Cotton Research & Development Corporation

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Spotlight

Summer 2007

on Cotton R&D

- ***Nature's workforce***
  Making it work
- ***Water use efficiency***
  What is it, and how to measure
- ***Conference 2008***
  Claim the date
- ***Bio-warfare on sucking pests***
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Australian Government

Cotton Research and Development Corporation

Summer: December 2007

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

Cotton Research and Development Corporation

ABN: 71 054 238 316

2 Lloyd Street, Narrabri NSW 2390

Our vision: A globally competitive and responsible cotton industry

Our mission: Invest and provide leadership in research, innovation, knowledge creation and transfer.

Our outcome: A more sustainable, profitable and competitive cotton industry providing increased environmental, economic and social benefits to regional communities and the nation.

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, the Hon. Peter McGauran MP and the Parliamentary Secretary to the Minister the Hon. Sussan Ley 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

Just as it is important to have groundbreaking research, the cotton industry also needs people with the capacity to adapt and adopt it.

Given the challenges and complexity of an ever-changing economic and environmental landscape, there has never been a greater need to foster people's ability to manage change and uncertainty, and for the industry to take stock of itself and ensure it has the capacity to foresee and overcome ever-present challenges.

People in cotton generally highly value their collective strength and capacity to adapt information and their skills to advance their industry. But the current operating environment has made it even more crucial to build this capacity further to manage the challenges ahead. Further reference to capacity building initiatives and how CRDC is planning for future investments is on page 32.

At this time of limited water availability and continued low cotton prices, there understandably is an even greater focus on how limited resources are used for research and I appreciate that this is a difficult time for researchers, growers and all members of the industry. Given prudent management in the past the CRDC is now able to use over $4 million from financial reserves this year at the same time as working closely with our research providers and seeking other sources of support where possible.

In this edition of *Spotlight*, we focus on the challenge of our capacity to keep improving water use efficiency. The test for today is to consider what is available to growers in terms of useful knowledge and tools.

The capacity of researchers to develop water measuring tools and an ever growing knowledge base of irrigation techniques and water saving measures is reassuring.

Also highlighted is the new capacity of the industry through researchers to investigate biodiversity on our farms and quantify how it can add value to production and contribute to the overall sustainability of the industry. It should give the industry and growers a sense of confidence to know that future challenges in relation to natural resource management are being identified and research is underway to make sure we are ready to handle them when they arise.

CRDC research investment is finding new beneficial predators and how these organisms rely heavily on native vegetation on and around cotton farms to survive. As further research comes to hand, the synergistic relationship with 'nature's workforce' is becoming more evident.

I would also like to welcome David Coleman to the organisation.

David, his wife Jane and two young boys will be moving to Narrabri in the New Year, where he will take on the role of General Manager – Business and Finance.

Having worked in IT, outsourcing, the agrichemical industry, superannuation, industrial and rural property sectors, David brings a wealth of experience for CRDC to draw on.

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

Cover Photo: Photo Melanie Jenson. Taking stock of the role natural vegetation and features play on farms is important to the future sustainability of the industry – see what the research is saying.

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

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Re-engineer the business of your cotton business

20 cotton businesses invited

Course convenor, former Australian Rural Leadership Program participant, Mark Morton.

A capacity building project is planned to begin in the New Year in a bid to help improve profitability for growers in the cotton industry at a time when many farmers are treading water and struggling to sustain business performance.

The first pilot group is planned to commence in March and will be open to 20 cotton businesses. It will take a radical look at effecting change in the industry and examine how farmers can create a new business structure and turn the current conditions to their advantage.

The project is being managed by PrincipleFocus, an agricultural consulting and training company with a track record in delivering change to Australian agriculture. The courses are being run by trainer Mark Morton, an associate of PrincipleFocus with 20 years' experience in the cotton industry and Sean Martyn, Managing Director of the company. Mark was a participant in the CRDC- funded ARLP (leader training).

"The training comprises an initial five day workshop in Armidale, followed by a series of meetings three times per year as growers develop their skills and practice their implementation. Their results will be benchmarked to measure their progress" Mark Morton explained.

"The idea is to place farmers in an environment where they can focus and develop their strategic objectives." The fee-based program attracts Farmbiz support.

"The cotton industry is having a triple hit at present. There is no water, the market is reasonably soft, and growers are experiencing an ever escalating cost of production," Mr Morton said. "The industry is going through another phase of existence, so growers themselves need to look at how they operate in this new environment.

"The industry's top 20 percent has recorded an annual increase in gross revenue per ha of 2.90percent over the last 15 years.

"But the average annual inflation rate with respect to the cost of production for the same period has been 3.97 percent p.a. and the profit margin has continued to decline for a 10 year period. There are some growers who have responded, many have not - they don't have the turnover in an uncertain environment and that has rather obvious implications for not only growers but supporting businesses and regional communities."

Mark Morton feels that, rather than focusing on the technical issues, farmers need to make decisions to cope with a changed environment.

"So with this course we are trying to give growers skills, training and processes through a holistic approach to business design. Farmers need to consider what is the cotton industry's sustainable competitive advantage and make use of that advantage. We are there to help people build their own vision and goals.

"But it's important for people to realise that it's not just a matter of turning up on a course and then everything will be all right. Growers also need to look at what is best practice and to think differently from the way they did five years ago. They need to address the issue of new skills, new thoughts and design new skills for a new industry.

As part of the project growers will also be given access to financial, accounting and production software, developed by Practical Systems Ltd, and Armidale agricultural software developer

? To enrol on a course, or for more information, contact Mark Morton on 0267726672 or mobile 042752842; email:mark@psystems.com.au

Science award

Two young cotton scientists have been honoured with one of the most prestigious science awards in the country, which will deliver long-term benefits to our farmers and rural communities, according to former Federal Minister for Agriculture Peter McGauran.

In September, Mr McGauran announced Angus Crossan and Warren Conaty were winners in the 2007 DAFF Science and Innovation Award for young people in agriculture, fisheries and forestry.

Dr Crossan, a PhD researcher at University of Sydney was awarded for his work to develop a catchment-based risk assessment framework incorporating land use and climatic data to help design a better method for sustainable pesticide use. His award was sponsored by CRDC.

Angus says existing pesticide regulation is based on a 'one-size-fits-all' approach.

"My aim is to explore the option of catchment-specific pesticide management to ensure sensitive ecosystems are protected, while still meeting the needs of rural industries," he said.

"Many catchments are unique and should be managed as such."

Also awarded was Warren Conaty, a PhD researcher at the University of Sydney, who believes a new method of irrigation timing for cotton crops involving leaf canopy temperatures may be more effective.

He said cotton growers currently rely on soil/water deficit measurements to determine their irrigation needs.

"But it is well established that stressed plants exhibit higher leaf temperatures due to reduced evaporative cooling," Warren said.

"By using infra-red thermometers, leaf temperatures in the canopy can be monitored to determine when a crop is water stressed," he says.

"Water savings can then be achieved by scheduling irrigation at the optimum temperature threshold."

Warren is investigating suitability for Australian conditions of BIOTIC (Biologically Identified Optimal Temperature Interactive Console), an irrigation scheduling tool developed in the United States.

MP Peter McGauran announced the winners at a gala dinner in Canberra.

"The awards were open to people aged 18 to 35 who presented ideas for projects that will deliver long-term benefits to our agriculture, fisheries, forestry, food and natural resource management industries," Mr McGauran said.

This year there were 18 awards on offer – 10 industry-based, as well as one from each State and Territory.

The awards are sponsored by the Government and rural Research and Development Corporations (RDCs) including Cotton RDC, Australian Pork Ltd, Fisheries RDC, Forest & Wood Products RDC, Grains RDC, Grape & Wine RDC, Land & Water Australia, Meat and Livestock Australia, the Rural Industries RDC and Sugar RDC.

Dr Angus Crossan receiving the award with Tasmanian Senator Eric Abetz.

Measuring heat stress: Nicola Cotee, PhD student

Heating up

Conditions in cotton growing regions have the tendency to be extremely hot and humid resulting in detrimental effects to both the cotton plant growth and yield.

Nicola Cottee, PhD student at The University of Sydney is looking to develop new ways to measure heat stress in cotton and ultimately enable more effective selection of varieties for better growth and higher cotton production in warmer cotton regions.

Techniques that measure leaf function through photosynthesis and cell damage were developed in glasshouse experiments and subsequently evaluated under field conditions at the Australian Cotton Research Institute, Narrabri and Texas Agricultural Experiment Station, USA. Preliminary results have shown that Sicot 53 and an experimental line; CSX 376 demonstrated good heat tolerance, while Sicala 45 and Sicala V2 were relatively less tolerant to heat stress.

These findings may provide the basis for the selection of agronomically superior cotton cultivars for breeding programs targeting growth and production in the warmer cotton growing regions of New South Wales and Queensland.

This is a collaborative research project involving the University of Sydney, CSIRO Plant Industry, Cotton Catchment Communities CRC and Texas A&M University.

? Contact: nicola.cottee@csiro.au or 6799 7480

Central Queensland aims higher

There is a widely held view among Central Queensland cotton growers that their industry has lagged behind southern, more temperate cotton growing regions in terms of locally relevant, basic crop agronomy and management research.

Richard Sequeira, Douglas Sands, Andrew Moore and Lance Perdergast of QDPI&F are currently running a research project aimed at laying the foundations for integrated systems-research in the region by bringing together crop agronomy, pest and disease management into a unified framework. The research will deepen and widen the knowledge base developed from previous CRDC funded projects for management of heliothis and silverleaf whitefly within the context of Bollgard II® production systems. The interactions between agronomic variables (e.g. sowing date, nutrition, and crop management), seedling and other plant diseases and insect problems that are poorly understood in the region will be documented and characterised with a view towards developing locally relevant best practice production guidelines for Central Queensland cotton growers.

The project will address the needs of the Central Queensland region in terms of research that will help cotton growers fully utilise new biotechnology, the opportunities provided by the environment and develop effective pest management strategies, thereby optimising inputs, maximising production and profitability of their industry.

? Contact Richard Sequeira (07) 4983-7410

Two annual reports?

CRDC introduces a new publication in December 2007: The *Report to Industry* magazine is produced as a summary document based on the 140-page *Annual Report* – a statutory document required to be published by all corporations, and in the case of CRDC and all other rural research and development corporations, tabled in Parliament.

The 2006-2007 CRDC *Annual Report* is a comprehensive overview and report of CRDC's performance and was tabled in early November in Federal Parliament.

The *Annual Report* is the approved public record of CRDC as a R&D Corporation responsible to the Australian people and the cotton industry.

To receive a copy of the *Annual Report* by mail, contact CRDC by phone 02 6792 4088 during business hours, or email (crdc@crdc.com.au).

Any *Annual Report* from 1999-2000 onwards is available as a downloadable document on the CRDC website: www.crdc.com.au

New website

Regular visitors to the CRDC website will have noticed an all-new look appeared mid-November. The address remains the same (www.crdc.com.au) and the new site has been developed to meet an ever increasing demand from producers and stakeholders for information from a trusted online source.

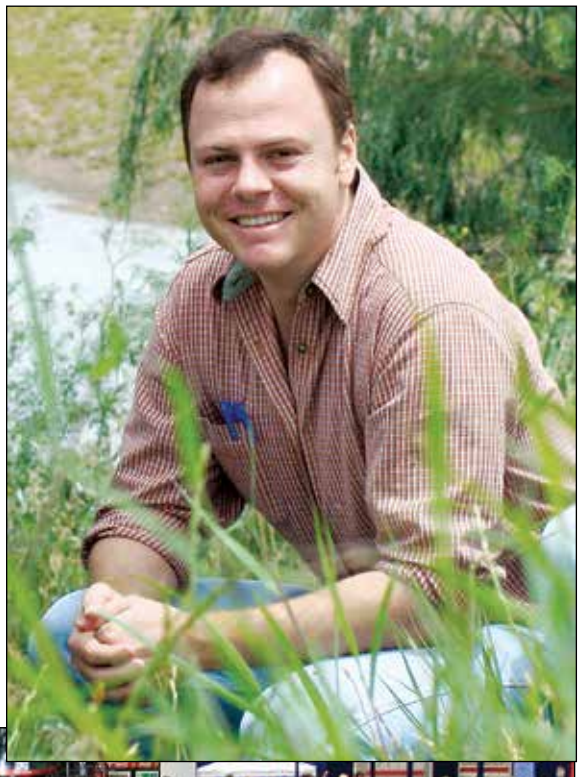
Initially, content generally reflected what had been available historically, however the new site is to become the platform for a comprehensive knowledge repository of published research reports, compiled documents and information sharing resources.

Improved search facilities will ensure all available information is found and shown to visitors. Progressively, CRDC shall extract information from published documents and research which has been available only in printed form.

? Go to www.crdc.com.au

Mark your calendar now for the 14th Australian Cotton Conference to be held on the Gold Coast from August 12 to 14.

Cotton Conference committed to needs



Ben Stephens, ACGRA Chair.

Attendees of the conference value the opportunity to network and bring themselves up to date on the latest research

Planning has begun in earnest to make sure the 14th Australian Cotton Conference remains one of the industry's best attended and received conferences. Organized by Australian Cotton Growers Research Association (ACGRA) it shall showcase the latest research and bringing the excellence of Australia's researchers, industry organisations and growers to the fore.

ACGRA chair Ben Stephens said keynote and support speakers will address numerous issues identified as vital to the industry's future over the course of the three-day conference.

"These topics have international, national, state, regional and local significance, and we have deliberately framed the agenda to stimulate debate and feedback, rather than provide a one-way flow from the experts to the conference participants," he said.

"The conference will comprise a mixture of general overview sessions followed by intensive hands-on discussion group involvement by participants to ensure that all subjects are comprehensively covered to the satisfaction of all attendees."

Foundation Sponsors CRDC and CSD have again committed to support the 2008 biennial conference which will be the 14th industry conference organised by ACGRA.

The first was held in Goondiwindi in 1982.

"ACGRA is committed to providing the industry a great opportunity to enhance our cotton knowledge and networks while taking a well earned break away from the daily grind at an exciting venue located close to a range of accommodation, the beach, restaurants, cinemas and entertainment," said executive officer Greg Kauter.

"The conference organising committee will pay particular attention to delivering a conference that will meet industry's needs and expectations from growing to garment.

"ACGRA's main aim is to provide all industry members with knowledge and solutions that will benefit your cotton business now and in the future.

ACGRA is also keenly aware of the financial challenges faced by many growers and service sector providers in the current situation.

"The Conference program will take account of the challenges and opportunities facing the industry when it finally does rain," Greg said.

"This was evident through the evaluation of the 2006 conference conducted by ACGRA, which showed networking opportunities, research information, industry's strategic direction, feedback from 'end users' and program activities as all highly valued."

The conference committee will be working hard to fulfill industry expectations to provide this again in 2008.

To be held at the Gold Coast Convention and Exhibition Centre, the conference will also include a trade display, welcome cocktails and the Conference & Awards' Dinner.

? www.acgra.net.au or contact ACGRA 02 6792 6440

Benchmarking Water Management in the Australian Cotton Industry

Graham Harris, DPI&F/Cotton Catchment Communities CRC

QLD DPI&Fs Graham Harris is a leader in the field of irrigation, and his research is helping growers measure and improve water use efficiency.

Within the cotton industry there are a number of irrigators who have been significantly improving their water use efficiency.

It is also becoming increasingly important for the irrigation sector to report on its level of irrigation management performance. A significant effort is needed by the industry to collect and report performance indicators to better inform policy makers and the general public of the best practice performance the industry is capable of.

It also will provide the industry with an opportunity to continuously improve its performance.

Benchmarking is a process of collecting data to enable comparisons of current performance against appropriate internal or external performance measures. It is important to use standard performance indicators when assessing your irrigation performance.

For the cotton industry these performance indicators are:

- Water Use Indices - the Gross Production Water Use Index (GPWUI), the Irrigation Water Use Index (IWUI)
- Irrigation System Efficiencies – the application efficiency (Ea), the Field Canal Efficiency (Eb) and the Farm Efficiency (Ef)
- Distribution Uniformity

The advantage of using standard performance indicators is that meaningful comparisons can then be made. The IWUI is a relatively easy index to calculate – it is useful for comparing between nearby fields or farms in the same season. However, as rainfall is not included it is not useful to compare over significant distances or between seasons. The GPWUI includes rainfall (either as a total or effective figure). This is a more useful index for comparing between seasons and across regions but does not reflect the contribution of irrigation to total water.

The accurate calculation of Irrigation System Efficiencies is a more complex task and requires investment in measurement equipment and expert advice.

WaterTrack™ is a commercially available software package which not only enables calculation of whole farm benchmark figures but also allows you to determine the performance of individual storages, channels and fields.

Calculating distribution uniformity for furrow-irrigated fields requires field measurement (using the IRRIMATE® technology) and computer modelling to simulate the irrigation event and its optimisation.

The Cotton Catchment Communities CRC has invested in a benchmarking project – "Benchmarking Water Management in the Australian Cotton Industry". This project has several components:

- Review of Australian and international data on cotton industry irrigation benchmarks
- Resurvey the original 25 farms surveyed for WUE by Sunnil Tennakoon and Steve Milroy, CSIRO in the 1990s
- Development of the Water benchmarking Tool for use by industry to calculate and benchmark their current water use efficiency
- On-going collection and analysis of IRRIMATE® data reported at a valley scale

Based on available data, the improvement in Water Use Efficiency since the 1990s survey by Tennakoon and Milroy has been impressive. Their study (for the years 1996-97, 1997-98 and 1998-99) found an industry average GPWUI of 0.74 bales/ML and an IWUI of 1.26 bales/ML.

There was considerable variation around these average figures – for GPWUI the standard deviation was 0.27 bales/ML and for the IWUI it was 0.66 bales/ML). Their study also showed significant variation in performance between valleys.

Table 1 shows the change in WUE for the industry as a whole from the 2000-01 to 2005-06 season. There was an improvement in the IWUI of 25% over this period.

Table 1: The progress in WUE by the Australian Cotton Industry

		2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Area Irrigated[1]	(ha)	430,411	373,800	234,000	185,000	270,000	276,000
Volume of Water Used[1]	(ML)	2,905,581	n/a	1,525,504	1,248,924	1,819,315	1,746,386
Production[2]	(bales)	3,210,400	2,993,180	1,766,090	1,554,718	2,598,392	2,410,037
Yield	(bales/ha)	7.46	8.01	7.55	8.40	9.62	8.73
Irrigation Application	(ML/ha)	6.75		6.52	6.75	6.74	6.33
IWUI	(bales/ML)	1.10		1.16	1.24	1.43	1.38

Source: 1 ABS and Australiana and 2 Australian Cotton Grower.

These figures above are broad averages and even greater improvements in WUE have been achieved by individual growers over this time.

This improvement has resulted from their investment in measuring surface irrigation performance and adopting changes in their practices, as well as investment in new irrigation technologies. Recent data on GPWUI and at a valley scale is hard to come by – an imperative if the industry is to document its on-going improvement in water use efficiency.

Table 2 summarises only current available data at a valley scale for GPWUI – this is drawn from irrigators who have participated in the annual Australian Comparative Analysis by Boyce Charted Accountants.

There is obviously some "noise" in the data but overall there is a tendency for WUE to have improved over the past six years across most valleys.

Table 2: GPWUI (bales/ML) for individual cotton valleys

Valleys	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Gwydir	0.75	0.98	1.07	1.42	1.33	1.08
Macquarie	0.87	0.80	0.97	1.18	0.45	1.11
Namoi	0.89	1.14	1.14	1.16	1.08	n/a
Emerald	1.09	0.79	0.54	1.30	n/a	n/a
Walgett/Bourke	n/a	0.53	0.72	n/a	1.02	n/a
Macintyre/Barwon	0.79	0.99	1.13	1.11	1.14	1.04

Source: Boyce Chartered Accountants

Water Use Efficiency
– What is it? and How do we measure it?

