, Nilantha Hulugalle, David Larsen, Susan Maas, Ian Rochester, Lewis Wilson, Neville Walton and Stephen Yeates, together with the authors of the first Rotation Crops and Cotton poster from which the 2009 Guide evolved.

For additional copies of the Guide, go to the CRDC or Cotton CRC websites – www.crdc.com.au, www.cottoncrc.org.au
or contact Tracey Farrell 02 6792 4088, Dave Larsen 02 6799 1534.

Data for management strategies

Long term resistance monitoring program and dose response data collection for new insecticides

Dr Louise Rossiter has continued a long term insecticide program for *H. armigera* and *H. punctigera*.

Resistance is one of the greatest threats to effective pest control in the Australian cotton industry, both against insecticides as well as transgenic cotton.

To mitigate this threat, the project *Helicoverpa insecticide resistance monitoring mechanisms and management*, undertaken by NSWDPI Research Scientist Dr Louise Rossiter has continued a long term insecticide resistance monitoring program for both *H. armigera* and *H. punctigera* over the last three seasons.

Dr Rossiter also investigated cross resistance and resistance mechanism research, accumulation of dose response data for new insecticides and resistance management formulation and promotion.

Insecticide resistance monitoring was successfully conducted in 2005/06, 2006/07 and 2007/08.

The objective of this monitoring was to detect resistance to chemistries used against Helicoverpa spp. and monitor trends and changes in resistance frequency. The data is used in the assessment and formulation of the Insect Resistance Management Strategy (IRMS) utilised by the cotton industry to delay and manage insecticide resistance.

Good news for the industry is that Dr Rossiter found very low resistance frequencies to the Integrated Pest Management (IPM) compatible chemistries of indoxacarb, spinosad and emamectin benzoate.

However, resistance is still present in field populations to those chemistries that *H. armigera* is known to have developed resistance to, including endosulfan, methomyl and organophosphates (profenofos), however, frequencies appear to have declined over the last three seasons.

And while widespread general pyrethroid resistance is still present in the field, resistance to the pyrethroid bifenthrin is very low, this is specific to this insecticide and does not extend to other pyrethroids.

Research also showed a very low frequency detection of resistance to endosulfan, pyrethroids and abamectin by *H. punctigera*.

"These results have direct implications for insecticide use within both the cotton industry as well as grains/ pulses which a number are registered for use in," Dr Rossiter said.

"The IPM compatible insecticides can continue to be used with confidence that the products will provide good control.

"While the resistance frequency to most of the older insecticides appears to have declined, it is important to note that the reduction in resistance frequency can probably be largely attributed to reduced insecticide use since the introduction of Bollgard II.

"Resistance is still present and detectable in the field allowing for selection when insecticides are used."

For this reason it is important that insecticides continue to be used within the IRMS to ensure that their effectiveness remains, particularly if their overall use increases.

As part of continuing to investigate the features of resistance mechanisms, an esterase gene has been successfully sequenced.

"This information shall be used to characterise the properties of this gene and its protein product and its possible role in insecticide resistance," Dr Rossiter explains.

"This shall enable investigation of resistance to move from the biochemical characterisation of resistance enzymes to investigating the features of the genes that drive these enzyme systems."

In addition to resistance monitoring and mechanism research for chemicals currently registered for use on cotton, it is essential that new chemistries entering the industry have accurate dose-response data measured prior to their introduction.

For the last two seasons this data has been collected for a new insecticide registered for use in cotton in 2008/09 named Rynaxypyr.

Dr Rossiter said this research has enabled an appropriate bioassay and discriminating dose to be determined for use in resistance monitoring which will begin in its first year of registration. This allows for measurement of future changes and the detection of resistance development before it is evident in the field.

The final aspect of Dr Rossiter's research is the formulation and promotion of resistance management strategies and principles.

The assessment and formulation of the IRMS by TIMS has utilised resistance monitoring data which has enabled changes to be made to the IRMS at the request of the industry.

The resistance monitoring data was also used to support an amendment to the pupae busting recommendations in conventionally sprayed cotton in 2007, providing some scope to reduce the need for pupae busting under certain conditions.

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Graphic by Craig Hensley.

Gauging the industry's environmental performance

Environmental Performance Indicators (EPIs) would allow a catchment and or industry to report on its environmental performance within a relatively simple structure that in many cases uses existing information and robust relationships between management and environmental outcomes.

So says Principal Environmental Scientist David Freebairn of Natural Solutions Environmental Consultants, who headed a project last year to develop a set of EPIs on cotton production for growers and the industry to demonstrate and report on sustainability and environmental performance.

The aim was to have these EPIs consistent with and (where applicable) common with the indicators being proposed by beef and grains industries in their NRM programs.

"There is a need for an industry to demonstrate its credentials, and in the case of the cotton industry, which has done many good things and made huge advancements in the field of NRM and environmental outcomes, there is still some public perception for example, that cotton uses a lot of water and chemicals," says Dr Freebairn.

"It provides the industry with an environmental benchmarking and reporting system and for reporting at catchment, region and industry scales."

Building a set of cross-industry EPIs to enhance the adoption of sustainable farming practices, reduce the administrative burden on Catchment Management Authorities and build a framework for continued collaboration on the identification and determination of appropriate EPIs for multi-enterprise farms were other major aims of the project.

Five elements were chosen to describe the status of natural resources specific to cotton production areas: soil health; water; biodiversity / nature; industry health; and carbon emissions.

"The soil and water indicators can be used to translate changes in practice to changes in soil and water resource conditions while biodiversity indicators provide a semi quantitative indication of vegetation and riparian condition," Dr Freebairn said.

"The carbon emission indicators are included in recognition of green house gas emissions being a new issue that requires development of understanding. Industry health has been included to provide a gauge of an industry's commitment to environmental management."

After initial trials, Dr Freebairn recommended that the proposed EPIs and assessment worksheets be trialled further across the cotton industry and that the beef and grains industries as well as NRM regional bodies be further engaged to facilitate collaboration in monitoring efforts.

He said the study showed that measurement of EPIs by farmers may not be seen as useful by farmers at this time, as in most cases, self-evaluation of the health of farm was already occurring.

"The process of establishing new or formal indicators can be difficult unless there is a direct and immediate benefit; the process is simple and quick and training and support is available to demonstrate the benefits."

It was suggested that web-based tools for calculating water use efficiency and greenhouse gas emissions be further developed to be more educative.

"Currently, the logic behind calculations is not readily accessible, and the ability to learn about management options to improve on-farm management is limited," Dr Freebairn said.

"But as an industry there is a need to do some measurement, and this could be done efficiently with survey methods (random stratified) and case studies to quantify practice change. These practice changes can be translated into improved natural resource outcomes through simple relationships such as soil cover verses water quality or nutrient balance and better quality of soil and water.

"While a set of EPIs has been proposed, a range of approaches is required to demonstrate NRM credentials including; random stratified surveys, establishment of reference sites as benchmarks, monitoring of sentinel sites, remote sensing and publication of case studies.

"A range of approaches is required to support communication of an industry's environmental management, with different audiences requiring different styles of information."

This project was managed by CRDC and funded by DAFF under the EMS Pathways To Sustainable Agriculture Program.