Graham Harris, DPI&F/Cotton Catchment Communities CRC

Water Use Efficiency (WUE) is a generic term that covers a range of performance indicators irrigators can use to monitor the performance of their irrigation practices. The performance indicators include:

- Water Use Indices – for example the Gross Production Water Use Index (GPWUI), Irrigation Water Use Index (IWUI) and the Operating Profit Water Use Index (OPWUI)
- Irrigation System Efficiencies – for example the Application Efficiency (Ea), the Field Canal Efficiency (Eb) and the Farm Efficiency (Ef)
- Distribution uniformity

When reviewing the WUE of your business you should consider all these performance indicators because a single performance indicator by itself can be misleading.

Water Use Indices are linked to production – they involve an output per unit of input as shown above in Table 1. The total water use should include estimates of soil water use and rainfall. Whenever quoting Water Use Indices ensure that you specify how they were derived – it is only meaningful to compare indices that have been calculated in the same way.

Irrigation System Efficiencies describe a ratio of water inputs to water outputs – they provide a measure of the proportion of water lost. The most useful Irrigation System Efficiency terms are summarised in Table 2.

Distribution Uniformity (DU) only applies at the field scale. It is a measure of how evenly water is applied at irrigation. Poor distribution uniformity results in portions of a field being under-watered, over-watered or both. It is reported as a percentage (%). For furrow irrigation the DU is calculated using the formula:

$$DU = \frac{\text{Average of smallest 25\% of infiltrated amounts}}{\text{Average of all infiltrated amounts}}$$

To determine the distribution uniformity of a surface irrigated field measurements of inflow and water advance are needed, together with computer modelling to simulate the irrigation event – this process is commercially available to the industry as the IRRIMATE® evaluation service.

The DU concept also applies to overhead sprinkler and drip irrigation systems but terms are used – the Christiansen's Coefficient of Uniformity and the Emission Uniformity respectively.

It is important that all irrigators make the most of their available water resource – particularly now with limited water supplies. These performance indicators enable irrigators to monitor the performance of their irrigation management and ensure they are achieving industry and world's best practice.

The Cotton Catchment Communities CRC Water Team is currently providing training in the use of these performance indicators as part of the Cotton and Grain Workshop Series Module: Irrigation Benchmarking & Water Budgeting – if you would like to participate in one of these workshops contact your nearest Cotton CRC Water Priority Team member.

Table 1: Water Use Indices for the Australian Cotton Industry

Gross Production Water Use Index (GPWUI)

$$\text{GPWUI (farm)} = \frac{\text{total production (bales)}}{\text{total water used on farm (ML)}}$$

$$\text{GPWUI (field)} = \frac{\text{total production for fields (bales)}}{\text{total water applied to field (ML)}}$$

Irrigation water use Index (IWUI)

$$\text{IWUI (farm)} = \frac{\text{total production for farm (bales)}}{\text{irrigation water supplied to farm (ML)}}$$

$$\text{IWUI (field)} = \frac{\text{total production for farm (bales)}}{\text{irrigation water applied to field (ML)}}$$

Operating Profit Water Use Index (OPWUI)

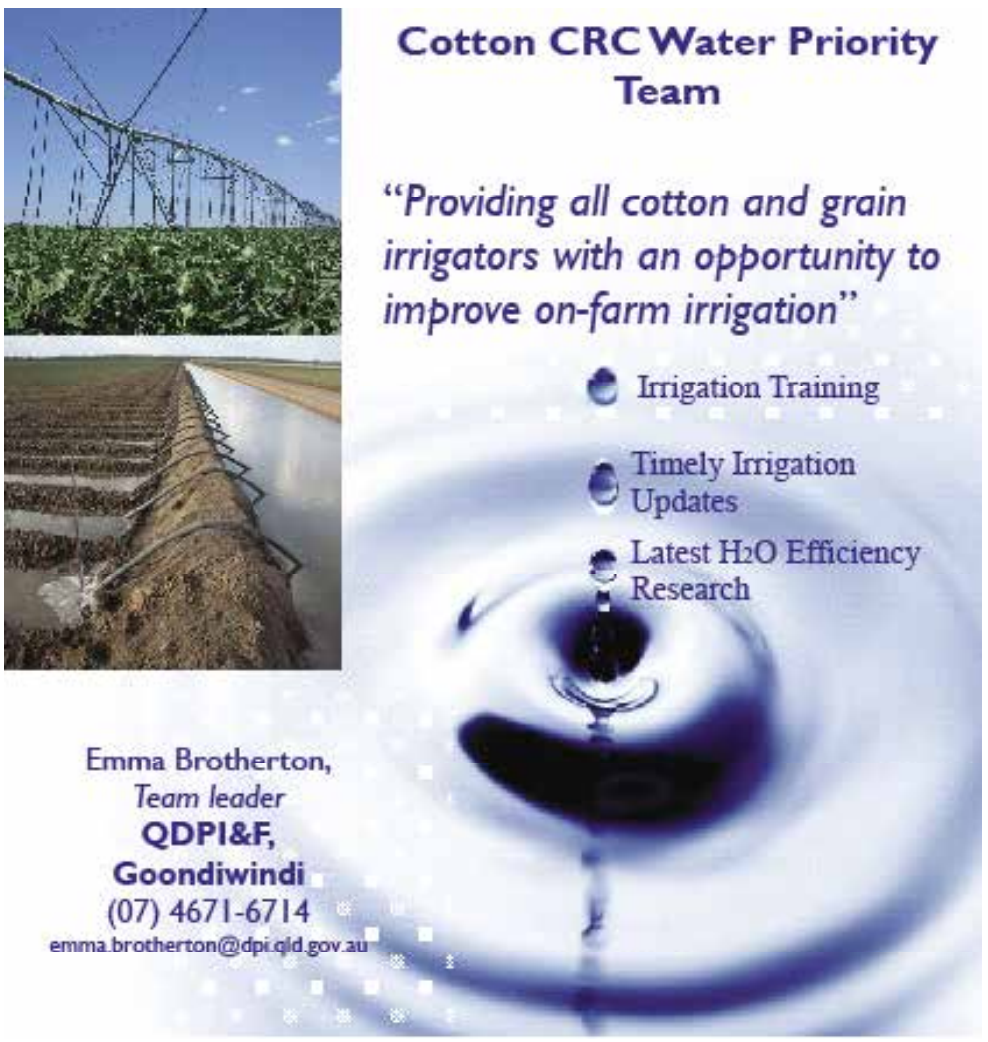
$$\text{OPWUI (farm)} = \frac{\text{Gross Return (\$) - Variable Costs (\$) - Overhead Costs (\$)}}{\text{Total Water Used on Farm (ML)}}$$

Table 2: Irrigation System Efficiencies (%)

$$\text{Application Efficiency } (E_a) = \frac{\text{irrigation water available to crop (ML)}}{\text{water recieved at field inlet (ML)}}$$

$$\text{Field Canal Efficiency } (E_b) = \frac{\text{water received at field inlet (ML)}}{\text{water received at a block of fields (ML)}}$$

$$\text{Farm Efficiency } (E_f) = \frac{\text{irrigation water available to crop (ML)}}{\text{water received at farm (ML)}}$$



Software is key to saving water

By Mary Ann Day

A two-year water management trial on two irrigated cotton farms has proved that measurement and better water management led to water savings and better yields.

The trials involved four irrigation experiments in the Namoi Valley over the 2005/06 and 2006/07 cotton seasons, on farms at Burren Junction and Boggabri.

A range of tools were used which have been developed to monitor and manage water on cotton farms. These included the CSIRO HydroLOGIC irrigation management software, the commercial Irrimate Surface Irrigation Evaluation Service, and the commercial WaterTrack whole farm water accounting software, developed by Aquatech Consulting, Scolari Software and Sustainable Soils Management. These three tools aid the farmer in separate aspects of water management.

"The aim of the trials was to improve the water use efficiency of Australian cotton," explained Dirk Richards from CSIRO Plant Industry at Narrabri.

"Our research program looked at water use throughout the farms.

"We used HydroLOGIC and Irrimate on the fields that had been selected for the trials and the WaterTrack software was run for the whole farm, including the field being monitored."

The Irrimate Seepage and Evaporation Meter and the Irrimate Storage Meters were also used on the farms to provide accurate measurement of losses and storage volumes.

"One of the main reasons for this research was to investigate the potential for integration of HydroLOGIC, Irrimateä and WaterTrackä. These tools target different on-farm water issues and the information generated within each tool can contribute to the value of the others as a whole," Dirk said.

As part of the trials, on each farm, a single field was split in two with a standard and optimised irrigation treatment.

"In the trials we found that there were substantial water savings as a result of better, more efficient irrigation, optimised water scheduling and because we identified on-farm losses," Dirk said.

"There were also savings to be made from changes in farm management and infrastructure, particularly with on-farm storages.

"All the products used in the trials were thoroughly tested previously and were further validated through these tests. We took field measurements throughout the season for soil moisture, plant growth, pumped water volume, irrigation application, and stored water volume.

"We then compared these measurements against the calculations of each product. As we went along, we also made some improvements to the products, based on advice from the growers involved."

Mr Richards said that results did vary between products.

Results showed that WaterTrack, which is specifically designed to calculate losses at each operation for the whole farm, and is balanced against measured water use, calculated different in-field benchmark figures to HydroLOGIC.

Accurately measuring storage volume and water loss is a part of whole farm management of WUE.

HydroLOGIC uses a powerful crop yield response model (OZCOT) and estimates water use indices based on an assumed irrigation system efficiency which includes water losses from storage, during distribution and in application. Any error in the assumed efficiency can lead to errors in the benchmark figures.

"But while HydroLOGIC calculated different gross water use benchmarking figures to those from WaterTrack, this is not unexpected as the tools are designed for different functions. It also indicates potential synergy within the different tools," Dirk added.

HydroLOGIC was able to confirm that both farms' irrigation scheduling was very close to optimum, while Irrimate demonstrated that the Burren Junction soil type required an extended irrigation time, with the risk of waterlogging.

Irrimate evaluations during the season also showed that the soil's ability to absorb water decreased as the season progressed.

WaterTrack calculated losses through seepage and evaporation in the storage, channels and drains and deep percolation losses in the field.

These losses were balanced with crop water use, water inflows and rainfall, to calculate daily and end of season on farm water balances which matched measured values. Potential water savings from improved infrastructure were also identified on the Boggabri farm using WaterTrack.

"Although our crop yield results varied because of some rain and the location of the fields in the trial, we still managed to identify water savings in management and infrastructure changes on both farms," Dirk says.

"At the end of the season, WaterTrack will be used to predict the optimum planting arrangement based on future water availability."

? Further information

If you would like to find out more about these trials please contact Mr Mike Bange, CSIRO Plant Industry, on 02 6799 1500, or Mr Andrew Murray, Aquatech Consulting, on 02 6792 1265. Information on HydroLOGIC and Irrimate can be found in WATERpak - a guide for irrigation management in cotton, published by the Cotton Research and Development Corporation, and the Australian Cotton CRC. This publication and other Cotton CRC information resources can be found at http://www.cotton.crc.org.au/Publicat/Water/index.htm.

Specific details on WaterTrack can be found at http://www.watertrack.com.au/ and Irrimateä at http://www.irrimate.com.au/

Irrimate, WaterTrack and HydroLOGIC lead the way in irrigation

Irrimate Flu Metres (top) and Flow Metres (above) have been used with great success by consultants and growers improve WUE and are a vital tool in quantifying water use – and loss.

By Mary Ann Day

With cotton farming in Australia dependent on irrigation and especially in today's climate of severe drought, it is vital for irrigators to keep track of their water.

Fortunately for today's farmers, there are a number of clever irrigation tools available on the market to help them to manage their irrigation better, to improve their water use efficiency and ultimately optimise their crop yield.

With the help of three key products, Irrimate, WaterTrack and HydroLOGIC, big savings in water use can be made.

Here we look at these technologies and see how these tools can best work for individual cotton growers and their requirements.

The CRDC became involved in the development of the Irrimate technology in 1997 when it funded an NCEA project (NEC2C) to develop best management practices for maximising whole farm irrigation efficiency in cotton.

It was then developed into a commercial service by Aquatech Consulting, Water Resources and Irrigation Engineers in Narrabri.

Today WaterTrack consists of two commercial software packages, WaterTrack Optimiser and WaterTrack Rapid which were developed jointly by Aquatech Consulting (engineering), Scolari Software of Dubbo (software) and Sustainable Soils Management of Warren (Soil Science). The Irrimate surface irrigation evaluation service and the WaterTrack whole farm water accounting software, have been designed to offer a variety of commercial products and services to improve water management.

The third product available, Hydro-LOGIC, a new irrigation management software package, has been developed by the CSIRO and the Australian Cotton Cooperative Research Centre, and is available from the Australian Cotton CRC free of charge to Australian cotton growers and consultants.

Irrimate

"The Irrimate in-field range of equipment and evaluation packages have been used since 2000 to measure how well growers are irrigating," said Jim Purcell, Director of Aquatech.

"With water budgets in some respects being even more important than financial budgets, savings on water use can be crucial to farmers and consultants.

"By using this Irrimate system, irrigators not only know how much water they applied and how much ran off as tailwater, but also how to change the way they irrigate to reduce losses.

"We have found from hundreds of Irrimate in-field evaluations that an average water saving of 20 percent is possible with an average furrow irrigation operation just by changing how we irrigate."

The Irrimate In -Field Evaluation Service includes measuring equipment and computer modelling software. It enables accurate measurement of irrigation efficiency and infiltration at any point down the field.

By modelling different irrigation practices such as changes in siphon flow rates, irrigation shift times, field length, and field slope, an irrigation can then be optimized.

Irrimate products now also include a specialized Seepage and Evaporation Meter for measuring seepage and evaporation losses in storages, channels and drains and a Storage Meter which measures and continually records storage volume and water surface area.

WaterTrack

WaterTrack offers two water balance tools, WaterTrack Rapid and WaterTrack Optimiser. Both provide whole farm water balance information at different levels.

The WaterTrack packages were developed through a joint venture between Aquatech

Consulting (engineering), Sustainable Soils Management of Warren (soils specialists) and Scolari Software from Dubbo, (software specialists).

"WaterTrack Optimiser models water transfer through every operation on an irrigation farm with results checked against real measurements. By using Optimiser, growers can find out where the farm water is going and how much is available for use at any point in time, now or in the future," Jim Purcell explained.

As the names imply, WaterTrack Rapid provides a rapid and simple summary of calculated water use performance and total losses. WaterTrack Rapid is accessed and can be paid for on the web and has been designed to require only basic levels of user input.

HydroLOGIC

Dirk Richards from the CSIRO Division of Plant Industry at Narrabri has been researching a two year project involving all three irrigation devices.

"The main aim of HydroLOGIC is to help with the effective and timely application of irrigation for furrow irrigated cotton crops," he explained.

"It can provide information to help growers to assess the results of different irrigation scheduling options on crop growth, crop yield and use of water.

"We carried out trials in 2002/2003 where CSIRO Plant Industry scientists showed that the yield could be improved using HydroLOGIC, under both full and limited water situations, without losing fibre quality," Mr Richards added.

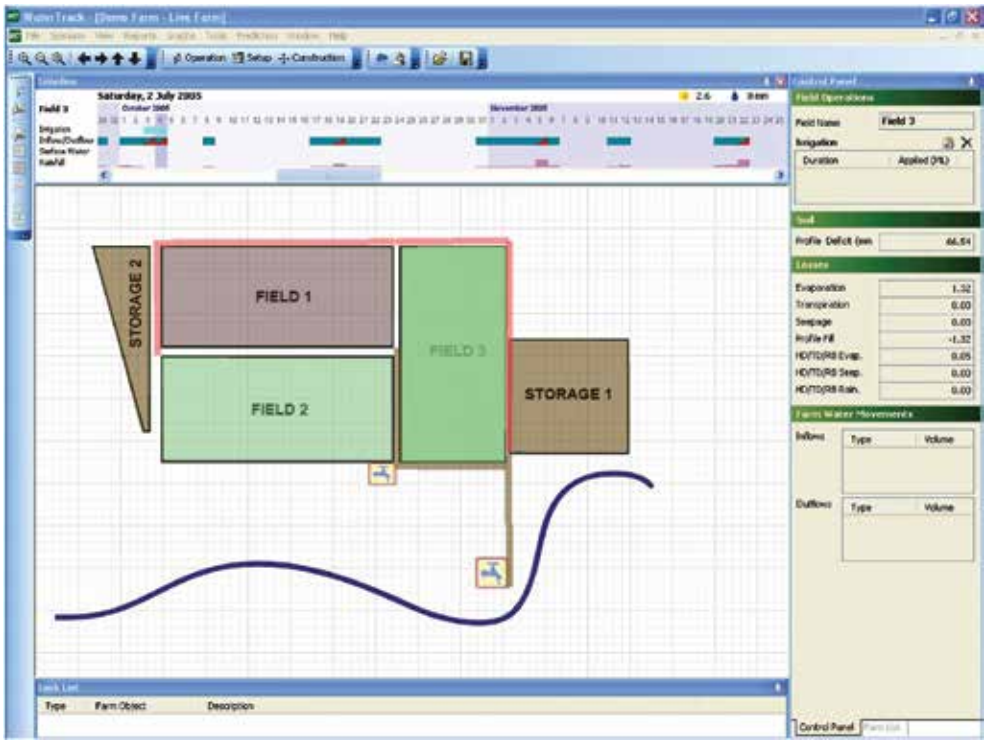
To use HydroLOGIC, cotton growers collect data from their cotton crops and then HydroLOGIC can simulate the most likely outcome on yield and water use.

HydroLOGIC uses OZCOT – a cotton crop simulation model also developed by CSIRO Plant Industry, which is continually updated.

Using HydroLOGIC requires a standard personal computer that can load HydroLOGIC from a CD.

? For more information on HydroLOGIC, contact your local cotton industry development officer, or visit http://www.cotton.crc.org.au/
For information on Irrimate and WaterTrack contact Aquatech (andrew@aquatechconsulting.com.au) or http://www.irrimate.com.au and http://www.watertrack.com.au

DIY irrigation calculator to check water use



By Mary Ann Day

Growers can calculate their water use indices on their farm with the help of an online benchmarking tool.

These indices can be used to make management decisions and are used in the Cotton BMP Land and Water Module to help demonstrate improvement in water management.

This tool was developed to help growers and consultants to understand some basic benchmarking terms, such as Irrigation Water Use Index and Gross Production Water Use Index and to perform basic benchmark calculations to demonstrate the value of these indices.

"This is also a way of encouraging more, in-depth investigation into measuring and monitoring on-farm water use so that water use efficiency can be measured with greater accuracy in the future," explained David Wigginton, sub-program leader for water within the Cotton CRC.

"This benchmarking tool performs some simple, but standard calculations at the whole farm scale.

"Like many simple tools, its accuracy is limited by the quality of the data and the estimates of effective rainfall and used soil moisture over the whole farm.

"However, we hope that those who have never performed whole farm irrigation benchmarking calculations, or those who use non-standard measures, will see some benefit in this standard process and progress in the future to more accurate methods of calculation such as Watertrack(TM)."

Users have the choice to contribute their figures to an overall industry average, which the industry can then use to demonstrate the increasing level of interest by growers to improve their water use efficiency, and the improvement in water management performance over time, of the Australian Cotton Industry.

Bruce Pyke, General Manager for Research and Extension, CRDC, commented: "This is an excellent, simple tool that can be used as a first step by growers and consultants to demonstrate some of the basic, standard information they require to measure water use on a farm. It will help to highlight what they currently measure compared to what they guess and will hopefully encourage many to go on and seek more professional advice that will eliminate the guess work.

"If they follow this path they will lift their water management to the next level."

? For more information on the tool, please go to: www.morganruraltech.com.au/cottonbmp/waterHome.aspx

Irrigation management guide

By Mary Ann Day

WATERpak, a comprehensive guide aimed at growers and consultants, is now available, to help them to manage irrigation in cotton and grains crops.

WATERpak provides technical information and practical advice to help irrigators improve irrigation practices, minimise environmental impacts and increase farm profits from irrigated cotton crops.

For the first time, WATERpak brings together in one place the many years of irrigation research conducted by a variety of organisations in the Australian cotton industry.

"The challenge for irrigators is to find the balance between the benefits of improved water use efficiency, environmental concerns and the maintenance of farm profits," David Wigginton explained.

"It is possible to improve water use efficiency and productivity within the field, by minimising tailwater losses, drainage and the potential improvement in yield through the reduction of waterlogging effects.

"It can be harder to control evaporation and seepage losses from storages and channels; however this is where most water is lost on cotton farms and it is vital that researchers and growers combine forces to prevent these losses," Mr Wigginton added.

Best Management

WATERpak and the cotton industry's Best Management Practices Program lists issues for attention, provides a process of identifying the potential management risks and gives an outline on how to manage those risks.

WATERpak provides detailed technical and practical advice that growers may be looking for when using the BMP Manual. So, the order of topics in WATERpak and the new BMP Land and Water module are similar.

This is aimed at minimising the time that cotton growers need to spend looking for information, and maximising the time spent implementing better solutions.

? For more information on WATERpak go to: web.cotton.crc.org.au/content/Industry/Publications/Water/WATERpak.aspx

Irrigation Workshops

The Cotton CRC Water Team is conducting Irrigation Benchmarking and Water Budgeting workshops. Participants go through the same calculations as the online tool, but do it all by hand in the workshops.

Convenor David Wittington says, "You can now participate in one of a series of workshops focusing on irrigation benchmarking, budgeting, scheduling and storage and distribution systems."

"These workshops are now available through the Cotton Catchment Communities CRC Water Extension Team. We want to provide high level skills for growers, farm managers and consultants, and put emphasis on practical material that can be taken away and applied in the field.

"We will also be running workshops on irrigation optimisation, pumps and flow metering and the workshops will be on an on-demand basis."

? Anyone interested in any of these topic areas, who would like to be involved in a workshop, should contact their local Water Team Member.

20 percent increase in cotton yield per megalitre of water supplied to farms is a primary focus of the Water Team.

Turn megalitres to bales:

tailor-made irrigation workshops offered

'Measure to Manage' is emerging as the proven approach to gain a true understanding of where irrigation water is going, and how effective the farm is in converting megalitres of water into bales of cotton.

That is why Emma Brotherton, head of the industry Water Team is encouraging all irrigators to talk to their local extension officers or irrigation consultants to see what is available in terms of funding, and to make a move to measure a number of irrigation events to identify any opportunity to improve current management strategies.

In coming months Irrigation Training Workshops will be delivered throughout all regions. These workshops can cover a wide range of topics but would be tailor-made to suit the needs of individual growers or consultants in any region.

"Currently there is a lot of interest in the benchmarking workshop which links directly to the Best Management Practice Land & Water Module," Emma said.

"In the 2006/07 season a number of extension officers ran WaterTrack™ demonstration sites to showcase the latest tool available to growers to monitor every drop of water entering and leaving their farm. From this, they can then determine where further gains can be made in managing water on-farm.

Measure and manage demos

"Other demonstration sites were run to showcase the advantages of in-field measurement to fine tune irrigation events.

"Three more specific demonstration trials included the continuation of the Siphon-less Irrigation project in the Border Rivers and Maranoa Balonne, an irrigation trial on the Darling Downs and the Farming Systems Trial in Emerald."

Adoption of in-field measurement is not only promoted through these demonstration sites but through the CRC extension team link with local Catchment Management Authorities to deliver water use efficiency incentive schemes to irrigators.

Successful incentive schemes delivered to date include the Border Rivers Gwydir CMA and Queensland Murray Darling CMA, with potential for a similar scheme to be run in Emerald and Namoi regions.

Water team activity

"The Water team provides timely updates through Cotton Tales, Cotton Grower Water Matters and the CRDC's Spotlight magazine along with other media," Emma said.

"This is coupled with an active role in local Cotton Grower Associations, Cotton Consultant Associations and AWM meetings.

The Water team works closely with ACRI irrigation researchers James Neilsen, Steve Yeates and Dirk Richards and other research agencies to deliver timely Information days that directly link with current irrigation research. This season resulted in the delivery updates on Bollgard vs. Conventional water use, limited water strategies using Hydrologic.

Improving water use efficiency (WUE) is an industry-wide aim. CRDC maintains a continual investment program aimed at building WUE. R&D funding aimed at supporting adoption of WUE technologies is directed to the industry via the Cotton CRC Extension Team.

"Improving WUE with a 20 percent increase in cotton yield per megalitre of water supplied to farms is a primary focus for us," Emma said.

"In addition to the other outlined activities, the water team is actively working to determine the baseline data for 2007 through the collation of existing information from a range of data sources and develop processes to enable growers to document benchmarking data for their own use.

"To date the water team has identified WUE benchmark data sets available on farm via the Hydrologic survey which was carried out in March 2007 and conducted in May 07 to develop baseline data on the uptake of irrigation services.

"The team will also revisit the uptake of overhead irrigation systems in the industry which was last done in 2001 by Joe Foley of the University of Southern Queensland and Steve Raine NCEA.

"The industry information will determine where we are in relation to meeting the objectives of the cotton CRC and allow the water team to build a more targeted extension strategy to meet these objectives.

"The Water team will continue to provide irrigators with the opportunity to up-skill in collecting benchmarking data via the irrigation training workshops."

Into the future, Emma said she would like to see the ongoing documentation of where the Australian cotton industry is positioned in relation to water use in comparison to the cotton industry world-wide.

"Continuing to provide growers with confidence in the latest information, technology, research and skills provided by the Cotton CRC and industry alike to implement the required management strategies on-farm to respond to the constant challenge of low prices, variable water supply and climate variability is our challenge and aim for the future," she said.

WaterTrack is a trademark of Aquatec.

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Taking climate into account

By James Neilsen CSIRO

To optimise irrigation strategies for cotton it is necessary to know the response of the plant to the prevailing soil and climate conditions.

Rather than approach the problem of moisture stress by looking at how much water is contained in the soil, a project being undertaken by CSIRO's James Neilsen, measures the plant moisture status directly. This has the advantage of considering the contribution of both the moisture content of the soil and the prevailing climate.

The project aims to quantify the effect that evaporative demand places on crop stress. This research is fundamental to the development of optimum water management as an improved understanding of plant responses to soil moisture and climate will help growers to make better water management decisions for optimum yield, quality and maximum water use efficiency.

In terms of soil type effects, results from previous field experiments from 2003/04 to 2005/06 at three widely different soil types has shown that (i) the response of cotton to water stress is different on heavy clay vs. sandy-loam; (ii) these differences can be accounted for when soil moisture content is normalised for water holding capacity, expressed as the fraction of transpirable soil water (FTSW).

For example on the heavy clay soil a 50 percent deficit is 90mm of water and on the sandy loam it was only 30mm.

This extreme case shows how working on a millimetre deficit for irrigation scheduling across a farm can be inadequate to prevent plant moisture stress, and the importance on understanding the water holding capacities of your soils.

Prevailing climatic conditions have had a considerable effect on the ability of the plant to cope with a given level of soil moisture deficit. Even under low levels of soil moisture deficit, on high evaporative demand days plants often experienced stress which impacted on yield.

Evaporative demand is the capacity of the aerial environment to cause evaporation from a plant canopy, it is influenced by a number of factors including: temperature, wind speed, radiation load and vapour pressure deficit which is the difference between the maximum amount of water vapour the air can hold at a given temperature and the actual amount held.

Climatic conditions with a vapour pressure deficit above 30mb (low humidity) and temperatures above 37oC meant cotton was unable to take up enough moisture even from a soil profile with readily available water; for plants in a dry profile, such conditions accentuate stress. This modified stress level means that the effect of a soil moisture deficit can be different depending on the environmental conditions and just monitoring crop status through soil moisture measurement will not give a complete understanding of plant water status.

? James Neilsen, CSIRO Plant Industry.
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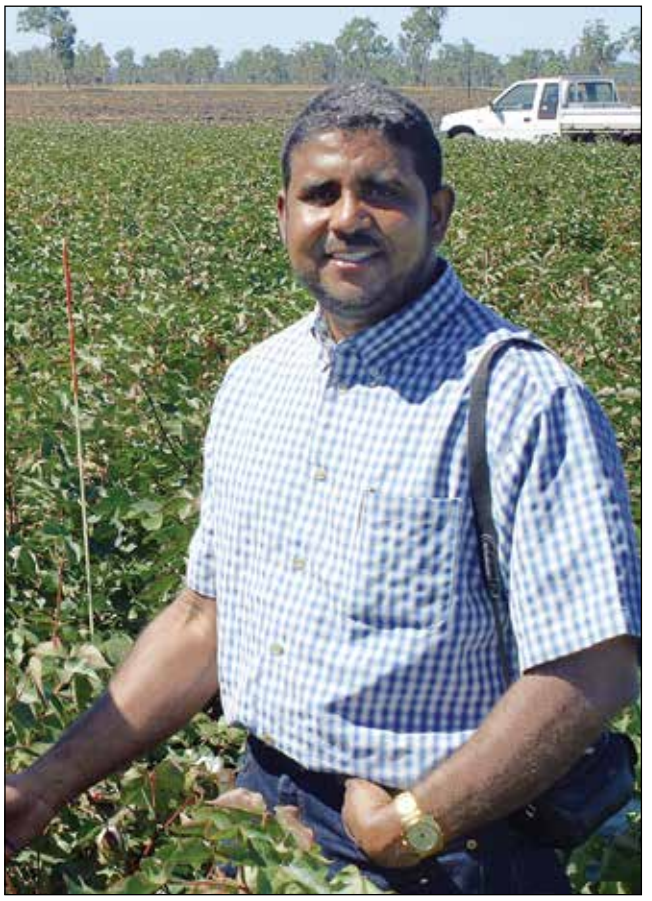
Above; Severe climatic and soil moisture stress affects plant development and must be taken into account when making irrigation decisions.

Below; Visual water stress symptoms in cotton.

Darling Downs crop competitions show very high water use efficiencies

José Payero, Geoff McIntyre, Graham Harris,
DPI&F/Cotton Catchment Communities CRC



Jose Payeo is a leader in his field, having completed an extensive body of work reviewing irrigation performance data worldwide to guide creation of performance measures for the Australian cotton industry.

The current drought is focusing attention maximising water use efficiency (WUE) in order to maximise profits while protecting the environment. WUE, however, is a very ambiguous term which is often misunderstood, misused, and misinterpreted.

Part of the confusion comes from the basic definition of WUE, which is commonly expressed as "yield" per unit "water." Although for a particular crop most people will know what the "yield" term means, understanding and measuring the "water" term can be more challenging. Several WUE indices can be calculated that use either "irrigation," "evapotranspiration (ET)", or "total water" as the "water" term. ET is the amount of water that actually goes through the plant plus the water that evaporates from the plant and soil surfaces. Total water includes all the water that goes to the field, including irrigation, in-crop rain, and water stored in the soil profile at sowing. The most common indices to measure WUE are:

- Irrigation water use index (IWUI) = yield/irrigation
- Crop water use index (CWUI) = yield/ET
- Gross production water use index (GPWUI) = yield/total water.

The WUE values that farmers can achieve depend on a variety of factors. These include location, available water, yield potential, effect of other yield-limiting factors, WUE index used, etc. WUE indices can, therefore, be very variable and it is difficult to set WUE standards that would apply across seasons and locations. Producers may then wonder what kind of WUE values should they target and what kind of values are possible?

As an example of cotton WUE values obtained on real farms, we analysed long-term cotton production records from the The Royal Agricultural Society of Queensland Irrigated Agricultural Crops Competition conducted on the Darling Downs from 1987-88 to 2005-06.

Cotton yields have been measured from the area from which one module was harvested. Initially, crop information recorded for all entries included yield and variety. Since 1987, more detailed essential crop management inputs have been recorded for all crop entries creating a substantial database of crop performance. The crop data records include information on: crop type, variety, planting date, planting rate, fertiliser program, insecticide program, herbicide program, growth regulators, irrigation, and harvest date.

The Darling Downs Cotton Growers Association (DDCGA) also initiated an annual award program in 1994 based on whole farm management and production. This dataset includes detailed crop management information to be able to determine indicative crop gross margins. Consequently, substantial irrigation management data has been collected from both the RASQ Irrigated Crop Competition and the DDCGA awards. The quality of irrigation data is quite variable and while information on the number of irrigations was generally provided, irrigation amounts were rarely measured. Estimates of irrigation amounts are, therefore, based on the assumption that one surface irrigation was equivalent to 1.0 ML/ha (100 mm). In-crop rain was usually measured on-farm, but in the absence of on-farm records, rainfall from the nearest Bureau of Meteorology weather station was used as an estimate. Information on stored and residual soil moisture was not available since most farmers did not measure or did not keep these records. Since growers with the best crops were more likely to enter the competitions, it is expected that results would reflect yields that are higher than average. Only complete entries that included information on yield, irrigation (amount or number of irrigations), and in-crop rainfall were retained for analysis. A total 23 dryland (since 2000) and 181 irrigated entries were included.

Results showed significant variability from year to year and among entries within the same year. Irrigation amounts, dryland yields, and the calculated WUE indices were affected by in-crop rainfall. The average in-crop rainfall was 4.23 ML/ha (423 mm), ranging from approximately 250 mm to more than 650 mm (Fig. 1). Number of irrigations and irrigation amounts averaged 3.4 irrigations (including pre-irrigation) and 3.5 ML/ha, respectively. As expected, the number of irrigations tended to decrease with in-crop rainfall. Since information on soil water at sowing was not provided, only rain plus irrigation is reported here as an approximation of "total water," which averaged 7.7 ML/ha (770 mm) but has steadily decreased since 2002 (Fig. 2).

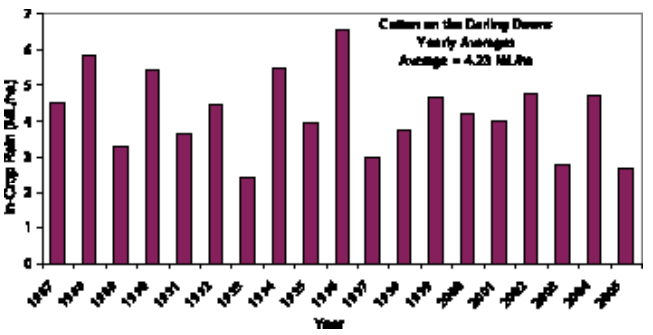


Figure 1. Average in-crop rain for cotton by year, reported by farmers participating in yield competitions on the Darling Downs, Australia.

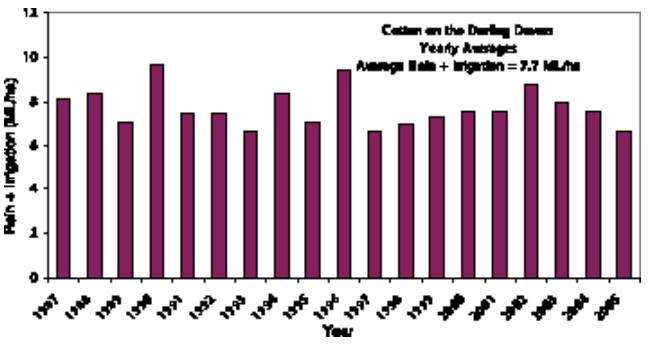


Figure 2. Average total water (rain + irrigation) for cotton by year, reported by farmers participating in yield competitions on the Darling Downs, Australia.

Cotton lint yields averaged 9.34 bales/ha for irrigated and 4.83 bales/ha for dryland production (Fig. 3). Irrigated yields peaked in 2001, and have steadily decreased in the last 5 years, reflecting the decrease in total water inputs. Average lint yield tended to increase when rain plus irrigation was less than approximately 7.0 ML/ha, levelling off with additional water inputs (Fig. 4). An estimate of GPWUI (yield/total water) was calculated using "Rain + irrigation" instead of the "Total water" term. The "GPWUI" calculated in this way averaged 1.25 bales/ML for irrigated and 1.59 bales/ML for dryland cropping systems, respectively (Fig. 5). The GPWUI tended to decrease with the amount of "Rain + Irrigation," ranging from about 0.5 to almost 3 bales/ML (Fig. 6).

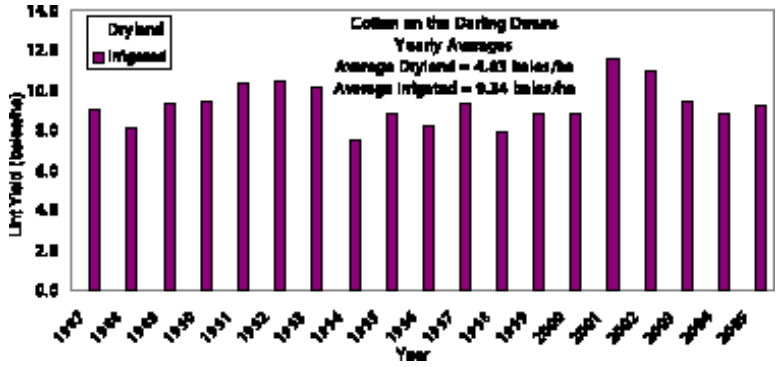


Figure 3. Average cotton lint yields by year, reported by farmers participating in yield competitions on the Darling Downs, Australia.

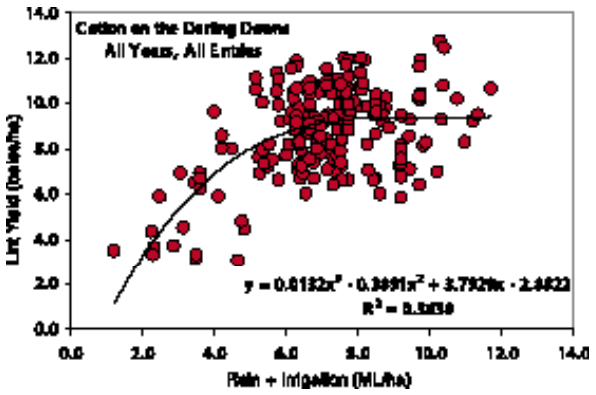


Figure 4. Cotton lint yield as a function of total water (rain + irrigation), obtained from data provided by farmers participating in yield competitions on the Darling Downs, Australia, from 1987-2005.