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Supporting IPM for future cotton systems

Nymph of the pale cotton stainer (*Dysdercus sidae*) Courtesy Lewis Wilson CSIRO

Dr Lewis Wilson

Mirids have emerged as the major pest of Bollgard II crops.

New information about the management of emerging pests benefits industry by helping pest managers to make more rational decisions on the need to control pests, and awareness of risks for different control options.

This will contribute to reduced pesticide use with flow-on economic, social and environmental benefits.

Recent research by CSIRO Plant Industry and the Cotton CRC, headed by Dr Lewis Wilson, has focussed on management of emerging pests in Bollgard II cotton crops.

"These pests have emerged as potential problems largely due to the reduction in insecticide use against Helicoverpa spp and also the change in insecticide use on Bollgard II toward management of sucking pests," Dr Wilson said.

A significant component of research has focussed on the fit of new insecticides into integrated pest management (IPM). Selection of insecticides can have a big influence on both control of the target pest as well as on beneficials, and the risk of secondary pest outbreaks.

Through this project 'Supporting IPM for Future Cotton Systems', it was found that low rates of fipronil provided strong efficacy against mirids, with or without salt, and were significantly more selective that the full rates of fipronil against beneficials, though still with a risk of flaring mites.

Low rates of indoxacarb alone provided poor efficacy against mirids but the addition of salt or canopy oil boosted this to efficacy equivalent of the full rate with low risk to beneficials or risk of flaring mites. Altacor (rynaxypyr) a new insecticide for Helicoverpa control was highly efficacious and had little negative effect on beneficials indicating a good IPM fit.

These results have been made available to industry via the Cotton Pest Management Guide, to assist pest managers in spray choices, and to industry to help in registration, thereby ensuring availability of new insecticides or uses of insecticides for industry.

A second component of the research is focussed on emerging pests. This has included thrips as an early season pest and thrips and jassids as late season pests.

Early season threats

Thrips can cause significant damage to young cotton plants, stunting growth. Research with early season

Thrips damage on a young leaf on a mature cotton crop. Courtesy Lewis Wilson CSIRO

thrips has emphasised the species composition of the thrips population, especially any changes in relative abundance of the western flower thrips (WFT, *Frankliniella occidentalis*) which is resistant to most insecticides used to protect young cotton.

"We found that the tobacco thrips, *Thrips tabaci*, was still the dominant species," Dr Wilson said.

"It was controlled moderately well at some sites but poorly at others, which could indicate resistance. However, at some locations the WFT was also abundant and poorly controlled by all available options indicating significant insecticide resistance."

Dr Wilson said control of thrips is problematic because damage is often cosmetic, plants will recover without loss, and because thrips are also predators of spider mites.

"Nevertheless in cooler regions, where control is justified, management of WFT may be difficult," he said.

"It is likely that we will need to look at alternative insecticide options that can be incorporated in a resistance management plan."

continued overleaf ...

Pale cotton stainers cause damage to maturing bolls causing staining and reduced micronaire (healthy boll on the left damaged boll on the right). Courtesy Lewis Wilson CSIRO

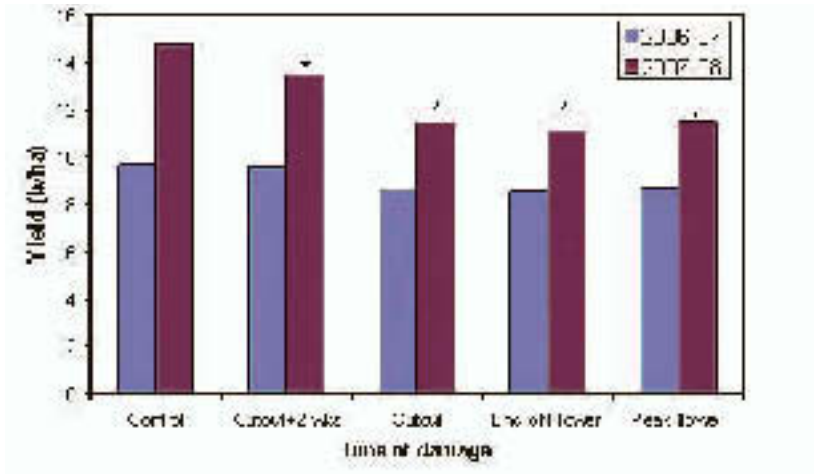

Figure 1: Earlier imposition of damage reduces yield more. This effect was stronger in 2007-08 when yields were higher. Asterisks indicate treatments significantly different from the control for each year separately.

Simulating pest damage by removing leaves.
Above: cotton before removal of the leaves from the top nine nodes.
Below: after removal of leaves from the top nine nodes.

Courtesy Simone Heimoana, CSIRO

Recent research by CSIRO Plant Industry and the Cotton CRC, headed by Dr Lewis Wilson, has focussed on management of emerging pests in Bollgard II cotton crops.

Monitoring of thrips population composition early in the season and determination of resistance profiles for both WFT and *T. tabaci* has been initiated in conjunction with Dr Grant Herron (NSW DPI) and CSD (see page 28).

Late season damage

Over the past five years there have been instances of cotton fields showing severe leaf damage from thrips or jassids late in the season. Unfortunately there is little information about the effect on yield of such damage, so using a mixture of real and simulated pest damage was investigated.

Simulated pest damage was done by manually cutting off leaves or by using an acid based spray to 'burn' leaves.

"We found that late season damage to leaves is only likely to reduce yield in crops with high yield potential (12+ b/ha) and if the damage is very severe and prolonged before cut-out," Dr Wilson reports.

"Crops with lower yield potential have a low risk of yield loss from such late season damage."

"This is valuable information as thrips are also predators of spider mites and these late season populations often very effectively prevent the build up of mites."

Mirids – major pest

Mirids (*Creontiades dilutus*) have emerged as the major pest of Bollgard II crops.

Dr Wilson found that controlling mirids with the most popular insecticide (fipronil) increases the risk of causing mite outbreaks, probably because this product reduces the abundance of beneficials (including thrips).

"Our results also suggest that in some situations Bollgard II crops are more at risk – this deserves further investigation," he said.

"Nevertheless, the results highlight the fact that insecticides applied against mirids in Bollgard II can reduce beneficial populations sufficiently to allow mite populations to build.

"It is important to have good mite sampling protocols in place in Bollgard II crops if insecticides are used to control mirids."

Pale cotton stainer

In the 2007-08 cotton season the pale cotton stainer (*Dysdercus sidae*) was very abundant and had the potential to damage many cotton crops.

A publication was developed quickly to help pest managers in deciding if this pest needed control. Thresholds for lint damage were also developed and indicate that for stained locks the threshold is greater than 50 percent of bolls with all locks damage, and for tightlocked bolls it is greater than 20 percent of bolls with all locks damaged.

"We also studied the feeding behaviour and have a better understanding of the damage symptoms," Dr Wilson said.

"Critically, feeding damage by this pest is not visible on the outside of bolls, so managers must cut bolls and seeds and examine them for damage."

Aphids and yield

A final component of the project was to finalise the research on the effects of aphids on cotton yield. Data over four years was combined and analysed and a simple relationship developed which predicts yield loss from aphid population scores.

This equation was used to develop look-up thresholds which have been extended to industry in the Cotton Pest Management Guide and as part of CottASSIST on the Cotton CRC website.

"The thresholds provide a more rational basis for deciding when the occurrence of this pest justifies control and when beneficials are providing adequate control," Dr Wilson explains.

"This information has been linked with new information on the aphid borne disease cotton bunchy top, to provide pest managers with a holistic approach to managing both the pest and the disease."

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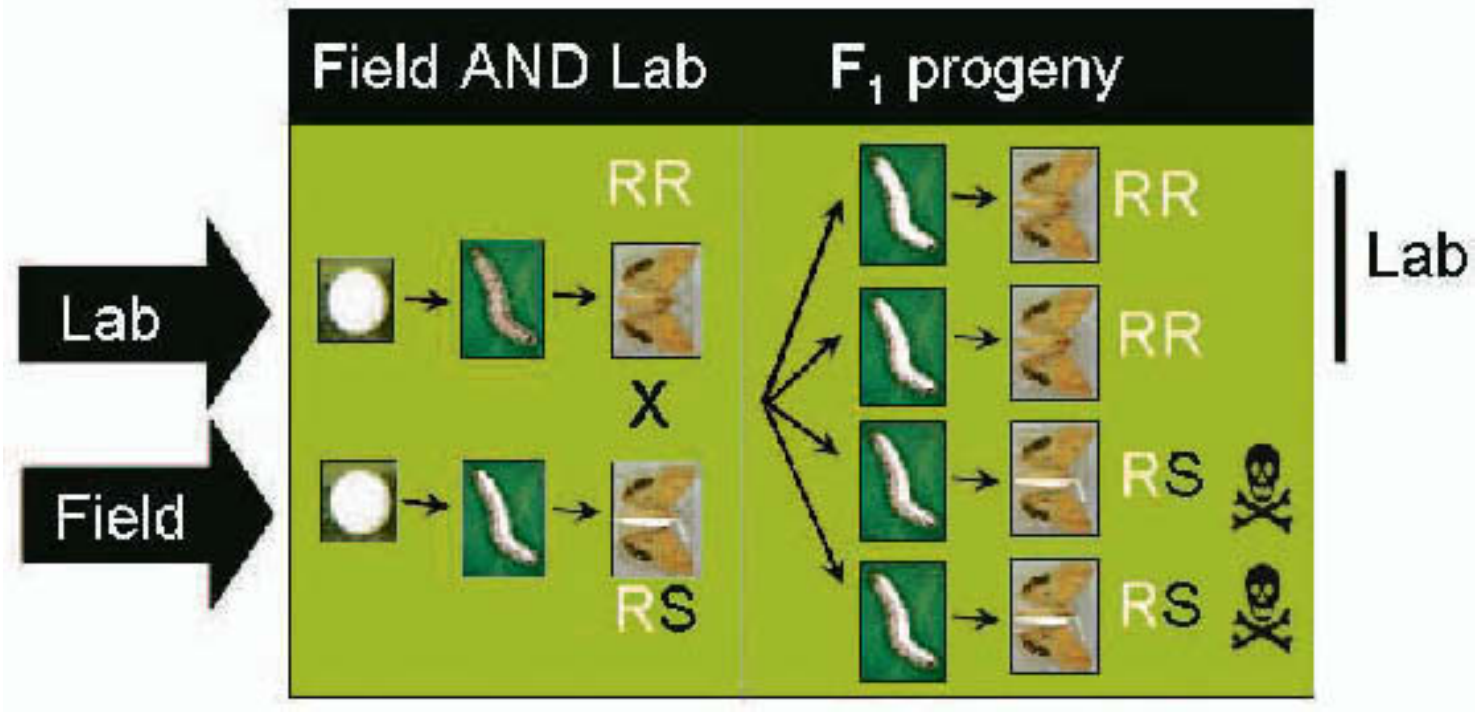

The F_1 screen gives frequencies of Cry2Ab resistance alleles that are up to six times greater than the F_2 screen. Unfortunately, the F_1 screen is likely to give the true frequency in field populations. In this screen one parent is collected in the field as an egg, and here it is indicated with one copy of the resistance allele. It is mated to a moth from a Cry2Ab laboratory strain that is known to carry two copies of the allele. If the wild moth carries the same Cry2Ab resistance allele as the laboratory strain, in the F_1 generation 50% of the larvae will be homozygous for the resistance allele (RR), and the remaining heterozygote progeny (RS) will be killed by the dose of toxin.

Monitoring for resistance to transgenic cotton 2005-2008

In the 2004/05 season Bollgard II replaced Ingard as the transgenic variety of cotton available to Australian growers.

Bollgard II improved on Ingard by incorporating an additional insecticide protein, Cry2Ab, to the already present Cry1Ac, to combat *H. armigera*.

Dr Sharon Downes of CSIRO Entomology says sequence information indicates that these genes are distantly related and the toxins they encode do not share a common binding site, consequently, it is thought unlikely that a single mechanism could confer resistance to both toxins.

Due to the perceived difficulty for *H. armigera* to evolve resistance to both proteins within Bollgard II, the Resistance Management Plan (RMP) for transgenic cotton was relaxed to allow growers to plant up to about 95 percent of the total area to this product. Bollgard II was well adopted, with more than 70 percent planted area

Through a project undertaken by Dr Downes titled Monitoring for resistance to transgenic cotton, the industry has sought to acquire early warnings of changes in sensitivity of insect populations to toxins that may signal the presence of resistance to transgenic varieties of cotton.

The sensitivity of field-collected populations of *H. armigera* and *H. punctigera* to Bt products was assayed before and subsequent to the widespread planting of Ingard cotton expressing Cry1Ac in the mid-1990s.

During Dr Downes' research, baseline levels of susceptibility to Cry2Ab were established in preparation for replacement of Ingard with Bollgard II in the 2004/05 season.

Dr Downes said preserving the efficacy of Cry1Ac and Cry2Ab is critical for the future of the industry, not only for the efficacy of the Bollgard II varieties of cotton, but also for the long-term future of cotton varieties expressing Cry1Ac or Cry2Ab in combination with other effective toxins.

"In this project we achieved our main aim of rigorously assessing the sensitivity of field populations of Helicoverpa to both Cry1Ac and Cry2Ab to detect early signs of the development of resistance to genetically modified cotton," she said.

"Through the introduction of a new screening technique - F_1 tests - we found that for *H. armigera* the assumed frequency of Cry2Ab resistance alleles in populations may be substantially (up to six times) higher than previously thought."

Dr Downes found that in 2007/08 there was a significant increase in the frequency of Cry2Ab resistance alleles obtained using F_1 screens compared to previous seasons for *H. armigera*.

Since the introduction of Bollgard II the frequency of Cry2Ab resistance alleles obtained using F_2 screens has also increased in *H. punctigera*.

"Despite these findings, Bollgard II should continue to provide excellent protection against Helicoverpa provided that the industry manages its stewardship responsibilities," Dr Downes said.

"We recommend that the industry improve its compliance with the RMP particularly in terms of producing high quality refuges.

"Also, because late in the season Helicoverpa may be exposed to cotton that only expresses Cry2Ab, it is important to implement an effective pupae busting procedure to kill that last generation which may be enriched with Cry2Ab resistance genes."