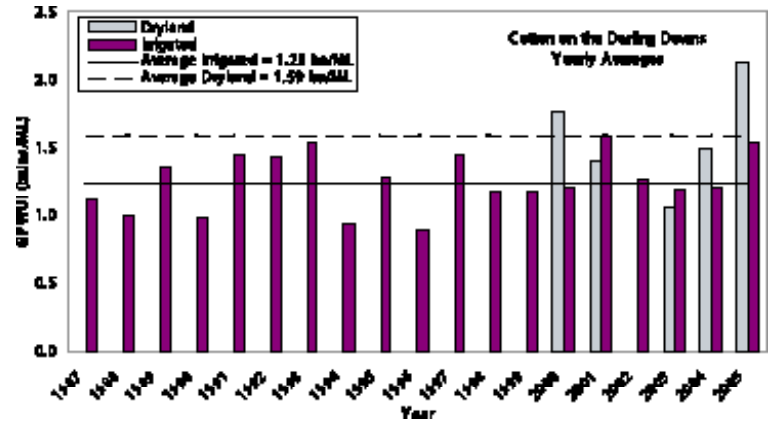


Figure 5. Average gross production water use index [GPWUI = (Lint yield)/(rain + irrigation)] for cotton by year, calculated from data provided by farmers participating in yield competitions on the Darling Downs, Australia.

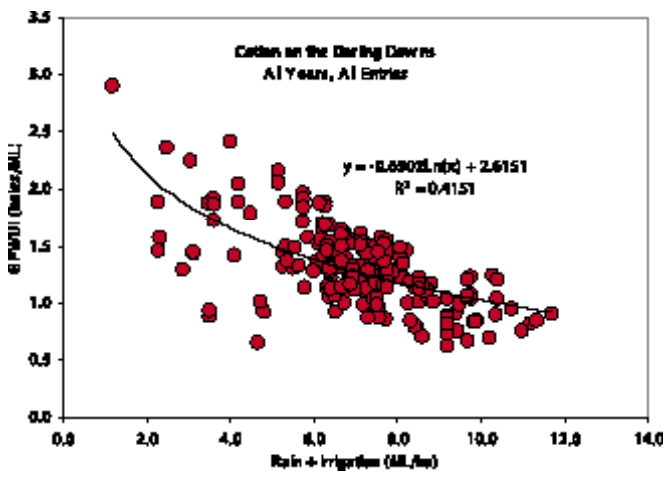


Figure 6. Gross production water use index [GPWUI = (Lint yield)/(rain + irrigation)] as a function of (rain + irrigation) for cotton, obtained from data provided by farmers participating in yield competitions on the Darling Downs, Australia, from 1987-2005.

The IWUI (yield/irrigation) averaged 2.75 bales/ML of irrigation (Fig. 7), which is a very high average. The IWUI for individual entries, however, was very sensitive to irrigation amount, ranging widely from around 2 to 12 bales/ML of irrigation (Fig. 11). These values indicate that very high IWUI values are possible in wet years and/or in areas requiring little irrigation. For years requiring more than 3 ML/ha of irrigation the IWUI tended to level off at a value of approximately 2.0 bales/ML.

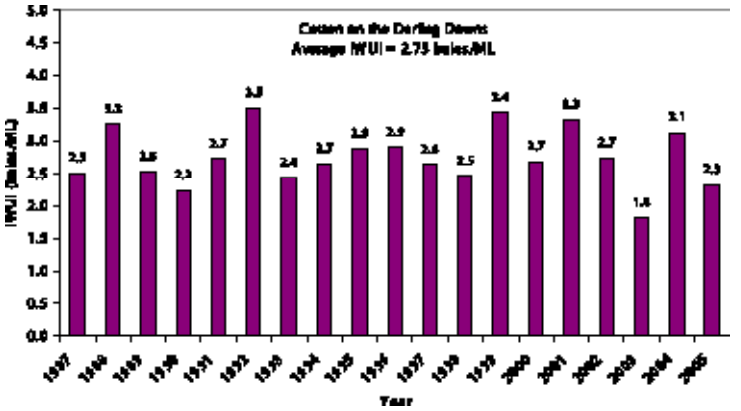


Figure 7. Average irrigation water use index (IWUI =lint yied/irrigation) for cotton by year, calculated from data provided by farmers participating in yield competitions on the Darling Downs, Australia.

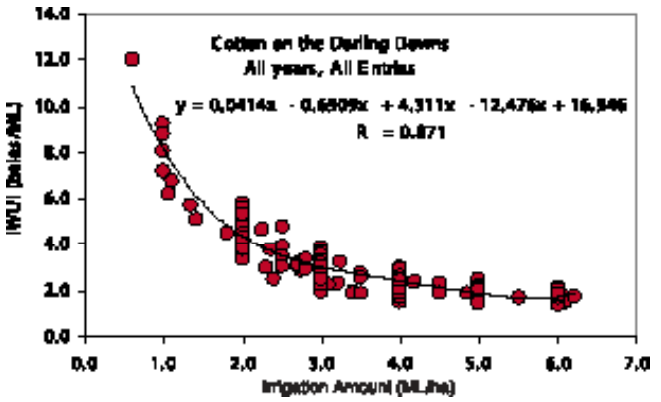
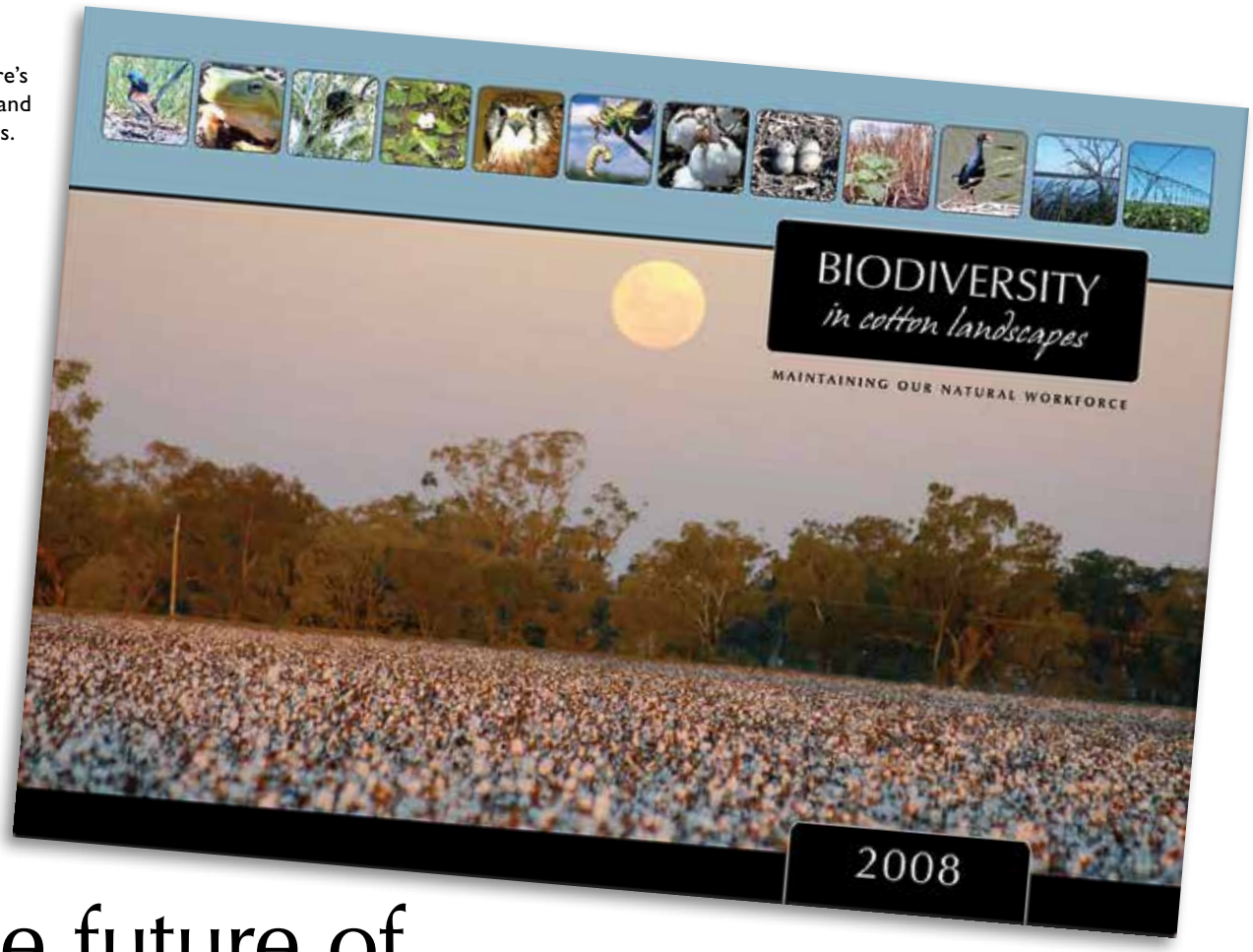


Figure 11. Irrigation water use index (IWUI = lint yield/irrigation) as a function of irrigation amount for cotton, obtained from data provided by farmers participating in yield competitions on the Darling Downs, Australia, from 1987-2005.

These results indicate that the GPWUI and IWUI values are very variable and tend to be high when irrigation requirements are low, and the opposite occurs when irrigation requirements are high. Therefore, it is easy to get high GPWUI and IWUI values in wet seasons, but difficult in dry seasons. Therefore, caution should be used when interpreting these indices to compare irrigation performance across seasons and locations. For this purpose more stable indices like the CWUI (Yield/ET) would be preferable, although it is more difficult to measure. A few points for farmers to consider are:

- Since WUE can be calculated in different ways and can be affected by a variety of factors, Increasing WUE is not necessarily always a good idea, depending on what measure of WUE is used.
- Using a combination of WUE indices and other water management indicators, like irrigation efficiency and uniformity, could be more useful than focusing on just one WUE index.
- If the WUE terminology is confusing, as it is, farmers should focus on reducing the “non-beneficial” use of water and trying and increase yields by controlling yield-limiting factors (irrigation, nutrition, insects...). “Non-beneficial” use of water includes water losses such as evaporation and seepage in storage, channel losses, runoff, deep drainage, and soil evaporation.
- Farmers should aim at increasing profits if it is environmentally sustainable, which may not necessarily be obtained by increasing yields or increasing WUE. In fact, in some cases, profits can be maximized with less than maximum yield and WUE. Profits are a function of a combination of economic factors; such as crop prices and cost of production; in addition to biophysical factors, like irrigation and yields.
- The high WUE values reported here were obtained on the Darling Downs and the Lockyer Valley, where the irrigation requirements are relatively low compared with other cotton producing areas in Australia.

Since water has become the main limiting factor to cotton production in Australia, farmers should seriously consider evaluating WUE. For this they will need to learn how to measure and interpret the different WUE indices, or they can get the assistance of a crop consultant. Also, the cotton industry has developed procedures to evaluate WUE. To help producers in this process, the National Program for Sustainable Irrigation Knowledge Management project through the Cotton Catchment Communities CRC Water Team has been delivering a series of workshops, aimed at industry producers and consultants. All the workshops provide participants with the option of achieving formal qualifications, through the alignment with national competencies from the vocational and technical education sector. Further information about these workshops can be obtained by contacting Mr. David Wigginton (Irrigation Knowledge Broker) or your local Cotton CRC Water Team member.



A 365-day a year tool to help enlist 'nature's workforce' which makes good economic and environmental sense for cotton producers.

Cotton industry investment securing the future of our natural resources

The Cotton CRC and CRDC have, over the years, made considerable investments in cotton production and cotton catchment related research.

This is recognition by the industry that the management of our natural resources is not only good for production but good for the environment.

The proactive approach taken by the cotton industry to address resource management issues has led to a number of outcomes including the development of the Australian cotton industry BMP program.

This has been a driving force in the improved environmental management observed on cotton farms and has put the industry in a good position to contribute towards meeting resource condition targets outlined in regional NRM plans for cotton-growing catchments.

Additionally, this approach has also enabled the industry to form partnerships with catchment management groups in both NSW and Queensland.

These partnerships have led to jointly funded research and extension projects and have also provided growers with access to on-ground incentive schemes. The schemes have assisted growers to implement a range of activities on their farms leading to improvements in water use efficiency and management of riparian areas, soils and native vegetation.

As a result of the industry's investment in research and extension growers have, and are continuing, to undertake activities which have resulted in significant improvements in environmental performance.

Following on from an initial environmental audit commissioned by CRDC in 1991, a second independent audit in 2003 showed that:

- One of the most significant improvements (since the 1991 audit) was the development and implementation of the BMP program;
- The industry continued to make ongoing improvements in water management both in terms of research and also the implementation of its findings;
- The industry's adoption of IPM has been significant with the use of more selective and less toxic chemicals, GM cotton, non-chemical control measures and application practices to reduce the risk of drift;
- The industry has also demonstrated increased awareness of the importance of the retention of native vegetation, sustainable development and biodiversity on farms.

While the industry has already made outstanding progress in terms of resource management, there is still more to be done.

This is the reason Cotton CRC and CRDC continue to fund research across a range of areas including groundwater management, improved water use efficiency, river health, integrated pest management, pesticide and nutrient management, and ecosystem services.

To highlight some of the great research that the industry supports, this edition of 'Spotlight' features the work of Alan House (CSIRO), Felix Bianchi (CSIRO) and David Perovic (Charles Sturt University) who are working in the area of ecosystem services and biodiversity.

In addition to investing in research, the cotton industry is also working with government agencies and catchment authorities to invest in the National Cotton Extension Team.

This team ensures that the findings from the research are made practical, applicable and available to growers so they can be incorporated into farm management activities. The Team works closely with local growers, Cotton Australia, cotton consultants, researchers and catchment body staff to deliver extension activities and materials including:

- Field days;
- Farm trials (inc. Nutrient Use Efficiency);
- Training workshops;
- Web tools(examples – GHG calculator, Day Degrees etc); and
- Publications including pest management guides, Managing riparian lands in the cotton industry, Birds on Cotton Farms, SoilPAK, WaterPAK, and soil and water information sheets (many of which are available on the Cotton CRC web site (www.cotton.crc.org.au))
- BMP modules.

One of the latest publications produced by the team is the "Biodiversity in cotton landscapes – maintaining our natural workforce" calendar which you will find included with this edition of 'Spotlight'. The calendar celebrates the diversity of life found on cotton farms and the steps the industry has taken to protect our natural environment.

As the name suggests, it also details the benefits of having a healthy, functional ecosystem working for you on your farm. It is filled with practical tips on how you can enhance this wonderful resource and each monthly theme is supported by a fact sheet which can be found on the Cotton CRC website (www.cotton.crc.org.au).

The calendar is specifically for the cotton industry and all the photos have been taken in cotton growing regions within NSW and Queensland with most supplied by people involved in the industry. The Cotton CRC Environment Team would like to thank all those who helped prepare the calendar and fact sheets and provided photographs.

The "Biodiversity in cotton landscapes – maintaining our natural workforce" project is funded by Namoi CMA, Greening Australia and Cotton CRC through Department of Agriculture, Fisheries and Forestry Sustainable Industries Initiative.

The project is supported by CRDC, Border-Rivers Gwydir CMA and Fitzroy Basin Association.

? For more information please contact one of the Cotton CRC Extension team members.

Alan House (CSIRO) presenting an outline of his project at a field site near Dalby.

It's a balancing act

by Alan House (CSIRO)

For a long-term sustainable cotton industry we need to know how to balance the production of cotton with the maintenance of a healthy catchment.

CSIRO Sustainable Ecosystems is working on a research project to examine the effectiveness of native vegetation to provide essential ecosystem services to cotton farming landscapes.

"One of the key issues in this balance is managing native vegetation in cotton catchments and the biodiversity that uses this resource," said Dr Alan House from CSIRO Sustainable Ecosystems.

"Improved management of native vegetation is valuable both in helping the industry meet its obligations to preserve biodiversity, but also because this biodiversity provides a range of important ecosystem services to the industry, including the natural control of pests.

"In this study we are examining how cotton farms can preserve biodiversity (including insects and birds) by managing patches of native vegetation."

An associated project is looking at how insects that contribute to pest control move from native vegetation into cotton and other crops. This research project by Felix Bianchi is also featured in this edition of *Spotlight*.

Alan said by integrating information on biodiversity and pest control, it would be possible to explore the consequences of different vegetation management options and recommend best practice for cotton farmers and catchment managers.

The project is located in southern Queensland, where cotton (both irrigated and dryland) is one of a range of crops grown in an agricultural landscape that also includes livestock (mainly cattle).

"Our study sites are situated in the Condamine and Macintyre River catchments, and broadly represent areas of low and reasonably high cover of native vegetation," Alan said.

"With support from CSIRO Sustainable Ecosystems, Cotton Catchment Communities CRC, Condamine Alliance, Queensland Murray-Darling Committee and the University of Queensland, we want to find out whether the composition of invertebrate communities is determined by how vegetation is "arranged" on farms, ie. the location, extent, shape and condition (structure and composition) of the vegetation.

"This might have an important bearing on the provision of pest control services by natural enemies in cotton landscapes, as well as on the long-term viability of these vegetation remnants in otherwise intensively farmed landscapes."

To do this, representative patches of vegetation will be surveyed (including irrigated and dryland cropping, pastures of exotic and native grass species, regrowth, native woodlands and grasslands) in each of four study areas, two in the Condamine and two in the Macintyre catchments.

These surveys will be used to design a sampling protocol for the invertebrates.

"Our focus will be on ground-active and ground-cover invertebrates, in particular ants, beetles and spiders, all of which have the potential to inform us about the 'ecological state' of the vegetation.

"This data will be analysed in relation to both the spatial pattern of vegetation and the condition measures," Alan said.

Using the same study areas, the project will also include a study of birds in relation to spatial arrangement and condition of vegetation. This is a PhD project hosted by the University of Queensland. We hope to have a student on board in early 2008.

Alan said this research would provide a sound scientific underpinning for the design of cotton properties that follow best management practice for enhanced ecosystem services.

"It will also assist regional NRM bodies and catchment management authorities to formulate management action targets for nature conservation, biodiversity, vegetation and land use management.

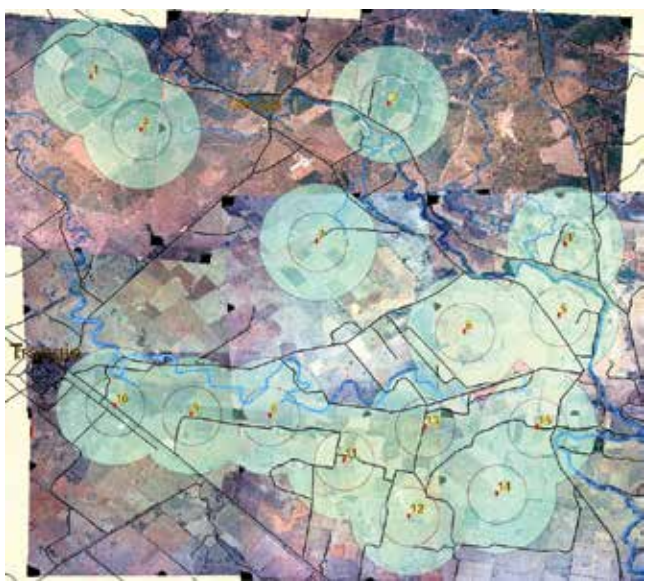
"As a result, the cotton industry will be able to demonstrate their credentials in progressive adaptive land management, and NRM bodies/ catchment authorities will be able to progress action targets across the landscape.

"It is anticipated that the results of this suite of integrated biodiversity projects will find general applicability in other cotton-growing regions, assist in the development of monitoring and evaluation strategies of future projects and contribute significantly to our understanding of Australian agro-ecosystems."

David Perovic is undertaking a PhD through Charles Sturt University and Cotton CRC.

Natural vegetation – enhancing its value for beneficial insects

by David Perovic (Charles Sturt University / Cotton CRC)



Study area in the Macquarie, around the towns of Trangie, Narromine and Gin Gin, covering seven cotton farms. The numbers and stars represent points where cotton was sampled for arthropods, and the circles represent the 1.5 & 3 km radius surrounding sampling points for which landscape structure/land use was analysed.

Increasing knowledge of the benefits of conservation and revegetation of natural areas surrounding cotton crops and the benefits to ecosystems services provided by non-crop areas may re-shape thinking about the way we view non-crop areas.

Far from being 'waste areas', research is showing natural vegetation on cotton farms is a multi-functional natural resource. Research being undertaken by PhD student David Perovic aims to show how the activity of natural enemies within cotton can be improved by the vegetation from non-crop areas.

"Natural enemies require more than simply a source of prey," David says, "these requirements can include shelter and alternative food sources and may differ for adults and juveniles of the same species. "Non-cotton vegetation may be important for providing these requirements, particularly as cotton crops are not present for the whole year round.

"As populations of arthropods re-colonise cotton crops after planting, the distance that they must travel from non-crop areas and into cotton may play an important role in how effectively a local population of natural enemies can act to protect crops.

David's initial research, being undertaken primarily in the Macquarie, has focused on identifying vegetation types which were associated with high densities of natural enemies in cotton crops. By analysing this relationship at different spatial scales it was possible to identify the distance from crops which these vegetation types need to be present in order to facilitate an improved activity of natural enemies within crops.

Results from this investigation show that the density of natural enemies is significantly enhanced by perennial areas surrounding cotton crops at a distance of up to three kilometres, which was the maximum scale considered in this study.

Spider densities were enhanced most strongly by horticultural trees (in the study area this consisted of grapevines, olives and citrus) at a scale of 750m, but strong correlations existed to as far as three kilometres.

The density of red and blue beetles within crops was strongly related to shelterbelt trees and horticultural trees within 750m to three kilometres; and density of trichogrammatids was most strongly correlated to both isolated farm/paddock trees and irrigation canals within 1500m.

The present season of sampling (November 2007 to March 2008) will focus on identifying how non-cotton resources are being utilised by natural enemies, by employing a variety of techniques using rare earth labelling.

"Rare earth labels offer a mechanism for testing how resources are being utilised, as they are systemic and move vertically through food webs," David said.

"Therefore food sources can be marked to identify the arthropod taxa which utilise them, for example by injecting the marker directly into the xylem of a plant, natural enemies which supplement their diet through nectar feeding can be identified, and subsequent movement of those individuals can be monitored.

"Likewise, the potential exists to mark herbivores and identify the predators which consume them. In this way we can identify alterative food sources for natural enemies outside cotton and how these sources may enhance their movement into crops."

Having identified the habitats used by natural enemies and their movement between these and into cotton, the aim is to construct a model using GIS software of landscapes which are conducive to natural enemy movement between crops, overwintering sites and alternative habitats.

"These models can give growers a powerful tool for landscape management and year-to-year arrangement of crops," David said.

Natural pest control:
does native vegetation help?

By Felix Bianchi (CSIRO)

While agricultural landscapes are dominated by arable fields, they also contain native vegetation, which is being investigated for its role in natural pest control.

Arable fields are generally ephemeral and highly disturbed areas because of cultivation practices such as tilling, planting, spraying and harvesting.

Because of the dynamic nature of agricultural fields they can be hostile environments for certain groups of insects, including beneficial insects (natural enemies) that can suppress pest populations in crops, according to Dr Felix Bianchi from CSIRO.

"In contrast, native vegetation constitutes permanent and less disturbed habitats, which often contain a high diversity of plants and insects and these habitats have often been documented as sources for natural enemies that can colonise crops and regulate pest populations," Felix said.

"Therefore, even though native vegetation does not contribute to agricultural production directly, it may still fulfil important functions for agriculture and IPM, such as the ecosystem service of pest control - on the other hand, native remnants may potentially also act as a source for pest insects."

Felix's research investigates the little understood role of native vegetation for natural pest control in Australian cotton production systems. In a project funded by the Cotton Catchments Communities CRC and Land & Water Australia, investigations are underway into the influence of native remnants on the colonization dynamics of pest and natural enemy populations in crops.

"Early colonization of crops by natural enemies, soon after the settlement of pests, is generally considered an important prerequisite for effective pest control," Felix explained.

The aim of the study is to assess whether (i) native vegetation acts as a source for pest and/or natural enemies, (ii) a high native vegetation:arable land ratio results in better pest suppression, and (iii) at what spatial scale native vegetation contributes to natural pest control. This study is linked with an associated project that examines how cotton farms can preserve biodiversity (including insects and birds) by managing patches of native vegetation.

In October 2007 the colonization dynamics of pests and natural enemy populations were investigated in two contrasting landscapes (10 km diameter) near Dalby.

One landscape was characterised by arable fields intermingled with patches of native remnants and tree lines, while the second landscape contained only a few tree lines.

In both landscapes, trays containing experimental cotton seedlings were set out in native vegetation, bare arable fields adjacent to native vegetation and bare arable fields that were at least 400 m from native vegetation.

In total, six native vegetation remnants and 12 fields were studied. The cotton seedlings contained (i) cards with Helicoverpa eggs, (ii) whitefly nymphs, (iii) leaf hopper eggs and (iv) no insects (i.e. clean plants).

The pest infested seedlings were used to assess the rate at which natural enemies remove/parasitize pests, whereas the clean seedlings were used to quantify the rate of pest colonization.

In addition, sticky traps were used to sample the insect community around the seedlings, resulting in more than 3700 seedlings and nearly 1000 sticky traps included in the experiment.

"Currently the experimental plants are checked for the presence of pests and natural enemies and the final results are expected mid 2008," Felix said.

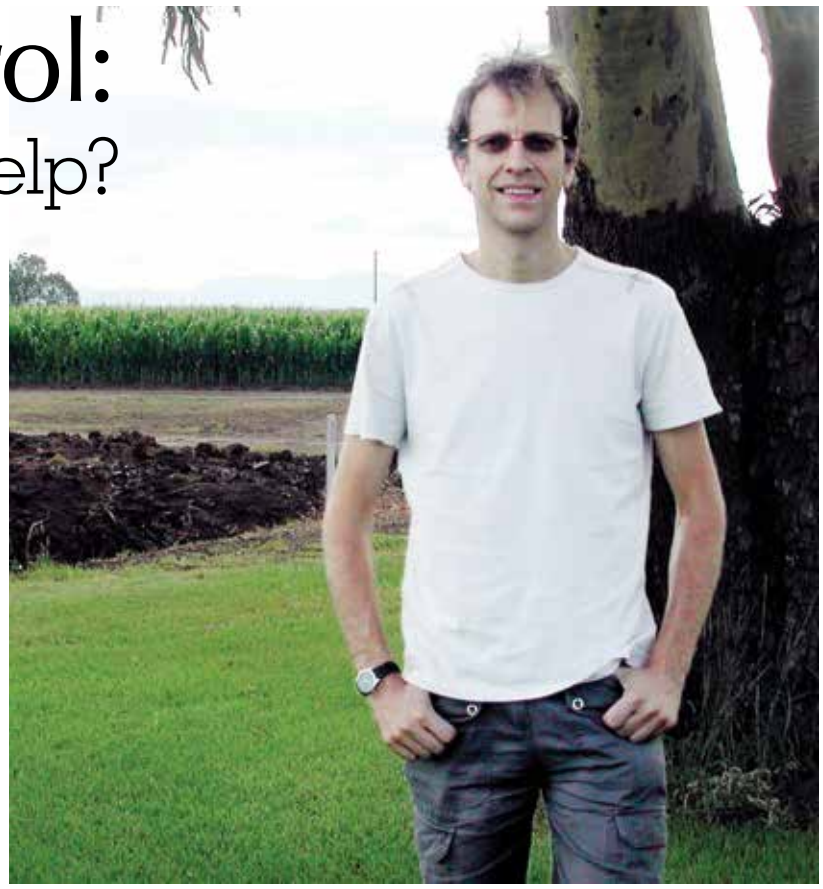
"If native vegetation turns out to be a source for natural enemies and not for pests, we expect that seedlings in arable fields adjacent to remnants have more natural enemies and therefore lower pest densities than seedlings far from native vegetation.

"Likewise, we expect lower pest densities on seedlings in the landscape with a high proportion of native vegetation as compared to the low native vegetation landscape."

Felix said this study will demonstrate the benefits and risks that native vegetation has for natural pest control in cotton as well as other crops.

"This information may improve the integration of biodiversity conservation and agricultural production and assist landholders to manage native vegetation to benefit their industry," he said.

"Ultimately, this information may contribute to the design of pest suppressive landscapes that are less prone to pest outbreaks and will be less dependent on the use of pesticides."



"Even though native vegetation does not contribute to agricultural production directly, it may still fulfil important functions for agriculture and IPM." – Felix Bianchi (CSIRO).

Experimental cotton seedlings and sticky trap - the module contains a seedling with a Helicoverpa egg card, a seedling infested with whitefly nymphs, a seedling containing leaf hopper eggs and a clean plant without insects. This equipment was used to sample insect communities and also assess the rate at which natural enemies remove/parasitise pests.

Study reveals the importance of native and non-crop vegetation

By Abigail McLaughlin

A investigation of the importance of native and non-crop vegetation to "beneficial" insect populations has yielded some useful information for cotton growers wanting to encourage populations of generalist predators on their properties.

The three-year study was undertaken by Ingrid Rencken, a PhD student at the University of New England (UNE), and the results published in her thesis.

'Maintaining and improving biodiveristy on cotton farms will provide a range of habitats for predatory insects," Ingrid said.

"Producers should look beyond the cotton field at adjoining non-crop vegetation and consider its potential in supporting insect predators.

"The movement and mobility of some predators suggests that even those habitats which are further away will have a positive role to play in supporting insect predators."

Much of Ms Rencken's work focused on the role non-crop vegetation (native trees, grasses, shrubs and introduced weeds) surrounding cotton fields play in supporting populations of "beneficial insects" – those species which predate upon cotton "pests".

The study was carried out in Northern New South Wales, in a cotton growing area surrounded by a windbreak of native trees and shrubs, mature river red gums, pastures and dryland lucerne, bordered by a travelling stock route.

A suction sampler was used to collect insects including *Heteroptera, Neuroptera* and *Coleoptera* between July and February each year, and fluorescent dyes and sticky traps were used to track movement between windbreaks and nearby cotton crops.

Ms Rencken found beneficial insects did occupy the windbreaks, and also noticed significant differences in abundance, depending on time of year, rainfall and the application of pesticides.

The insects were found to use the windbreaks as oviposition sites - with different species preferring certain conditions, meaning a range of habitats was needed to support a suite of generalist beneficial insects.

An experiment specifically looked at the impact irrigation had on the arthropod populations in windbreaks. Ms Rencken selected sites in the windbreak which were indirectly benefiting from the irrigation channels and tail drains used to water the nearby cotton, and compared the insect populations there to nearby areas which received no water.

There was no significant difference in the total numbers of arthropods collected in the two sections of the windbreak however, significantly, more of the beneficial predators such as *Araneae, Neuroptera, Coleoptera, Hymenoptera* and *Homoptera* were present in the irrigated section.

Whilst a specific experiment using florescent dye and sticky traps failed to prove movement between the windbreak and the nearby cotton crops, a further study investigating the colonisation patterns of the generalist predators in newly planted cotton, indicated that they colonised fields very early, in some cases two weeks after planting and were highly mobile over distances of 500 metres.

The observed migration distance of 700 metres suggested the predators were not only migrating from adjacent vegetation but also from further afield. This suggests cotton producers ought to take the broader landscape into consideration when looking at the habitats on their properties and adjacent areas.

The regional movement of generalist predators over distances of 10 km was also investigated using three seasons of data collected by researchers at the Australian Cotton Research Institute.

The movement of generalist predators varied depending on the pest pressure, spray activity and spatial pattern of cotton and native vegetation, but again showed beneficial insects were mobile and spatial patterns need to be widened when considering habitat management.

Observations have suggested that predators were not only migrating from adjacent vegetation, but also further afield.

Cottoning on to training bonus

Cotton producers may soon be able to turn their environmental stewardship into a tertiary qualification, thanks to a FarmBis initiative.

A unique project has set out to align national training competencies with the industry's widely adopted Best Management Practice program, BMP.

FarmBis has funded the research as one of its Targeted Industry Initiatives designed to enhance learning outcomes across the rural sector.

The project is being managed by the Cotton Research and Development Corporation under the direction of National Cotton Training Coordinator Mark Hickman (DPI & F : Cotton Catchment Community CRC).

Mr Hickman said the BMP manual principles were widely adopted. A recent industry survey indicated 90 percent of cotton producers adopt the principles. Although not all had sought formal accreditation for their learning.

"It is very exciting that cotton growers or property managers might qualify for a Diploma of Agriculture if their property is BMP accredited."

Mr Hickman said it was expected the project would increase farmer interest in the BMP program and help instil a culture of learning in the industry.

"Leaders within the cotton industry are very interested in the practical outcome of this project. The outcome will value add to an already successful BMP program and cut new ground for education within the industry."

Jason Sinclair is one of three producers who have taken part in a pilot evaluation of the project. Mr Sinclair manages a farm west of Condamine for Peter Corish and is excited by the potential.

"I thought it was a great initiative by FarmBis and jumped at the chance to get a personal qualification," Mr Sinclair said.

"This property has undergone a rigorous assessment as part of the BMP process and we have just undergone a full self assessment of the program. I was also involved in BMP planning at another Corish family property near Goondiwindi," Mr Sinclair said.

FarmBis is a Commonwealth-State training initiative. It has a range of targeted industry initiatives and offers subsidises of 65 percent on accredited business training.

National Cotton Training Coordinator Mark Hickman – "leaders in the industry are very interested in this project".

? For details of courses available, visit the website www.farmbis.gov.au or contact Michael Gilbert in Brisbane on 3239 3064.

Value of benchmarking:

the 2006 Boyce report

The 2006 Boyce Report can be downloaded from www.crdc.com.au or www.cotton.crc.org.au.

For 10 years, Moree-based Boyce Chartered Accountants has been producing the Australian Cotton Comparative Analysis. This summary of the "economics of growing cotton" has been welcomed by the industry as an excellent way to identify and address areas for improvement on individual farms.

CRDC too recognised the value of the report, says CRDC Research Manager Bruce Pyke, when six years ago it joined forces with Boyce Accountants to help fund the preparation of the report into a format that could be made available to all growers. In recent years, the Cotton Catchment Communities CRC has also lent its support.

The most recent report analyses 2006 crop data from a cross section of growers across the Gwydir, McIntyre and Macquarie valleys. (Other valleys were excluded as the sample sizes were not large enough for analysis.)

Every attempt was made to ensure the report's data was meaningful and not skewed by the impact of drought. Growers who grew only skip cotton or whose solid cotton did not receive full water were excluded from the analysis.

The report also advises that it's best for growers to do comparative reviews using the 2002 and 2005 years, as the data from 2003, 2004 and 2006 has still been distorted by drought (e.g. the average hectares planted per participant decreased from 1027 in 2005 to 889 in 2006).

Another consideration was to apply an average price of $375 per bale of cotton sold to each participant's data when categorising them into the "top 20 percent" and other categories used in the report. This ensured that the analysis was not distorted by growers who 'got lucky with price'.

However, it should be noted that each grower's own figures were then used in the averaged results for each category.

With all these controls in place, interesting trends from 1997 to 2006 outlined in the report are:

- The net price per bale is decreasing, $460 to $440/bale – 4% decrease
- The yield per hectare is increasing, 7.4 to 9.3 bales/ha – 26% increase
- The average operating profit per hectare for the average grower is decreasing
- The gap between the operating profit per hectare for the top 20% and the average grower is widening.

However, Bruce Pyke warns that the report should not be seen as a summary of the health of the entire industry and not to over-emphasise the trends.

Instead the main value of the report is for growers to use it to benchmark against their own figures.

"Growers can look at how their expenses are running compared to those in the report to determine where they appear to be tracking well and where they may be able to concentrate their efforts for improvement."

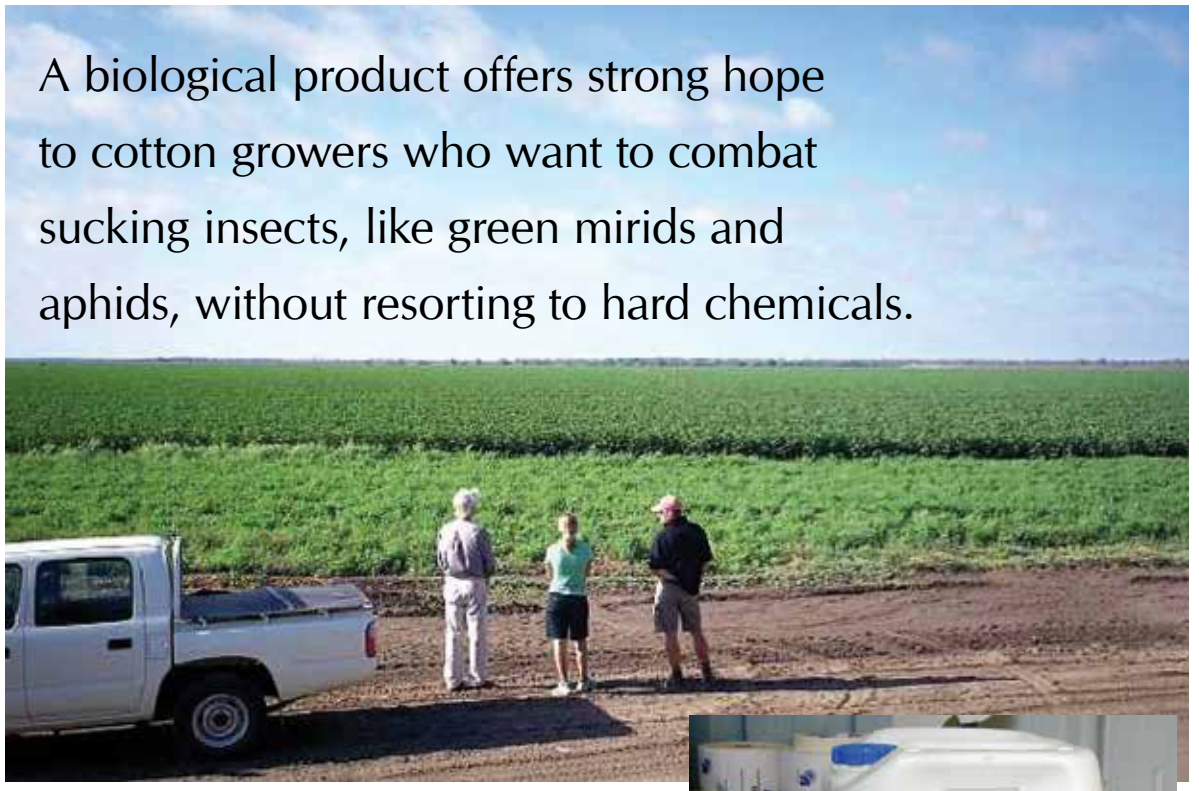
Bruce said the high performers (the top 20 percent) have been able maintain operating profits more effectively than the average growers. They have achieved this by keeping better control of operating costs while continuing to grow high yields, through a combination of attention to detail, improving water use efficiency, maintaining conservative levels of debt, generally exercising good timing with operations and having clear planning and long term vision in tough times.

Throughout the report, there are some excellent questions to help growers relate the findings to their operations. For example: What steps can you take in a "normal" year to keep operating costs below $2,600/ha? Have you investigated group purchasing arrangements? There also a useful calculator to help growers measure their own Return on Assets.

But there is no magic bullet. Even the report's authors admit "This report does not provide all the answers. It is a benchmark or a standard to strive for".

"It's about producing more cotton for a lower cost per bale - if this report can help unravel some clues behind the ways to do this, then it has achieved its purpose," said Bruce.