Dr Downes' research found that there have been no reported field failures of Bollgard II and the occasional occurrence of threshold levels of Helicoverpa in some Bollgard II fields is not due to Bt resistance.

"Although survivors on Bollgard II are not currently resistant, it would be useful to control them so that they are not exposed to low doses of toxin which can select for resistance in the future," she said.

"Despite having a history not developing resistance to conventional insecticides, the industry needs to regard *H. punctigera* as a potential risk of developing resistance to Bt."

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The Bt resistance monitoring program is an ongoing project. Contact Sharon via email if you would like to be added to her distribution list for end of month reports throughout the season. A full report on the results from the 2008/09 seson will appear in coming issues of Spotlight.

The tents used in Dr Downes' field experiments were "open" - with holes to enable natural enemy exchange - or "closed" - with no holes to exclude natural enemies.

Novel methods to determine natural enemies

To prolong the utility of Bollgard II against *H. armigera*, growers must follow a resistance management plan (RMP).

This strategy is largely based on information from studies of the ecology and population genetics of *H. armigera*, and the outputs of computer simulation models that use biological information to predict the likelihood of resistance under different scenarios. These models assume that any individuals which are resistant to Bollgard II survive to successfully reproduce in cotton landscapes.

Dr Sharon Downes, through her project *Mortality of Helicoverpa in Bollgard II cotton fields and implications for Bt resistance management*, developed novel methods to determine in the field how natural enemies in Bollgard II versus unsprayed refuge crops affect the probability that *Helicoverpa armigera* will survive from hatching until adulthood.

Part of this objective was testing how the application of pesticide in Bollgard II fields to control sucking pests affects natural enemy communities and, in turn, survival of *H. armigera*.

A secondary objective was to co-ordinate the collection of surviving Helicoverpa larvae from Bollgard II crops and rear them for inclusion in the Bt resistance monitoring program.

Dr Downes' research found that survival of Helicoverpa larvae differed significantly across the main crops employed in the current Bollgard II landscape but the particulars of this trend differed among small and medium larvae. Survival of small larvae was greater in pigeon pea and Bollgard II cotton that was sprayed for sucking pests and mites compared with conventional cotton and unsprayed Bollgard II cotton.

However, this trend held during mid and late season but early in the season there was no difference in survival across the crops.

Survival of medium larvae was greater in pigeon pea compared with conventional cotton and unsprayed Bollgard II cotton and this trend was consistent throughout the period during which these crops were attractive.

"The similar survival in unsprayed Bollgard II and conventional cotton is intuitive based on past work showing similar communities of natural enemies in these crops," Dr Downes said.

"The higher survival in pigeon pea (for both size classes) and Bollgard II cotton that is sprayed (for small larvae) suggests that these crops may have fewer natural enemies compared with unsprayed Bollgard II and conventional cotton.

"The survival results also suggest that spraying Bollgard II fields for mirids and mites may reduce the abundance of natural enemies (relative to unsprayed Bollgard II fields), and that this process affects mortality of smaller larvae."

It was found that it is possible, for example, that sprays reduce numbers of predators that specialise on small larvae. These suggestions are supported by data on arthropod communities across replicate fields. Dr Downes says in particular, spiders appear to play a significant role in mortality.

For small and medium larvae there was a strong negative relationship between survival and abundance of spiders in open tents but not with any other category of predators (arthropods less than 5mm, arthropods 5mm or more, ants, ladybeetles) or parasitoids. Moreover, across replicate fields the abundance of spiders mirrored the mortality of larvae in open tents in the same crops.

For small larvae there was a strong positive relationship between survival and the abundance of small non-predatory arthropods. In addition, across replicate fields the abundance of these arthropods opposed the mortality of larvae in open tents in the same crops. These results suggest that alternative small prey may improve survivorship of small larvae.

The project also looked at the issue of surviving larvae in the occasional Bollgard II field.

"During the past three seasons, surviving larvae were found in Bollgard II fields on some properties in all main cotton valleys," Dr Downes said.

"We determined, through collaboration with the previous project, (*Monitoring for resistance to transgenic cotton 2005-2008*, see previous page) that Bt resistance, or the absence of Bt proteins in the host or surrounding plants, is not the mechanism allowing these larvae to survive on Bollgard II.

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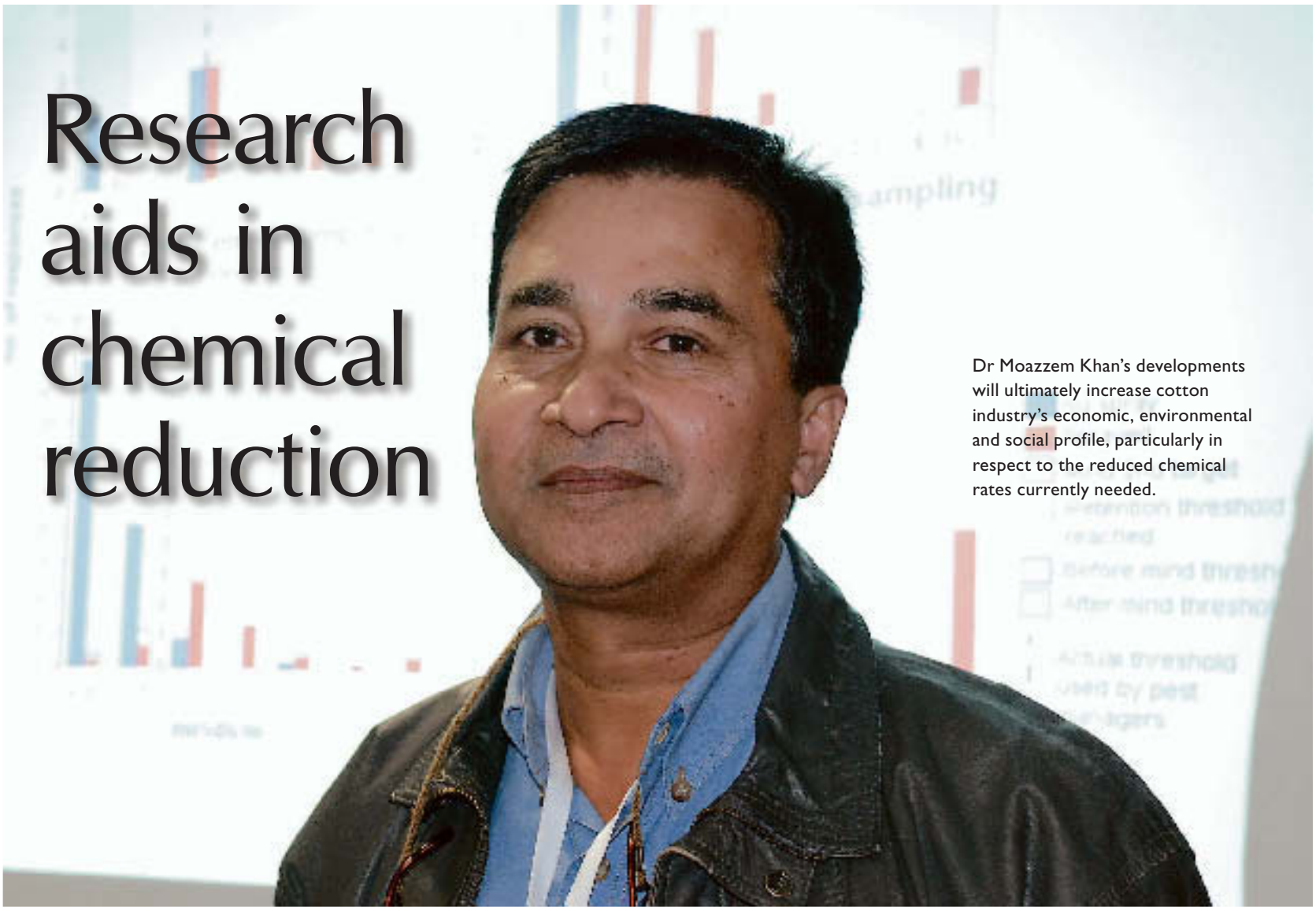
Research aids in chemical reduction