"We welcome input and ideas from growers as to how they use the report, what value it has to them and what kind of further analysis would be beneficial."



A biological product offers strong hope to cotton growers who want to combat sucking insects, like green mirids and aphids, without resorting to hard chemicals.

Cotton field managed with Green Fire against sucking pests

By Tristan Viscarra Rossel

Bio-warfare on sucking pests

Green Fire will begin the chemical registration process next year.

NSW Department of Primary Industries (DPI) have been investigating a biological extract for two years with its commercial partner, Native Fire Actives Pty Ltd. They have found a formulation, called Green Fire, which has performed well in commercial field trials over three seasons.

Green Fire has proved to be an effective control for green mirids without significant reduction of any beneficial insect populations.

Project leader, Dr Robert Mensah, said that like most biological compounds, Green Fire works by direct kill or modifying the feeding and oviposition (egg laying) behaviour of the insect on the plants.

"Green Fire is actually killing both the adult mirids and nymphs and it also deters the nymphs from feeding after hatching," he said.

"It's a product that can be used in conjunction with IPM. Using a plant extract instead of hard chemicals can minimise the impact on natural enemies. So the beneficial predators and this plant extract can work together to manage insects on transgenic or conventional cotton."

The study has determined the efficacy of different rates of Green Fire on aphids and mirids and compared that with industry standard chemicals such as imidacloprid insecticides for aphids and fipronil insecticides for mirids. Its effect on key predator species in cotton, such as predatory beetles, bugs, lacewings and spiders, has also been investigated.

In the 2005/06 season, the studies showed that all rates of Green Fire above 500ml/ha were highly effective on green mirid adults and nymphs and on apple dimpling bugs, similar to Regent®, a broad-spectrum fipronil insecticide used against mirids.

Researchers also found that both high and low rates of Green Fire did not cause any significant reduction in beneficial insect populations however Green Fire at 1000ml/ha and 2000ml/ha did reduce ant populations, similar to Regent®.

Green Fire did not cause any phytotoxic effect against cotton plants in any of the field trials and cotton yield harvested from Green Fire treated plants was not significantly different from the Regent® treated plants.

In the 2006/07 season, two field trials showed that under low mirid pressure (0.5-1 mirids per metre), Green Fire at 500ml/ha and 750ml/ha worked equally as well as Regent® at half rate (62.5ml/ha). And even at very high mirid pressure (over 5 mirids per metre), Green Fire applied at 500ml/ha reduced green mirid numbers comparable to that of full rate Regent® (125ml/ha).

The 2006/07 season trials also showed that Green Fire may have miticidal activity, with the Green Fire plots having significantly less mite numbers than the Regent® plots.

With the introduction of transgenic cotton plants in the '90s, sucking pests have emerged as a major pest in Australian cotton crops and a survey by Consultants Australia Inc. showed that 40 percent of all insecticide sprays used in the 2004-5 cotton growing season were active against green mirids.

"If we continue to spray these hard chemicals, it might cause green mirids to develop resistance to synthetic insecticides," Dr Mensah said.

"The best way forward is to develop biological insecticides and that is why Green Fire is a very good alternative to other insecticides."

Green Fire is applied exactly the same way as the existing commercial pesticides and is expected to have a similar cost per application.

Green Fire will embark on its chemical registration process next year.

? Dr Robert Mensah, ACRI 02 6799 1525; Robert.Mensah@dpi.nsw.gov.au

Cotton Consultants Australia Inc (CCA) Annual Survey series

By Rossina Gall

Cotton Consultants Australia Inc (CCA) post season grower and consultant Survey Series builds upon 20 years of uniform data collection on cotton production in Australia and provides in-depth benchmarking and forecasting information purchased by CRC, CRDC and cotton supply companies.

"CCA offer uniform data collection which is immensely valuable for showing trends over time," explains CRDC's Bruce Pyke.

"This benefits the entire industry and supports important industry messages such as the decline in chemical usage since implementing Integrated Pest Management (IPM) and GM cotton."

He said that survey information also identifies the impact of R&D and outlines areas needing attention.

Analysed by Western Research Institute (WRI) at Charles Sturt University, the CCA survey could become the independent benchmarking survey for the industry.

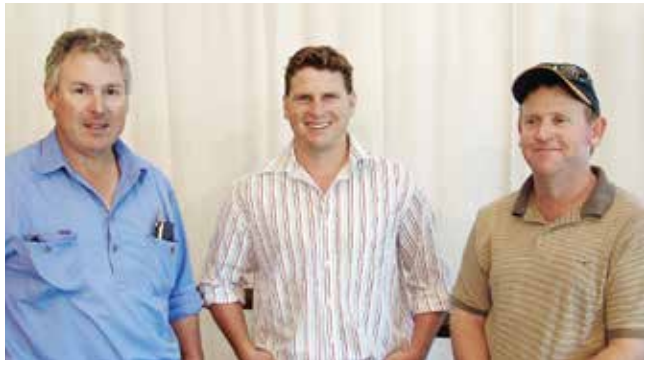
"CCA is in the best position to provide accurate and timely data 'straight from the horse's mouth' and a sole industry survey addresses "grower survey fatigue," says Amber Dimond, CCA executive officer.

In 2006, 122 of approximately 800 growers (representing 19 percent of area planted) completed the survey anonymously. The 2007 grower and consultant surveys are currently being analysed and depending on adequate funding, next year's survey will be posted April and due in June 2008.

Contributors receive an executive summary to benchmark their operation against the entire industry.

? For information: www.cottonconsultants.com.

Chris Dowling and Tom Davison.



Peter Gall, Moree, Justin Ramsay, Moree, Andrew Smart, Precision Cropping Technologies Narrabri catch up after the symposium.

Researchers Oliver Knox CSIRO, Ian Rochester CSIRO, Rob Welsh NSW DPI, James Quilty Syd Uni and Peter Gregg Cotton CRC.

Andrew Smart, Precision Cropping Technologies Narrabri, Veronica Aster, Landcare Inglewood.

The combined knowledge of David Nehl, James Quilty, Oliver Knox, Chris Dowling and Helen Squires was invaluable to both growers and consultants.

Healthy Soils Regional Forums

Healthy soils, healthy plants, healthy profits

Building carbon and organic matter in the soil is the key to improving profitability, according to renowned scientists from CSIRO, NSW DPI, QLD DPI&F, Sydney University and Queensland University of Technology speaking with more than 100 growers and consultants at the "Healthy Soils" forums at Narrabri, Goondiwindi and Hillston in November.

"The forum addressed grower concerns including increasing and maintaining soil carbon and organic matter in dry conditions and how to improve nitrogen use efficiency (NUE)," said NSW DPI soil specialist and Soils Team Leader Helen Squires.

"We also covered the effects of rotational crops, stubble retention and soil biology on soil structure and water holding capacity.

"Managing sodic soils and the benefits of precision agriculture are also a hot topic."

She said that the forum brought together some of the world's leading researchers in their field and that growers could share practical constraints and successes on the field.

Speakers included Chris Dowling of Nutrient Management Systems addressed the reasons soil health should be measured and monitored, while Dr Peter Grace, Professor of Climate Change at The University of Queensland informed the participants of the role of nitrogen fertilisers as a greenhouse gas contributor in the cotton industry.

Leading researchers and scientists from CSIRO, NSW and QLD DPI also had many take home messages.

The March issue, *Spotlight* will cover some of the topics addressed at the forums however if you would like more information now please contact the Soil & Disease Priority Team member in you area.

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Soils & Diseases National Priority Team

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A recent CRDC survey reveals that 90 percent of cotton growers believe there will be soil health problems in the future.

Based on this and grower requests outlined in CRDC's "Soil Health Issues for Australian Cotton Production" survey, the Soils & Diseases National Priority Team was established in May and is ensuring that latest soil health and disease research is disseminated to cotton growers at regional workshops, forums and fields days across Qld and NSW.

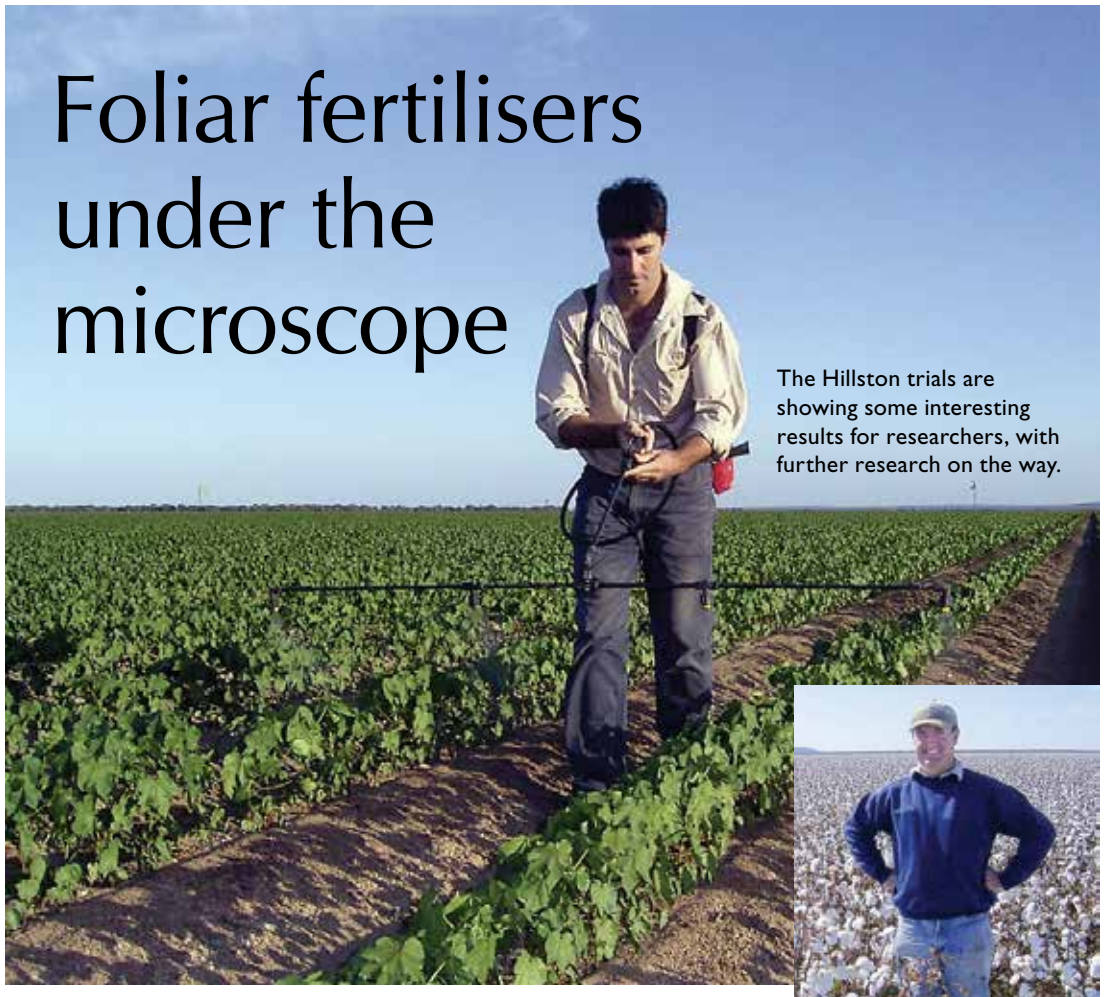
"Its been a busy year with "Healthy Soils" workshops at Mungindi, Dirranbandi, St George and Goondiwindi as well as 'Soil sampling' workshops at Moree and Dalby," said Soils Team Leader, Helen Squires of NSW DPI.

She said that growers are looking for information on measuring soil health and how management decisions, such as chemical usage, controlled traffic and stubble retention have on the overall health and productivity of their soils. Soil biology is also a topic of high interest.

Helen said that the team, along with the Nutrition and Fibre Quality Extension Priority Team, has also developed a set protocol for collecting Nitrogen Use Efficiency (NUE) data this season and that the information will highlight the benefits of some widespread nitrogen management practices.

A series of case studies has also been developed which share grower experiences on soil health issues they have encountered and corrected along with representing credible research. The case studies cover topics from reducing deep drainage to variable rate fertiliser use after cut and fill operations. The case studies will be available on the Cotton CRC web site www.cotton.crc.org.au

Foliar fertilisers under the microscope



The Hillston trials are showing some interesting results for researchers, with further research on the way.

NSW DPI's Barry Haskins has undertaken trials to measure the effect of foliar fertilisers.

byTristan Viscarra Rossel

A replicated field trial at Hillston in western NSW has shown that using zinc, phosphorous, potassium and other liquid-based foliar trace elements showed no increases to either cotton yield or fibre quality.

Project leader and Hillston district agronomist, Barry Haskins, from the NSW Department of Primary Industries said that foliar fertiliser treatments did not result in significant increases in crop yield over untreated plants.

"The yields from both treatment and control sections in the trial were exceptionally high, averaging 12.95 bales/ha at 38.2 percent turnout (although the research gin used in the trial is known to cause slightly higher turnout results than commercial gins)," he said.

"This alone suggests that plant yield was not greatly limited by nutrient deficiencies."

The paddock selected for the field trial was expected to show zinc and phosphorus deficiencies and to exhibit nutrient tie-up as a result of sodic subsoils. Soil tests taken at 0-10cm and 0-60cm confirmed very low nitrogen, phosphorus and zinc levels and highlighted sodicity in the surface and subsurface of the soils.

The field trial aimed to measure the effect of various foliar fertilisers on cotton vigour, health, yield and quality, in a cool season climate. The foliar fertilisers applied were predominantly zinc, phosphorus, nitrogen and potassium based (see table 1).

While there was no significant difference in yield between treatments, tissues tests taken in December 2006 to observe the influence of the foliar fertiliser in the petiole and leaf tissue showed unexplainable variation, which didn't coincide with any of the nutrient treatments. Barry added that only small amounts of nutrients could be taken into the plants through leaf tissue anyway.

"We expected the control treatments to show a nutrient deficiency. It probably was deficient in some nutrients in the leaf tissue tests but we couldn't gain any response using the foliar fertilisers," Barry explained.

The paddock, which had been fallowed in 2005, was managed during the trial for water, nitrogen, pests and weeds. It received 150kg/ha MAP + 2 percent Zn and 115kg N/ha (as ammonia gas) in late April 2007, was sown with the variety Sicot 43BR in October 2007 and received a further 66kg/ha of nitrogen and 2L/ha Microsol® in December 2007. The crop used 12.5ML/ha of water.

Barry said he would like to undertake the trial again, as some of the foliar fertiliser products are anecdotally claimed to benefit crop rigour, waterlogging tolerance and yield, and such benefits may be dependant on seasonal conditions such as temperature.

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Table 1: Product rates and nutrients applied in the trial.

Product	Rate/ha	kg nutrient/ha					
		Zn	N	P	K	S	Mg
Broadacre Zn	3L	0.3					
Quickstart hitrace	7.5L	0.3	0.675	0.45	0.19	0.45	0.24
Fiz	2.2L	0.31		0.37	0.07		
Liquifert Zn+ Urea	1.35kg + 0.85kg	0.297	0.46			0.14	
Knite	30L		1.2		3.6		

Farm manager Justin Ramsay of "Cockatoo" Moree has seen first hand the benefit of healthy soils.

Growers focus on food, water and structure of soil

Cotton growers need to embrace farming systems that encourage natural mechanism in the soil if they want better returns per megalitre said Justin Ramsay at the Healthy Soils forum at Goondiwindi in November.

The manager of Auscott's "Cockatoo" farm near Moree said that healthy soils lead to increased productivity and improved profitability and that cotton growers will incorporate more rotation crops and look at alternate irrigation methods including drip and overhead in the future.

"We found that standard farming practises decrease organic matter, reduce soil water holding capacity and slowly degrade soil causing sodicity surface, crusting, and compaction," Justin said.

"With increasing energy costs including fuel, fertiliser, herbicide, steel and rubber we had to find a better way."

Today, Justin says yields have increased, fallow costs are down and plant soil moisture has improved after concentrating on three main soil components.

"We focus on food (organic carbon), water (improving soil moisture and holding capacity) and structure (physical capacities)," he said.

"We ensure there is a good carbon to nitrogen ratio. We've reduced fallow periods, planted more rotation crops and have decreased the number of passes to two or three.

"We also include green manure and faba beans cover crops with good economical results."

Despite the lack of rain Justin is improving soil structure and soil water holding capacity (SWHC).

"Researcher Ian Rochester says that organic matter holds six times it weight as soil, which holds only 1/3 of its weight," Justin explains.

"We now leave stubble standing over summer and then mulch it to increase organic matter (humus).

"We had difficulty planting directly into stubble, except under pivot, as it caused water logging issue when irrigating.

"Soil to seed contact was initially inhibited by stubble on top of the two metre permanent beds until we started using trash rippers."

He said that Roundup Ready and Flex cotton varieties helped reduce tillage and implementing controlled traffic decreased soil compaction and improved irrigation flow.

Justin said that it is important to work soil at the optimum time and maintain soil tilth. He said historical electromagnetic (EM) data allowed him to target sodic soil areas and apply large amounts of gypsum on smaller areas as apposed to spreading it across the entire field.

"Change is hard but the rewards are there," he said.

James Quilty, University of Sydney and Peter Gregg Cotton CRC were just two of the specialists on offer to answer questions and share their research findings to enable attendees to improve soil health.

Separating snake-oils from valuable organic amendments:

Improving topsoil physical condition

The cotton industry needs research into the impact of soil amendments such as compost teas, microbial ferments, humic substances, blood and bone, kelp extracts and fish emulsions on soil biology, soil structure and organic carbon says Peter Gregg, Cotton Catchment Community CRC.

With funding from CRC, CRDC and University of Sydney, PhD student James Quilty is addressing the industry need and trialing eight soil amendment products, on cotton farms at Trangie and Hillston over the next three years

"Trials commenced in August at Trangie, where I applied rate and double rate of blood and bone, humic acid and a kelp extract prior to planting on three cotton farms," says the 31-year-old agricultural science student.

"In May I will apply chicken litter, fish emulsion, a biological inoculant and possibly a composted gin trash at three more cotton farms in Hillston.

"I am also undertaking a greenhouse experiment applying varying rates and analyzing effects of herbicides in conjunction with the products."

James monitors the crops and soils throughout the season and measures microbial biomass carbon using a fumigation technique. The total soil organic carbon will be measured using the Leco CHN elemental analysis method.

Changes in structure and stability of the top five to 10cm of soil will also be investigated. Structural change in the surface crust can greatly impact on infiltration rates and seedling emergence.

"Studies suggest that organic amendments can have a positive influence on soil structure, plant growth and yields and a lot of growers and home gardeners are currently using them. If these products do what manufacturers claim then the next exciting challenge is economically incorporation them into a broad acre farming system," he said.

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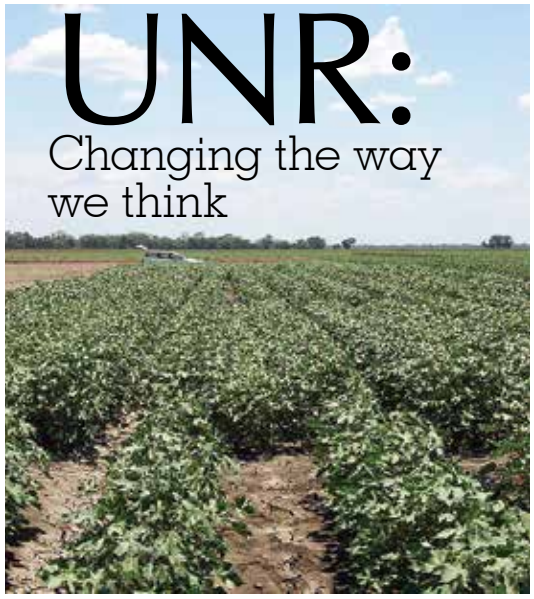
UNR: Changing the way we think



By Melanie Jenson and Rose Roche

Unravelling the complexity of 'ultra-narrow row' (UNR) cotton's growth and development has discovered that on average, lint yield is higher when cotton is planted in rows less than 40cm apart.