Dr Moazzem Khan's developments will ultimately increase cotton industry's economic, environmental and social profile, particularly in respect to the reduced chemical rates currently needed.

The Australian cotton industry is now better informed about mirid management, which could lead to more timely and appropriate chemical selection, thanks in part to recent research from Moazzem Khan's CRDC-funded project Improved understanding of the damage, ecology and management of mirids and stinkbugs in Bollgard II.

Dr Khan's research spanned from 2004 to 2008 with the main objectives to understand mirid damage and ecology in Bollgard II, to develop action thresholds and to investigate selective management options for mirids and stinkbugs.

The project also aimed to provide the cotton industry with improved management guidelines for mirids and stinkbugs that are compatible with the adoption of IPM approaches and Bollgard II.

The researcher found that both green (*Creontiades dilutus*) and brown (*Creontiades pacificaus*) mirids are causing damage to Bollgard II cotton.

He says crop-stage wise action thresholds will facilitate judicious and timely application of chemicals.

Furthermore, his research also found that use of salt mixture as a mirid management option will reduce chemical rates and the impact of chemicals on beneficials.

These developments will ultimately increase cotton industry's economic, environmental and social profile, particularly in respect to the reduced chemical rates currently needed.

"Such decisions will reduce the likelihood of flaring other pests such as whitefly, aphids and mites," Dr Khan said.

"The reduced use of broad-spectrum chemical will reduce the environmental foot print of growing cotton."

Dr Khan found that green mirids cause significantly more square loss than brown mirid, whereas brown mirids cause significantly more boll damage than green mirids.

While green mirids move to cotton at seedling stage, brown mirids move in around early boll formation stage. In Bollgard II, abundance of brown mirids is greater in mixed cropping areas with soybean and mungbean than in cotton monoculture areas.

In monoculture Bollgard II farming systems, >95 percent of the mirid population is green mirid. This contrasts with mixed cropping areas where the green mirid population is around 80 percent of the total population.

All stages of mirids cause damage to bolls.

Fourth and fifth instar nymphs and adult males and females cause significantly more damage than other stages. Third instar nymphs cause 33 percent and first and second instar cause 25 percent of the damage caused by fourth instar nymphs.

Bolls up to 20 days old incur significantly more damage compared to bolls aged 25 days and over. Older bolls incur negligible damage.

Yield loss due to mirid feeding varies with crop stage.

Damage at squaring stage (from seedling to 60 percent plants at first flower) fully recover later in the season provided plants do not suffer from any other stress such as water stress.

However, at this stage if mirid feeding causes greater than 30 percent fruit loss, plants fail to recover fully.

Early boll stage (from 60 percent plants at first flower to 60 percent bolls reached 20 days old) is the critical stage for mirid damage. At this time, the mirid population has usually reached its peak and can cause maximum damage (fruit loss) which will contribute to significant yield loss.

At late boll stage (from 60 percent bolls reached 20 days until cut out) the mirid population usually declines and bolls do not incur any significant damage.

Proposed action thresholds for mirid management in irrigated Bollgard II are:

- 65 percent fruit retention and/or;
- four mirids per metre at squaring; and
- three per metre at early boll stage.

At late boll stage mirids cause negligible damage and therefore do not warrant control.

Since dryland cotton performance is dependent on moisture availability, which can be very unreliable, the action threshold proposed for both squaring and early boll stage is three per metre and/or 65 percent fruit retention. Assessment for action threshold is based on beat sheet sampling.

For the control of mirids, Dr Khan found that salt mixtures increase mortality by 20 to 40 percent compared to reduced rates of chemical alone. Five to 10g of salt per litre of water produces maximum effect. Salt mixed with reduced rates of fipronil (Regent), dimethoate (Rogor) and indoxacarb (Steward) are quite effective against mirids.

Low rate of indoxacarb and fipronil plus salt are also quite effective against pale cotton stainer as are deltamethrin (Decis) full and half rate.

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Dr Grant Herron, a Senior Research Scientist with NSW DPI's Entomology, Insecticide Resistance Group at Elizabeth Macarthur Agricultural Institute, has developed methods to breed mirids under laboratory conditions and test them for susceptability to insecticides.

Insecticide resistance monitored

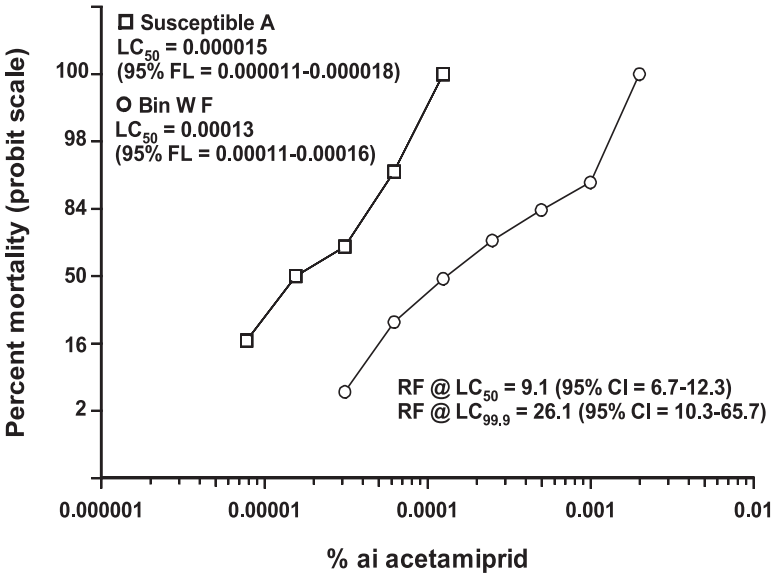

Figure 1. Cotton aphid dose response for Susceptible A (baseline) and field strain Bin WF against acetamiprid (Intruder).

With the introduction of transgenic cotton, sucking insect pests have become more troublesome, so requiring increased targeted insecticide control and resistance development.

Pre-emptive baseline data has proved critical for the successful management of cotton aphid because resistance could quickly be confirmed. However, no baseline data for mirids currently exists, preventing an early confirmation of resistance and subsequent resistance management.

For this reason, Dr Grant Herron, a Senior Research Scientist with NSW DPI's Entomology, Insecticide Resistance Group at Elizabeth Macarthur Agricultural Institute, developed methods to breed mirids under laboratory conditions and test them with insecticides.

This work has just reached the stage where lab strains are strong enough for testing to commence.

As part of on-going screening for insecticide resistance, cotton aphid and two-spotted mite are annually collected from Australian cotton growing regions and tested in the laboratory for insecticide resistance.

Two-spotted mite were tested against Propargite (Comite), chlorfenapyr (Intrepid), abamectin (Agrimec) and bifenthrin (Talstar) and resistance was detected, but high frequency resistance was restricted to bifenthrin (Talstar) only.

"Molecular testing is now used to detect Pirimicarb (Pirimor) and organophosphate (Lorsban) resistance in field collected cotton aphid strains . This technology significantly reduces the time required from sample collection to resistance diagnosis," Dr Herron said.

"Although aphids have become scarcer in recent years pirimicarb (Pirimor) resistance was still detected and field control failures recorded.

"Prima facie acetamiprid (Intruder) and thiamethoxam (Cruiser) (both neonicotinoids) resistance has been detected in cotton aphid for the first time."

Acetamiprid (Intruder) resistance was confirmed using full log dose probit analysis in one strain to be 9.1 fold (figure 1). Full log dose analysis with thiamethoxam (Cruiser) is yet to be done to confirm resistance and provide a resistance level.

"Clearly there is a need to reduce overall neonicotinoid selection to prevent or slow any increase in neonicotinoid resistance," Dr Herron said.

"An effective method to contain resistance would be to move away from the more persistent neonicotinoid seed dressings to either organophosphate or carbamate dressings, however the down side of this being growers are then locked into rather toxic chemicals such as aldicarb and phorate-based products and limit neonicotinoid use to foliar sprays."

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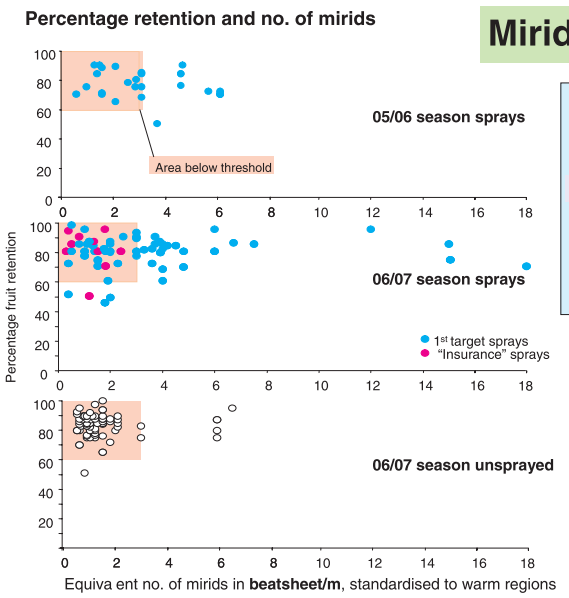
Mirid spray survey

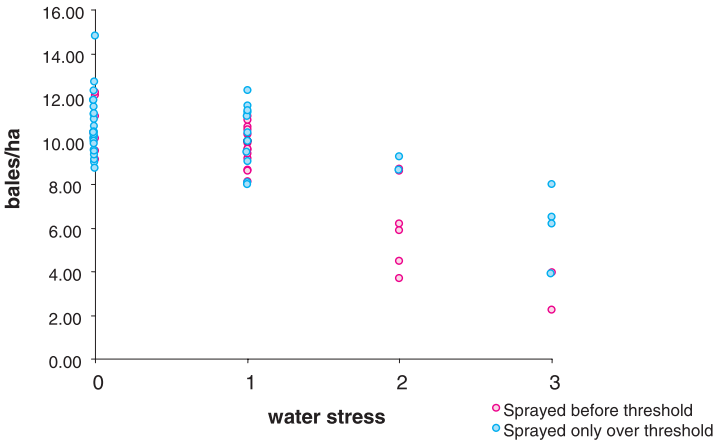


General thresholds	Warm area	Cool area	
Beatsheet :	3	1.5	mirids/m
Visual :	1	0.5	mirids/m

60% retention at all stages

The relationship between spraying for mirids, and both the retention and mirid number thresholds. All mirid numbers were standardized to the equivalent number of mirids in a beatsheet sample in the warm region. Only spray events targeting mirids first are included, and samples in which retention was measured as fruiting factor are not included. "Insurance sprays" occurred because of management constraints (see text). Many spray events occurred within the shaded area which demarcates mirid populations below threshold and therefore not needing control

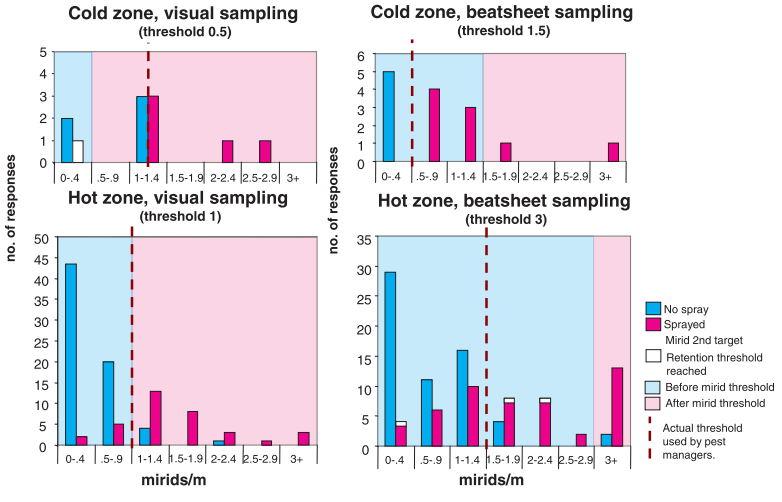
Yield vs mirid spray threshold



Water stress had a strong effect on yield (P<0.001).
- There was no significant difference between spraying over or before threshold (P=0.084)

The relationship between yield, water stress, and spraying mirids before or over threshold. Spraying mirids only over threshold had no effect on yield, if anything there was a trend towards a yield advantage.

Mirid spray survey: mirid number thresholds



Showing the relationship between the recommended thresholds (the line between the grey and stippled shading) for both the different regions and sampling methods; and the thresholds used by the pest managers (dashed line). Pest managers using beatsheets did not raise their threshold to the beatsheet level. Three cases where people used sweep nets not included.

Mirids have become more of a pest in cotton recently and the aim of a project undertaken by Mary Whitehouse was to identify factors which could influence mirid damage to cotton.

Managing mirids made easier

With the advent of Bt cotton, mirids have become more of a pest in cotton and are attracting a number of insecticide applications.

This has the potential to disrupt Integrated Pest Management in cotton and increase the risk of mite, aphid or whitefly outbreaks.

The aim of a project undertaken by Mary Whitehouse of CSIRO Entomology between 2005 and 2008 was to identify factors which could influence mirid damage to cotton. In particular, the project looked at current mirid management methods, tested the effectiveness of potential predators and identified other interspecific interactions which could reduce mirid damage to cotton.

Dr Whitehouse found that pest managers who only sprayed for mirids once the numbers had exceeded the recommended threshold suffered no yield loss, and if anything it was beneficial to the profitability of the field.