"Previous experiments across Australia and the US were inconclusive about the yield and maturity benefits of UNR, so we wanted to once and for all pin down the facts," says Rose Roche, who has conducted six years of field experiments as part of her PhD with The University of Queensland and CSIRO Plant Industry.

"Across all our experiments the average lint yield in UNR plantings was 16 per cent higher than in one-metre spaced rows."

However, yield differences were not consistent, ranging from four bales/ha higher to no difference at all.

A key finding of this research is that competition between plants occurs very early and is much higher than expected in UNR plantings – as a result plants don't grow as quickly or as big and hence reach maturity at the same time as one-metre rows – as opposed to UNR theory which predicts earlier maturity.

This was a growth response of cotton previously not accurately documented and will change the way we think about how cotton grows in different plant populations, across all row spacings.

"While UNR looks like a promising option for higher yields, CSIRO is conducting further research and evaluation of agronomic requirements and economic benefits to understand under what circumstances growing UNR would be a consistently better option," Rose said.

"This has included irrigation and nutrient management; planting rates; harvest efficiency and fibre quality.

"I have been working closely with growers to capture their ideas/experiences with growing UNR and a major part of this project has been through collaborative experiments on farm to evaluate the whole system."

This will result in a large scale review and analysis involving, growers and extension staff through workshops and focus groups – leading to a set of guidelines/recommendations for growing UNR.

"As part of this review we will be getting experiences/advice from UNR growers to ensure that it covers all aspects of growing UNR," Rose said.

"Some of the ongoing research includes a detailed investigation of the impact of early season water management to increase early growth of UNR cotton.

"We are also investigating in more detail the impact of plant configuration on fibre maturity in the smaller bolls produced in a UNR crop with Mike Bange and Stuart Gordon from CSIRO."

Mike Bange says Rose Roche's work showed that cotton grown in narrow row populations had less bolls of varying ages.

"It is possible therefore that fibre properties of narrow row populations, and in particular the distribution of fibre properties between bolls, are more consistent than conventionally sown cotton that have more bolls initiating at different times during the boll-filling period," he said.

"We have collected samples from these trials to assess whether this is the case.

"We will be using measurements from the HVI located in Narrabri as well as the AFIS PRO, Cottonscan and SiroMat instruments located at CSIRO Textile and Fibre Technologies in Geelong, the latter two instruments being used to compare the cotton fibre fineness and maturity of collected samples.

"If results are promising we will also utilise the miniature spinning system also located in Geelong to assess whether cotton produced this way offers any textile benefits."

This research was supported by the Australian Cotton CRC, the Cotton Research and Development Corporation, Cotton Catchment Communities CRC and grower collaborators.

? For further information: Rose Roche 02 6799 1594 www.csiro.au/plantindustry <link to fact sheet>

In May this year, the industry's future leaders gathered in Goondiwindi. Pictured are Back row L-R; Shawn Fleischfresser (Dalby), Nigel Burnett (Emerald), Meg Kummerow (Pittsworth), Brendon Warnock (Narrabri), Dale Clark (Warren), Brendan Barry (Mildura), Philip Firth & Paul Hawkins (Wee Waa), Greg Hutchinson (Moura), Daniel Hayllor (Dalby), Mitchell Carter (Narrabri), Dallas King (St George), Rod Gordon (Goondiwindi). Front Row;L-R Sandy Young, (Narrabri), Rose Roche (Narrabri), Melinda Crockett (Narrabri), Will Kirkby (Moree), Ross Burnett (Emerald), Daniel Skerman (Dalby), Annabel Wiseman (Emerald), Fleur Anderson (Theodore).

Cotton's future in good hands

In September, 21 potential cotton leaders including 14 growers, a researcher, a merchant, four consultants and two extension officers completed the inaugural Australian Future Cotton Leaders program.

Funded by Cotton Australia (CA), Cotton Research and Development Corporation (CRDC) and Commonwealth Department of Agriculture, Fisheries and Forestry, the unique leadership program addresses industry succession planning and supports selected individuals wanting to take on leadership roles in the future.

"The industry needs to support its active and talented people. The program provides necessary and relevant skills to accelerate them along the leadership pathway," explains Cotton Australia chief executive officer, Adam Kay.

Delivered via tele-seminars, email and face to face sessions, the five month program develops communication skills including public speaking, negotiation, conflict resolution and media and public relations. Participants also develop individual projects with guidance from experienced mentors from various industries.

"The highlight for me was Mentormatch. It's brilliant to build a relationship and get advice from a person with years of experience," says 26-year-old, Mitch Carter, AIM (Advanced Irrigation Management) Consultants in Wee Waa.

"I also found the communication and personality styles information very relevant."

Helen Dugdale, CRDC said the participants are outstanding and that a further $1000 per participant was allocated as a travel bursary to undertake extra courses. She said that participants found the experience inspiring and positive especially during a tough drought period and that the program showed the industry's willingness to support its emerging leaders.

Graduates of the program say they hope it continues and that they are now confident "to become more involved in their local area", "to step forward when called upon to represent the industry," and "to become more involved in promoting and developing the industry."

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Research into PAM's potential

By Tristan Viscarra Rossel

Soil that is low in organic matter can limit agricultural production through surface crusting, soil compaction, poor aeration, impeded root growth, poor water penetration and erosion.

Soil conditioning through chemical amelioration or organic matter supplementation can improve soil structure to overcome these problems.

Polyacrylamide, or PAM, is a long-chain hydrocarbon of high molecular weight that is synthesised from natural gas for a range of environmental and industrial uses. It is frequently used in Australian cotton production as a soil conditioning agent.

A recent study undertaken by the National Centre for Engineering in Agriculture at the University of Southern Queensland and E.A. Systems Pty Ltd in Toowoomba estimated that one in five Australian cotton fields are currently being treated with PAM, mainly to reduce irrigation-induced erosion and increase infiltration in soils with low infiltration capacity.

Although PAM is being investigated by growers, suppliers and researchers for its potential to mitigate seepage and evaporation from dams and channels, the scientific basis for this remains unknown and its practical application remains difficult.

The purpose of the study, *Desktop review of polyacrylamide use in the Australian cotton industry*, was to establish the extent to which PAM was useful in the Australian cotton industry, to identify knowledge gaps and to make recommendations for future research, development and extension.

One potential threat for the industry to examine is that some PAM formulations can contain impurities such as acrylamide (AMD), which can be toxic to aquatic organisms and humans.

AMD is a human neurotoxin which may cause skin and respiratory tract irritation and is classified as a probable carcinogen.

Fortunately, food grade quality anionic PAM of high molecular weight is possibly the best PAM formulation for land and water application because it is highly soluble and most pure, capable of providing substantial benefit at extremely low concentration.

The report found, however, that there is very little information about how PAM breaks down in the soil but AMD is one of its known breakdown products.

Alarmingly, there is also little information to demonstrate how to remove PAM from the soil once it has been applied.

Another issue is that lack of understanding of the scientific and technical requirements for successful commercial application of PAM has produced inconsistent results.

For example, when PAM is applied as a liquid in the irrigation water, its benefits are highly sensitive to dosage rate, water quality and soil type.

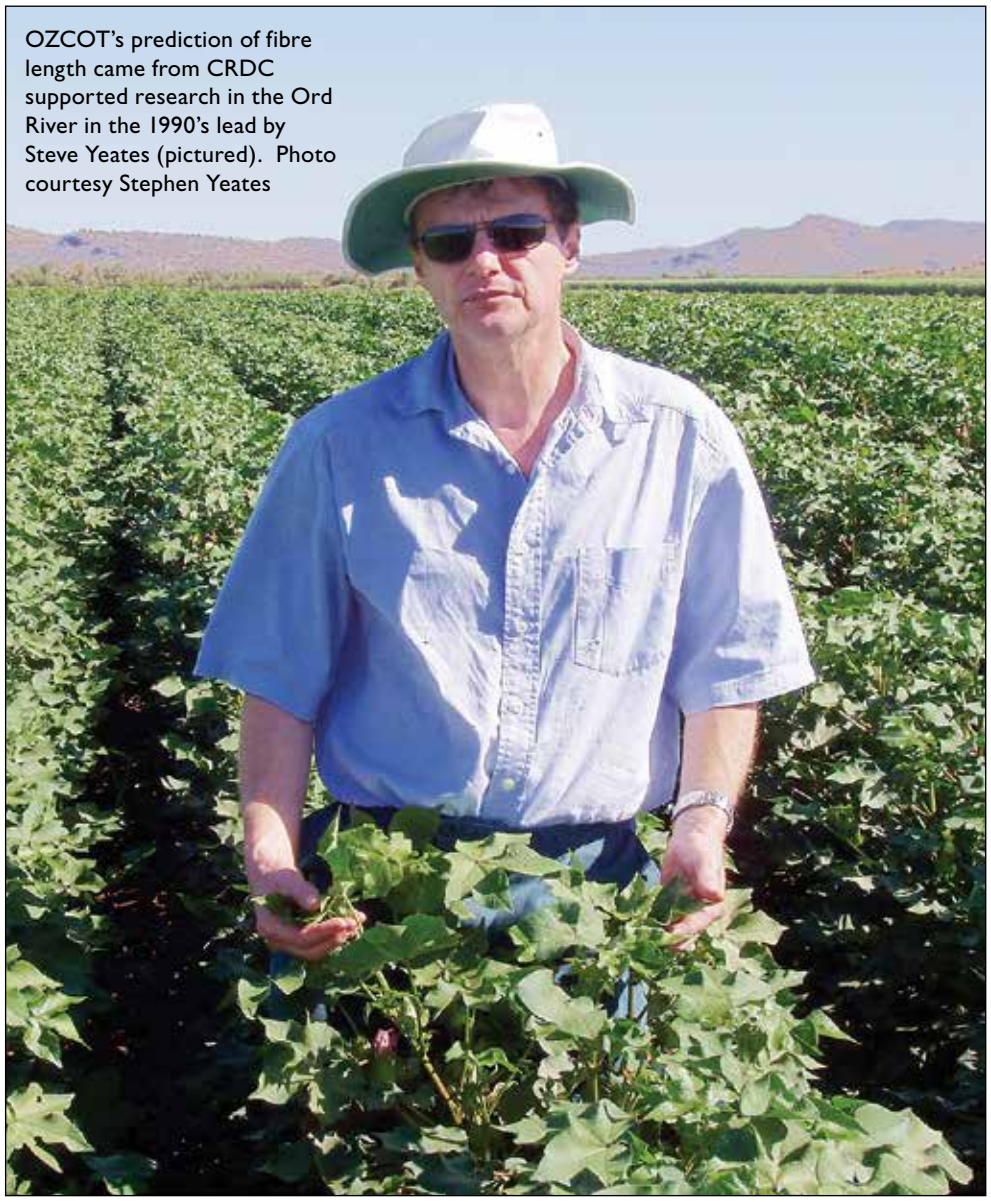
The report recommends research, extension and education about the practical application of PAM for cotton growers, with the development of a best practice method to help growers reap beneficial, long-term results.

The report also recommends a collaborative research effort in the application of PAM to mitigate seepage and evaporation from dams and channels to better understand this opportunity.

Towards best practice

1. Establish why the PAM is to be used to help dictate dosage and management.
2. Consider all options of soil erosion control, such as changing siphon size at the field ends, wheat stubble or organic matter supplements.
3. Describe the soil, particularly the infiltration characteristics, before and after PAM use.
4. Assess the quality of the irrigation water and measure the rate at which water is being delivered to the field.
5. Design PAM dosage after collating all information.
6. Collect sufficient data to assess the impact and benefits of long-term PAM use.

? Download the full report, Desktop review of polyacrylamide use in the Australian cotton industry, at www.crdc.com.au



OZCOT's prediction of fibre length came from CRDC supported research in the Ord River in the 1990's lead by Steve Yeates (pictured). Photo courtesy Stephen Yeates

Predicting fibre quality with OZCOT

By Tristan Viscarra Rossel

The OZCOT cotton growth model has been used for many years to help scientists and industry to predict how climate and management affect cotton yields. This helps to identify better management strategies.

Dr Mike Bange of CSIRO Plant Industry said that OZCOT is one of the most powerful research tools available to the Australian cotton industry.

"OZCOT integrates knowledge about how cotton grows and it's also a valuable repository of cotton physiology knowledge," he said.

"We use it to communicate information about the risks associated with different management practices and climate."

New science is being incorporated into OZCOT so that it will be able to predict fibre quality as well as yield.

According to Mike, this is an exciting development because it will allow researchers to look at the impact of different crop management strategies on both yield and quality together.

"Researchers can use historical climate records to evaluate the risk of different cotton crop management strategies for both yield and fibre quality. Ultimately it can be used to develop guidelines for the management of cotton to optimise yield and quality."

Recent CSIRO research in Narrabri is improving the model's ability to simulate the development of fibre quality.

Dr Greg Constable developed a concept module for OZCOT to simulate fibre quality development but it required data to improve its accuracy and robustness. It was simulating fibre length well, but not micronaire.

Interestingly some of the data for fibre length came from research in the Ord River region, which has a wide temperature range during fibre elongation.

Over the past two years, Mike and other CSIRO scientists have collected the data required to improve OZCOT. This new research has allowed Mike and Greg to review the way the model estimates micronaire and develop a new temperature function to improve predictions of micronaire.

CSIRO and Cotton CRC scientists are continuing to enhance the model. Then the benefits of assessing long-term climate data and new management strategies will be available to cotton growers and farm advisors.

? Dr Mike Bange, CSIRO Plant Industry
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OZCOT – Australia's unique cotton model

OZCOT is a predictive cotton crop growth model, originally developed by Dr Brian Hearn at CSIRO Plant Industry, which uses information about soil, climate, irrigation and variety to predict cotton growth and yield.

While OZCOT is essentially a science model, with mathematical expressions that represent cotton growth and development, it's not just a research tool. Other applications include:

1. Used with long-term climate records to evaluate suitable locations and row configurations for dryland cotton, and to clearly understand the variability in yield performance.
2. As the engine in HydroLOGIC, a decision support package that evaluates irrigation scheduling strategies to optimise water use efficiency or yield with limited irrigation supply.
3. To assist management and agronomy development for expansion into southern NSW and northern Queensland. Unsuitable temperature (such as late or early frost) and rainfall patterns (such as during harvest) can be identified through long term climate records.
4. Used in the APSIM developed by the Agricultural Production Systems Research Unit to assess the impact of cotton within cropping systems.
5. With the climate change debate, OZCOT is being applied to gather yield and water use efficiency estimates from increased CO2, higher temperature, more evaporation with more variable climatic conditions. This information can help design research to develop climate change enabled farming systems.

Stephen Yeates of CSIRO Plant Industry said that the science captured in OZCOT comes from literally hundreds of field experiments over the last 30 years.

"OZCOT is not a static model; an ongoing effort ensures that new understanding of cotton growth or agronomy is captured," he said.

OZCOT has the capacity to account for different soil types, regions, varieties, insect damage and aspects of crop productivity, including plant spacing, explained David Johnston, also of CSIRO Plant Industry.

"The programming is steadily improving to take advantage of new techniques. This will allow OZCOT to interact better with other models, expanding its capabilities and make it more widely available within the Australian cotton research community," David said.

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2007-08 research project summaries

The following summaries are from research papers presented at the conclusion of projects funded from CRDC-funded investments.
For full reports and further details, contact your cotton industry extension officer.

CSP184

CSIRO Fibre Quality Lab

By Greg Constable

This project part funded operation and maintenance of HVI900 and FMT3 cotton fibre testing instruments and associated air conditioning in CSIRO's fibre testing laboratory at ACRI for the 2006/07 season. The laboratory supports measurements of fibre quality from cotton experiments in CSIRO's breeding program and research projects by other organisations and projects with more than 20,000 samples tested by HVI and 10,000 samples by FMT.

Global cotton production and market dynamics indicate Australia needs a future edge with fibre quality. This means developing varieties, management and processing to ensure better fibre, with possible opportunities for premium fibre products. Thus CSIRO cotton breeding program raised the emphasis on developing improved fibre varieties.

Negative associations between yield and fibre quality are challenges for variety development. We have accurately measured these associations and ensure the rare combinations of high yield and quality can be identified. Accurate measurement of fibre quality is an important component of that work. Progress has been good, with improved fibre length achieved in high yielding varieties and breeding material with premium fibre identified.

Note: this project supported the operation of a fibre quality laboratory at ACRI to service most research projects. Specific details on fibre quality results are listed in those project reports.

CSE113

Release and post-release monitoring and follow up release of Eretmocerus hayati in cotton production areas

By Paul de Barro

Eretmocerus hayati was first released in late October 2004 and over two and a half years it spread as far south as the Sydney Basin, into northern NSW cotton production areas, in Qld from the NSW border to the Burdekin and as far west as St George, Roma and Emerald; coverage throughout this area is now complete.

However assessing impact is not straightforward as a recent survey showed areas in coastal vegetable production areas that silverleaf whitefly numbers were considerably lower and many growers had either not intervened against the whitefly or had greatly reduced the need for pesticides.

Drought and subsequent lack of crops and weeds have made it more difficult to assess probable impact. Work in vegetable production systems in Bundaberg has shown silverleaf whitefly is better able to colonise crops at a distance <2 km from the nearest source in order to achieve optimal colonisation by the parasitoid.

The release of E. hayati has been a remarkable success and suggests it has considerable promise as a control agent. Next is to combine on-farm management decisions with our knowledge of landscape features such as farm layout and cropping composition to understand circumstances which affect the capacity for the parasitoid to effectively control silverleaf whitefly. A grower management guide can be then developed on how to encourage the parasitoid to colonise crops to achieve a sustainable reduction in the use of pesticides and associated costs.

CSP167

Cotton Biotechnology: Core Project

By Danny Llewellyn

Transgenic Ingard, Bollgard II and RR cotton varieties have already demonstrated potential to revolutionise insect and weed control options in our industry, but variety development does not end with the first releases of new transgenic cultivars.

Plant breeding is an ongoing process, with improved varieties with better agronomic performance and in some cases improved transgenes. The first Bollgard II cultivars are now giving way to improved varieties with better yield and/or Fusarium wilt. Over the three years the main objective was to support the replacement of RR cotton with RRFlex in the best available BG II cultivars, resulting in CSD's release of three new BRF varieties in 2006 and (Sicot 70BRF) in 2007. Other material screened will become varieties in the future and these new BRF varieties will impact on profitability and sustainability through better weed and pest control.

The project also provided support to the breeding program by assisting with the introduction of new conventional and transgenic germplasm through quarantine to provide new sources of traits for enhanced disease resistance and enhanced fibre quality. The project has also helped produce novel or experimental cotton germplasm for other co-investment biotech projects by producing transgenic plants that contain gene constructs that may help in the development of new traits in cotton (like waterlogging tolerance) or that help extend knowledge of how particular genes work during cotton fibre growth. This ensures CSIRO has the relevant expertise to take advantage of new developments in biotechnology and increases its understanding of the molecular controls that underpin important biological processes like fibre yield or fibre quality and so provide novel targets for transgenic manipulation or selection.

CSP181

Enhancing cotton research capacity at ACRI through superior IT support

By Tony Pfeiffer

An efficient and world standard computing system at ACRI has benefited research programs through data processing, storage, statistical analysis, modeling and development of end-user packages. The network also provides printing services and communication. These services underpinned the quality of research conducted at ACRI and personnel rely heavily on uninterrupted access to computing support.

This project enabled ACRI to operate its computing services as a whole. Supporting IT in this way is the most efficient and cost effective means for the cotton research effort by:providing ACRI cutting edge IT technologies making ACRI a world class research facility for dedicated cotton research;going beyond generic services provided by research institutions based in capital citiesensuring timely access to IT services; avoiding duplication and fragmentation of IT resources by different institutions at ACRI; and ensuring ACRI has an IT champion leveraging significant resources from the CSIRO and NSW DPI.

The systems manager now supports 63 CSIRO, 49 NSW Ag and 10 other computer users. and supports the network servers and phone system.

CSP156

The potential for native Fusarium to give rise to new cotton field pathogens

By Bo Wang

Genetic variation among 348 isolates of Fusarium oxysporum f.sp. vasinfectum (Fov) were collected from diseased cotton plants in 31 fields in six cotton-growing regions in SW and Queensland in 2002 and 2004.

Twenty-eight haplotypes were identified based on 146 polymorphic bands. The haplotypes separated into two distinct groups with 21 in group I and seven in group II. The two unique vegetative compatibility groups of Fov known to occur in Australia (VCG 01111 and VCG 01112) were correlated to the two AFLP groups. Group I was widespread, occurring in all regions sampled and all but one of the fields, while group II was limited to three fields in the Boggabilla region. Group I was further divided into two subgroups. The two haplotypes in subgroup I-B (I-20 and I-21) may represent the emergence of a new form of Fov. No spatial population differentiation was discernible at the national level. When each region was analysed separately, clear differentiation was found in the Boggabilla region.

CRC104

Effectiveness of foliar nutrition

By Lindsay Campbell

The salts of many essential plant nutrients are soluble in water and may be applied to plant leaves directly as a foliar fertiliser. This practice has become widespread in the American and Australian cotton industries over the past 20 years as a means of correcting crop nutrient deficiencies and supplying nutrients to plants during peak demands when root uptake may not be adequate to meet plant demands. The efficacy of these foliar fertilisers, and the yield and quality benefits that may be obtained is debatable. Variable plant responses to foliar fertilisers have been recorded, ranging from yield increases of 30 percent to a reduction in photosynthesis and leaf functioning. Knowledge about the precise mechanisms of penetration of foliar applied chemicals is limited, and the factors contributing to the effective uptake of foliar applied nutrients are insufficiently understood to explain the highly variable yield responses recorded. This review will examine the factors affecting the penetration and uptake of foliar applied nutrients, and discuss the potential of this practice to supply nutrients to developing crops and supplement soil fertilisation in a commercial system.

CRC114

Roundup Ready Report

Triple Bottom Line Reports from Cotton Consultants Australia

By Brendan Doyle

This report outlines the results of research undertaken by Cotton Consultants Australia (CCA). The research was conducted by the Institute for Rural Futures at the University of New England.

CCA conducts the annual qualitative survey of agronomic consultants to the cotton industry.

Data are drawn from this survey to outline weed management issues in the industry and to illustrate the performance of Roundup Ready Technology. Sections 2 and 3 of this report present information from this data source.

CRC119

Travel: Scientific Exchange Oliver Knox - 6th Pacific Rim Conference, Canada

By Oliver Knox

The poster, 'Evaluation of border cell number and Cry protein expression from root tips of Gossypium hirsutum (Oliver G.G. Knox and Gupta V.S.R. Vadakattu), was well received and generated plenty of interest among the 90 attending delegates as well as some interesting debate. The keynote address was given by Miguel Altieri. His views on the requirement for the application of precautionary principals, that GM soybean is a cause of Amazon deforestation, that Bt crops provide no enhancement of diversity or abundance, and that GM crops are the product of commercial companies with no consumer requirement, were all issues that were refuted in almost every talk that followed.

Of the subsequent sessions (there were no concurrent sessions at this meeting) there were several areas in which my understanding of Bt in the environment was greatly enhanced. I was particularly interested to note that after nearly 50 years of Bt use there is still much unknown about Cry proteins' mode of action.

The session on novel toxins featured a lot of work on parasporins. This group of proteins are closely related to the Cry proteins that appear to have a non-haemolytic anti cancer action. The future development of this area of Bt research should be truly fascinating.

The session on public safety was short, but there was overwhelming evidence for the low environmental and human health concerns involved in using Bt and its derived formulations and technology.

CRC108

Spray Application Training - Darling Downs, Qld & Rowena

By Bill Gordon

Two Spray Drift Workshops were held at Norwin Hall and St Ruth Hall in January. The workshops were designed to give participants a working knowledge of nozzles and application parameters that reduce the risk of spray drift but maintain efficacy of the products used. Outcomes included;

- All respondents thought that the workshops were worthwhile and they gained extra useful and relevant information.
- Approximately 30% of respondents changed their nozzles to produce coarse droplet spray quality. The other 70% of respondents were already running with nozzles that produce a coarse spray quality.
- The respondents noted that the four main areas where they gained extra knowledge was on droplet behaviour, weather conditions, nozzle selection and planning.
- 21 participants expressed interest in undertaking the commercial applicators course.

CRC121

Travel: Scientific Exchange Stella Loke - 5th International Conference on Mycorrhizas, Spain in July 2006

By Stella Loke

I feel that the trip was particularly successful. In my own research I have found that diverse communities of arbuscular mycorrhizal fungi (AMF) actually survive in the cotton cropping soils at Narrabri. Before I started my PhD it was generally considered that AMF are sensitive to agricultural practices and that diversity is low in these systems. In Spain I met with several people who have also found high AMF diversity in cropped soils. This was very exciting. I also had many queries about the AMF PCR primers I developed during the project.

CRC120

Travel: Scientific Exchange Michael Bange - Beltwide Cotton Conference 2006 and Texas A&M University

By Mike Bange

- Attended a workshop prior to the conference 'Optimising irrigation management in cotton production systems'.

Attending this gave me an opportunity to participate in an American industry workshop addressing water use efficiency. There was no new information or research presented that was not being covered by Australian research and extension efforts.

- Attendance at the 2006 Beltwide cotton conference.

The emphasis in the agronomy area was on the release of Round-up Ready Flex. Many agronomy and physiology studies were initiated in all the states to test the performance of Flex under different agronomic regimes as there was a belief that the varieties containing RRF were released relatively early and did not have the performance of conventional counterparts. In fact, the recommendation from Monsanto was not to plant any more than 50 percent of RRF or mix the varieties on the farm. There was also considerable discussion on weed resistance to Roundup and on weed management. Many of the topics were already covered in our Weedpak.

There was also considerable emphasis on testing different practices on fibre quality. Many studies had incorporated economic analysis including assessment of fibre quality on textile performance using micro spinning technologies. Many of the studies mentioned were also being conducted in Australia.

I was able to meet with agronomists and physiologists and discussed plans for collaboration, namely in the areas of fibre quality and for screening for tolerance for abiotic stress (namely temperature and water).

- Presentation of the paper 'Factors influencing crop maturity in Cotton'.

- Met with Professor Tom Cothren Texas A&M College Station

Dr Cothren is a joint supervisor of Nicola Cottee's PhD exploring means of identifying tolerance to abiotic stress among genotypes in cotton. I discussed with Dr Cothren the planning of Nicola's research program whilst she visits with A&M. Nicola will have the opportunity to repeat her field experiments conducted during the 2005/2006 season at Narrabri as well as participating in studies that will explore her techniques with other abiotic stresses as well as being exposed to other novel approaches employed by Dr Cothren's research group.

- Met with both Giovanni Piccinni and Daniel Munk

Both researchers are interested in conducting a sabbatical with researchers in Australia. Dan Munk will arrive in Australia shortly.

- Travelled to Blacklands Research Station.

I gave a presentation on the development and delivery of decision support and simulation modelling in the Australian cotton industry. I also met with their new simulation modeller Armen Kemanian. He will be travelling to Australia in the near future and I encouraged him to visit Narrabri. There are significant opportunities for establishing collaboration in the area of cotton simulation modelling for in-field and whole farm management of natural resources.

CRC61

Development of a field method for measuring deep drainage potential

By Alex McBratney

The efficiency of surface irrigation is influenced by the water infiltration and drainage characteristics of the soil. Deep drainage is the downward flux of water below the depth to which plant roots can extract water. Excessive deep drainage can lead to the development of shallow water tables and subsequent problems of secondary salinisation. In addition, drainage losses beyond the root zone are wasted resources.

In the past, deep drainage has been neglected due to the belief that the heavy clay vertosols, on which a large proportion of irrigated cotton is grown exhibits negligible water loss. However recent studies have highlighted the potential for appreciable drainage on the cracking clay. To enhance the efficiency of irrigation, the hydrological processes affecting soil water flow need to be understood and the rate of deep drainage need to be known.

Various methods have been proposed for measuring deep drainage. Direct methods are using lysimeter and soil flux meters and indirect methods are based on soil-water balance, Darcian flux, and the use of water-borne tracers. These methods need specialised and expensive instruments, measurement is quite tedious, requires technical skill and can be expensive. Most of these methods are employed for research purposes.

Under irrigation the rate of deep drainage can vary considerably over a field due to spatial variation of soil properties, the uniformity and quantity of water application. Thus to quantify the rate of deep drainage a considerable number of samples are needed to represent a field. There are also methods that estimate deep drainage based on modelling and inferring deep drainage from soil data, electromagnetic sensed data or environmental variables. Soil-water balance or salt balance models have been used extensively.

Current estimates on the rate of deep drainage for irrigated cotton soil are based on models that are simplification of reality and rely on many assumptions. Mainly due to the high cost and the limited resources (e.g. lysimeter), limited measurements have been made. Thus a cheap and easy way to estimate the risk of deep drainage is needed urgently, which is the aim of my research.

UA11

Postgraduate: Damien Lightfoot – Fibre improvement through modulation of transitions in cotton development

By Damien Lightfoot

A major challenge facing the cotton industry is crop loss due to insect attack. The primary insect pests of cotton preferentially attack the boll and damaging the fibre. The recent introduction of Bt-transgenic varieties, containing genes with anti-pest properties from the soil bacterium Bacillus thuringiensis, has had positive impacts on pest control and pesticide usage. These transgenes are under control of constitutive promoters, resulting in endotoxin expression in all parts of the plant. This constant high level transgene expression may have several detrimental effects, such as placing strong selective pressure on pest populations to develop resistance, non-target effects of the transgene on other organisms, a yield penalty to the plant, and the presence of transgenic protein in secondary commercial products.

For these reasons, this project aims to identify promoters that could be used for tissue-specific expression of anti-pest molecules in only the boll wall of the plant.

As a result cotton promoters were identified which could provide an alternative tool to constitutive promoters for use in future transgenic varieties.

Why I love my science job

Researchers and scientists are a key driving force behind the cotton industry.

Science is what many management decisions are based on in the cotton growing industry – it is science which has allowed the industry to be a forerunner in agriculture and to stay ahead of potential problems by being proactive.

Scientists are on a perpetual voyage of discovery and can contribute to the fabric of society and the future of agriculture through their discoveries.

The range in career opportunities for scientists to be a part of the industry are almost limitless.

What attracts people to the world of science and what do they find when they get there?

In this feature, Spotlight writer Rossina Gall catches up with five of the industry's young scientists and finds out what they love about their jobs.

Jo Price

BSc; Grad Cert Rural Science (Cotton), UNE

When asked why Jo Price loves her job, she replies "I still love science, the people I work with are great and I find it very rewarding to know that this research is helping cotton growers".

The outgoing 27-year-old Technical Officer works with Dr Ian Rochester at CSIRO Plant Industry at ACRI at Narrabri, sampling cotton crops across the industry, conducting nutrient analyses of both soil and plant tissue samples.

At school Jo knew her natural ability and interests lay with science.

"I enjoyed biology in year 12, particularly learning about the structure and function of living organisms," she said.

After studying Science at The University of New England, Jo was gained her position with CSIRO.

"Results of the research with Ian have been included in the NUTRIpak manual and will be incorporated into the revised NutriLOGIC decision support system," Jo said.

Having grown up on a sheep and cattle property just outside Inverell, Jo understands the importance of continually improving practices to ensure a prosperous and sustainable future for Australian agriculture.

"I have just completed a postgraduate certificate in cotton production which has been invaluable in terms of extending my knowledge and understanding of cotton production," Jo said.

Helen Squires, BSc

"When it came to choosing a career path it changed every second week for me, but when it came down to it I always knew I would work in science or agriculture," says Helen Squires.

"I was always making up experiments and watched every single nature documentary I could, I guess you could say I was David Attenborough's TV child."

After completing a Bachelor of Science, majoring in soil science at the University of Sydney, Helen worked in property planning in Southwest Western Australia on mixed cropping and grazing enterprises.

"If I was told 10 years ago that I would be working with soils, I would have laughed," says the 26-year-old Soil Specialist with the Cotton CRC Extension team.

Helen Squires grew up in the hills at Niangala south east of Tamworth on a sheep and cattle farm, a very different outlook to the flat country surrounding Narrabri, where she is currently based.

Today she dedicated to extending the latest research and information regarding soil health to cotton and grain growers in NSW and QLD.

"I love that my job as it allows me to play an active role in the extension of innovative science which allows growers to make positive changes on their farms."

Warren Conaty BScAgr

When it came to choosing a university degree, Warren Conaty was torn between his love of plants and animals, but a recommendation to study agriculture, as it offered a more diverse course then veterinary sciences was heeded.

"This was an excellent decision as I soon realised learning names associated with a sheep's digestive system was not much fun," he says.

Later, enjoying the research aspect of his honours study so much, a move into scientific research took place, away from Warren's initial choice, agronomy.

"I have always been very interested in plants, so it seemed the natural decision to study botany and plant physiology," he said.

"My honours thesis on the physiological effects of water logging on range of cotton genotypes at ACRI gave me the opportunity to continue my studies in cotton physiology."

The 22-year-old PhD student applied for a CSIRO scholarship funded through Cotton CRC and is based in Narrabri exploring irrigation scheduling through plant based measurements and believes water use and water use efficiency will become increasingly important in all Australian agricultural industries as competition between users and the environment increases.

"I am passionate about working in the Australian irrigation industry to contribute to the sustainability of the cotton industry through my research," he said.

Dr Michael Bange
B.App.Science Rural Technology; PhD Crop Agronomy/Physiology

"For a researcher the challenges are often big, but when someone changes, even slightly, because of research I did it makes all the effort worthwhile," is how Dr Michael Bange describes a highlight of working as a Principal Research Scientist with CSIRO Plant Industry and the Cotton CRC.

Having lived in rural areas as a child, Michael had his sights set on becoming a jackaroo.

But after enrolling at Queensland Agricultural College, Michael discovered a passion for agricultural science, going on to finish a degree in Rural Technology at University of Queensland.

While working as a university lecturer in agronomy, decision support and meteorology, he then completed a PhD in Crop Physiology/ Agronomy with the Agricultural Production Systems Research Unit in Toowoomba.

"I have been lucky enough to work with researchers in all parts of Australia and overseas with summer crops and pastures," he said.

"And during my time in the cotton industry I have conducted and lead research in a variety of areas, with my work now researching the management and understanding of cotton growth especially fibre quality.

"The Australian cotton industry is intelligent and dynamic and recognises that change is brought about by supporting the people and communities in which it resides."

Dr Robert Long
BAppSc (Biol) PhD

It was the mentoring of a "bizarre and interesting" biology teacher that inspired Dr Rob Long to pursue a career in science.

As a youngster, Rob only ever aspired to be a stage magician, but now working in Geelong as a postdoctoral fellow for CSIRO, the 31 year old says things have worked out for the best.

"Following the completion of a very broad undergraduate science degree and while pondering doing an honours year in molecular biology, I snagged a job in the horticultural industry working with and eating strawberries," he explains.

It was this job that steered the enthusiastic young scientist into the realms of plant biology.

"I am currently conducting plant and textile research intended to improve the quality and value of Australian cotton fibre," he says.

"I feel my research is helping to address quality issues such as the validity of the micronaire measure, and looking to see how agronomic practices like defoliation can be managed better to maximise fibre quality.

"I find it exciting to be the first to see how new CSIRO cotton varieties perform from a textile perspective.

"I am very proud to be part of such a great industry that has achieved so much and I look forward to playing a role in future achievements."

Proposed R&D Strategy for Capacity Building 2008-13
Secure the future of the industry and its capability through fostering the development of people.

Capacity: It's a 'me' thing

A recent analysis of CRDC funded PhD student's highlights the value of the investment.
Of the 76 graduates:

- 47 still work in cotton research
- 18 work other science related fields
- 3 work on farms

It is hard to imagine that the term capacity building meant much to anyone when the modern cotton industry commenced in the 1960's.

But attracting, developing and retaining capable people has always been a key to the success of the Australian cotton industry. What was it that attracted people then?

In Paul Khal's novel "Cotton Pickin' Pioneer", he describes the sense of excitement and the adversities that came with being involved with something new and promising. It was only some 20 years later that a reputation for being an innovative and profitable industry had become a drawcard for many talented people – a trend that grew as the industry itself expanded in size, location and profitability.

Growers, researchers, consultants and others were attracted by the opportunities as well as the sense of achievement and enjoyment that comes from working with other capable people. In recognition of the real value gained through investment in capacity, CRDC has continued to make large investments in developing capable people.

Recognising that capable people will continue to be vital to the future of the industry the declining number of people directly engaged in cotton production, research and the supporting service sector is a significant concern. Generational change is another important element to be considered.

"In times of drastic change, it is the learners who inherit the future. Those who have finished learning find themselves equipped to a world that no longer exists." (Eric Hoffer)

Perhaps these trends are to be expected as an industry reaches some maturity in development. No doubt they are exacerbated by drought, declining profitability and greater competition for people under high rates of employment. Similar issues and trends are being experienced in agriculture as a whole and the number of students undertaking agricultural and related science courses has also been impacted. How will agriculture and the cotton industry meet the challenge of ensuring that we have sufficient capable people into the future? And what capabilities will we need in people in the future?

They will be different, just as the skills, experience and knowledge required now are different to what they were 20 years ago. What is clear though is that we will need to continue developing world-leading researchers who can create the innovations and knowledge required by growers. And supporting growers, consultants, ginners, classers and merchants in further development of their capacity to extract the most benefit from our industry research will also be a key. While recognising that they are not separate matters, future investment in our people is no less important than investment in the research itself.

CRDC is considering what it should and can do to further assist capacity building. As the Corporation develops its next five-year strategic R&D Plan for 2008-13, under consideration is the broader rural context together with the recognition of opportunities for collaboration within our industry and with external organisations.

While these issues may be large, it will be essential for our industry that there is a well considered and cohesive approach to Capacity Building.

CRDC is considering these matters in consultation with the Australian Cotton Growers Research Association, Cotton Australia and the Australian Government.

Views from individuals and organisations are sought right up to the finalisation of the Plan in the first half of 2008. The outcomes of these deliberations will be incorporated in our next strategic R&D Plan.

Capacity Building: What is that?

Investing in Capacity Building provides people with development opportunities. For the cotton industry, these investments result in capability which is focussed on:

- research and innovation
- adaptation and adoption of research
- leadership; and
- managing change and risk.

These outcomes will be vital in addressing the increasing need for an adaptive and resilient industry.

Ask yourself some big capacity questions!

How will agriculture, and me, and the cotton industry meet the challenge of ensuring that we have sufficiently capable people for the future?

What capabilities will I need in people in the future?

Where are my gaps in current, and future capability?

How will we attract and/or develop that capability?

How will I retain that capability?