"Nevertheless, we did find that pest managers were less likely to use the beatsheet threshold than the visual survey threshold, indicating that more extension work is needed in this area," she said.

The project was able to identify a number of predators that could reduce mirid numbers and affect mirid feeding behaviour.

In particular the plain brown lynx spider, which is very common in cotton, was a very efficient predator of mirids. More work is needed to confirm their effectiveness under field conditions.

Dr Whitehouse also found through the research that mirids may not attack cotton if alternative foods, such as Helicoverpa eggs, are available. Thus a Helicoverpa egg lay in a Bt crop could be advantageous if the field has a heavy mirid infestation because it could reduce the likelihood of the mirids present attacking the cotton.

This finding needs to be confirmed under field conditions, but highlights the importance of including fruit retention as well as mirid numbers in the action threshold for mirids.

The reproductive status of the mirid had little effect on mirid damage, but damage caused by mites and aphids overrode any damage caused by mirids. This indicates that if pest managers have to choose between mirid and mite control, they should be more concerned about controlling mites.

Overall, the results of Dr Whitehouse's project indicate that insecticide applications to control mirids can be kept to a minimum; 54 percent of the sprays in the mirid survey were applied to mirid numbers below threshold.

"If these sprays were irradicated, there would be a huge saving in insecticides, no cost in yield, and a large advantage in terms of the development of IPM in cotton," she said.

"The results of this project indicate that this should be the goal of mirid management in cotton."

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The entomological outcomes of Dr Sequeira's Central Queensland research represent strategic and tactical tools that are highly relevant to the viability and profitability of the cotton industry in Australia.

Unlocking success for Central Queensland

Dr Richard Sequeira has identified major agronomic and crop protection issues of cotton production in Central Queensland

From an agronomic perspective, the Central Queensland environment was always thought to support economically viable cotton production in a wide sowing window from the middle of September to early January.

However research recently presented by Dr Richard Sequeira has identified major agronomic and crop protection issues that are closely linked to the profitability and sustainability of cotton production enterprises in Central Queensland, which include optimal sowing times, novel technologies and strategies for managing insecticide resistance and managing silver leaf whitefly.

Dr Sequeira, the Principal Research Scientist - Plant Sciences Delivery with Qld DPI&F, said the ideal positioning of Bollgard II varieties in the CQ planting window is critical to the future of the local cotton industry because growers needed baseline information to determine how best to take advantage of the higher yield potential offered by the Bt cotton technology, optimise irrigation water use and fibre characteristics.

His project includes a number of key agronomic findings.

Over three growing seasons, Bollgard II crops planted in the traditional sowing window from the middle of September to the end of October consistently produced the highest yields. The project delivered a clear and quantitative assessment of the impacts of planting outside the traditional cropping window - a yield penalty of between one and four bales/ha for November and December planted cotton.

"Whilst yield penalties associated with December-planted crops are clearly linked to declining heat units in the second half of the crop and a cool finish, those associated with November-planted cotton are not consistent with the theoretical yield potential for this sowing date," Dr Sequeira says.

"Further research to understand and minimize the physiological constraints on November-planted cotton would give CQ cotton growers far greater flexibility to develop mixed/double/rotation cropping farming systems that are relevant to the rapidly evolving nature of agricultural production in Australia."

Dr Sequeira found that the equivalence of cultivar types with clearly distinguishable genetically based growth habits, now gives growers important information for making varietal choices.

The entomological outcomes of the Central Queensland research represent strategic and tactical tools that are highly relevant to the viability and profitability of the cotton industry in Australia.

"The future of the cotton industry is inextricably linked to the survival and efficacy of GM cotton," Dr Sequeira said.

"Research done in the Dawson irrigation area demonstrates the unquestionable potential for development of alternative and highly effective resistance management strategies for Bollgard II using novel technologies and strategies based on products such as Magnet.

"Magnet and similar technologies will be increasingly important in strategies to preserve the shelf life and efficacy of current and future generations of GM technology."

However, he says, more research will be required to address logistical and operational issues related to these new technologies before they can be fully exploited in commercial production systems.

From an economic perspective, Dr Sequeira believes silver leaf whitefly is the sleeping giant in terms of insect nemeses of cotton, particularly from the standpoint of climate change and an increasingly warmer production environment.

Good news for the industry is that an effective sampling and management strategy for silver leaf whitefly delivered by this project will go a long way towards minimising production costs in an environment characterised by rapidly rising input costs.

"Silver leaf whitefly has the potential to permanently debilitate the national cotton industry by influencing market sentiment and quality perceptions," Dr Sequeira said.

"Field validation of the silver leaf whitefly population sampling models and management options in the Dawson irrigation area and southern Queensland during 2006-07 documents the robustness of the entomological research outcomes achieved through this project."

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Rotation offers natural solutions

Dr Nilantha Hulugalle and his team of Tim Weaver and Lloyd Finlay.

The effects of rotation crops and stubble management on soil quality, carbon sequestration, deep drainage, nutrient leaching, yield and profitability of succeeding cotton in irrigated and dryland vertosols is now clearer thanks to a three year study.

From 2005 to 2008, seven irrigated experiments (Ashley, Narrabri and ACRI, Goondiwindi), and one dryland experiment in Queensland (Brigalow in the Darling Downs) were conducted by Dr Nilantha Hulugalle.

Key management issues considered were tillage systems, rotation crops and stubble management, and in particular, sowing cotton into standing wheat and vetch stubble.

There were three key objectives which related to cropping systems in vertosol-based cotton farming systems:

- Determine the effects of sowing cotton into standing wheat and vetch stubble on soil and water quality and conservation. Find solutions to management problems associated with in situ mulch in furrow-irrigated vertosols.
- Compare cotton-wheat and cotton-vetch rotations in terms of soil quality, water conservation and long-term cotton production.
- Determine efficacy of organic and inorganic amendments in stubble-mulched irrigated and dryland vertosols.

Dr Hulugalle found that sowing cotton into standing wheat stubble facilitated drainage and leaching of salts, as well as water conservation through rainfall harvesting. He found in this scenario, leaching of nutrients such as nitrates was also higher.

However carbon sequestration did not differ significantly from control treatments due to drought during 2006 and 2007, where winter rotation crop growth was poor.

"Economically, it was found that under restricted water availability and on a whole-farm basis, minimum-tilled cotton-wheat was more profitable than continuous cotton, whereas with unlimited water or on an individual field basis the reverse is true," he said.

The research also showed that growers would be better off reducing the area of cotton sown and giving it sufficient water rather than reducing irrigation frequency over a larger area.

"Within soil layers in the cotton root zone, drainage with frequent irrigation was greater than that with infrequent irrigation, however drainage out of the crop root zone was similar under both irrigation frequencies and may be related to differing drainage pathways."

In another experiment, vetch in a cotton-wheat-vetch rotation responded positively in terms of growth and nitrogen (N) fixation to phosphate fertiliser, which was found not to be the case in a cotton-vetch sequence.

"Nitrogen fixation by vetch in the former rotation was also higher due to a longer growth period (sown late-February versus later May) and wetter soil profile at sowing (sown into fallow versus sowing immediately after cotton)," the research found.

Wheat grain yield and quality was also improved by including vetch in the cotton-wheat-vetch rotation relative to cotton-wheat rotations.

Dr Hulugalle found cotton yield was higher when a wheat crop was included in the rotation. However, in comparison with cotton-wheat where stubble was incorporated, the cotton-wheat (standing stubble)-vetch sequence required less N fertiliser (due to N fixation by the vetch) and irrigation water - due to better subsoil water storage and presumably, reduction of evaporation by the in situ mulch.

Under restricted water availability and on a whole-farm basis, profitability was in the order of cotton-wheat-vetch > cotton-wheat > cotton-winter fallow-cotton > cotton-vetch-cotton.

The "Mulch Manager", a machinery attachment which is able to kill vetch while minimising herbicide application rates and trafficking was developed to aid the inclusion of vetch into the rotation, as vetch can be notoriously hard to eliminate.

Dr Hulugalle also quantified the amount of carbon (C) added to soil C stocks by the roots of Bollgard II-Roundup Ready Flex varieties, which proved to be less than that added by non-Bollgard II varieties.

"Above-ground stress such as insect pressure also reduced cotton root growth and C addition to soil, whereas minimum tillage and wheat rotation crops increased them," he said.

"In comparison with above-ground dry matter, however, contribution by cotton root material to soil C stocks is small."

However sowing corn in rotation with cotton increased concentrations of the light carbon fraction but not total soil carbon, which is still positive news, as a close relationship was found between the light carbon fraction and microbial activity.

Dr Hulugalle therefore feels that microbial activity and hence, nutrient cycling, may be improved by including corn as rotation crop.

By including vetch in the cotton-corn rotation, soil organic carbon (SOC) was increased as was exchangeable potassium, while decreasing exchangeable sodium (Na) concentrations.

Continuous cotton systems sown on permanent beds had lower pH and higher soil organic carbon in furrow soil than that under conventional tillage.

Differences were small between conventionally-tilled and minimum-tilled furrows, and between wheel-tracked and non-wheel-tracked furrows. Large inter and small intra-seasonal changes also occurred with respect to soil physical and chemical properties in furrows. Interactions between surface soil factors in furrows may not, therefore, play a major role in influencing water application efficiency and infiltration within a season. Inter-seasonal differences could, however, affect hydrological processes.

Dr Hulugalle also found that in a K-deficient dryland vertosol with high subsoil salinity and sodicity, only application of cattle manure (16 t FW/ha) resulted in a sustained improvement in soil quality, whereas gypsum and inorganic fertilisers had no effect.

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Key outcomes

- identifying cotton-wheat-vetch with in-situ stubble mulching as one which can reduce cotton's N fertiliser and irrigation water requirements while maintaining yields
- identifying the practice of irrigating with treated sewage effluent as potentially risky to soil health
- determining that increasing complexity of cropping systems (i.e. sowing rotation crops) under conditions of restricted water availability can improve whole farm profitability
- identifying carbon sequestering management practices such as minimum tillage, vetch rotation crops and manure application
- identifying corn as a rotation crop which could facilitate nutrient cycling
- identifying manure as a soil amendment which could alleviate K deficiency.

In 2008, a survey of growers and growers' consultants demonstrated how R&D is the driver of industry productivity.

For every $1 invested by CRDC in cotton R&D, investors benefitted by $11.

R&D in Action

CRDC is to publish a comprehensive report on the impacts of R&D on the cotton industry between the five years of 2003-2008. The report titled 'R&D in Action' is to be an online publication and due to be available on the CRDC website around the end of March 2009. Go to the 'E-Library' tag on www.crdc.com.au Accompanying that report, the BDA report, "Triple Bottom Line Evaluation of CRDC Investment over the 2003-2008 Planning Period" will also be available in the E-Library section of the CRDC website.

R&D the key driver for industry's productivity push

In an independent study of industry's R&D investments managed by CRDC in the five years to 2008, as many as one in four projects demonstrated a major economic, social or environmental impact. The study was commissioned by CRDC in 2008 and undertaken by BDA Group, and the report found the cotton industry's 1:4 ratio for major impact in R&D investments was well in advance of other rural industry R&D performance.

The BDA study also found that for every $1 invested in cotton R&D by CRDC, investors benefitted by $11. This is the value of the benefits that have been taken up by the cotton industry, or public stakeholders in rural R&D such as taxpayers who match industry's levy contribution to R&D through the Australian Government.

The comprehensive study sought to deliver an evaluation of the impacts achieved under the CRDC Strategic R&D Plan 2003-2008.

Over the five years considered in the BDA study, CRDC invested around $60m and this new review highlights the importance of investing in R&D to drive productivity growth together with the capacity to adapt and respond to challenges and ongoing improvements to environmental performance.

The consultants conducting the study sampled the major projects completed in the five years to 2008. Their analysis showed $500m returned to stakeholders from just the major projects studied. They estimated that CRDC had delivered a minimum return of $813m from all projects over the period.

Major impacts from CRDC's investment included the developments in BMP, water use efficiency, fusarium wilt management, Bt resistance stewardship, EMS pathways and cotton breeding. A further 13 important project impacts were also identified.

A key to success across these vital areas was the collaborative approach taken by CRDC in managing R&D investments. Over the five years to 2008, CRDC invested around one in every five dollars invested in cotton industry R&D.

The consultants found around 50% of the total industry R&D was undertaken by public R&D organisations and through its many collaborative R&D partnerships, CRDC was involved in around 60 percent of all cotton R&D undertaken in Australia. Cross-industry collaboration between cotton and other rural industry R&D activity also grew substantially during the period.

Results from this study highlighted the ongoing impact of R&D as a key driver in productivity growth and improved environmental performance. A key aspect of improved performance measured at the farm level was the capacity of producers to adapt to climate change, economic and environmental challenges.

As a direct measure of productivity increases in the Australian cotton industry, in the five seasons from 2003-2008, cotton lint yields improved by over 300kg/ha compared with the average for the five seasons 1998-2003. The five years 2003-2008 saw seasons with highly variable water availability and drought but produced the five highest seasonal average yields recorded by the industry. The environmental benefits delivered over the same time also saw continual and rapid decline in pesticide residues.

Looking at the improvements made on farm in the five years to 2008, ongoing assessment of the progress made by CSIRO's breeding program shows that approximately half of the increases in yield and productivity resulted from the R&D investments in plant breeding and the use of improved varieties coming from that field of R&D investment.

The remaining half was achieved by producers' management and application of improved technology available as a result of R&D investments.

These technologies span the areas of water use efficiency, improved agronomy and nutrition, disease and pest management and the rotations of cotton with other crops. This led the study to conclude that investment in R&D provided the main impetus to the continued improved productivity of the cotton industry.

Beyond the farm gate, continuous improvement in cotton fibre quality continued to substantiate a niche for Australian cotton with improvements to low contamination status together with improved fibre performance metrics of length, strength and maturity.

Further, in 2008, a survey of growers and growers' consultants demonstrated how R&D is the driver of industry productivity.

Underpinning on-farm productivity has been the increasing capacity of people in cotton. From 2003-2008, 80 percent of producers had attended spray application courses, 60 percent attended OH&S training, 58 percent attended IPM courses, and over 50 percent attended water management and soil health courses.